How does the landscape tell the story of the First World War?

A landscape change study of the former front zone in Flanders (Belgium)

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Dissertation submitted to obtain the degree of Doctor of Sciences: Geography

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Voorwoord

Na vier jaar is het boek bijna klaar, enkel rest mij nu nog het schrijven van het voorwoord. Na een hele periode waarbij dit boek werd geschreven vormt het invullen van deze blanco pagina toch wel enigszins een opgave. Het doet raar dat ik nu op een andere manier moet of eerder kan schrijven aan dit voorwoord in vergelijking met alle andere maanden en jaren voor dit moment. Het puur wetenschappelijk schrijven en denken zit met andere woorden nu toch wel duidelijk ingebakken in mij en moet ik nu even loslaten.

In dit doctoraat vormt de Eerste Wereldoorlog het grote thema van dit onderzoek. Maar hoe komt men erbij om dit onderwerp te kiezen als doctoraat? De oorlog is een thema dat mij al vanaf kind af aan enorm aanspreekt. Een thema dat enorm vaak werd en nog steeds wordt besproken in mijn thuisstad, de boterstad Diksmuide. Het is een stad dat in de woorden van de dichter Hedwig Speliers als het ware "uit de kraters klom". Dit stukje geschiedenis zit ingebakken in de streek en vormt een deeltje van de hedendaagse gevormde cultuur. Al gewoon rondwandelend kan je elke Diksmuideling hier gerust over aanspreken en automatisch volgen er menig verhalen. "Hier opt land ek kik vele bomn gevoen wi" is één van de typische uitspraken die vaak voorkomen. Iedereen in de streek heeft op eender welke manier wel iets te maken met de oorlog, dit via familie of via de gevonden oorlogsrestanten die nog steeds aan het licht komen na honderd jaar verborgen geweest te zijn in de bodem. Toch moet ik zeggen, dat ik na vier jaar onderzoek, nu toch wel anders naar het oorlogslandschap in de streek kijk dan voordien. Mijn denken heeft als het ware een transformatie ondergaan waarbij alles wat ik zie toch nu wel ietswat anders wordt geïnterpreteerd en bekeken dan voordien.

De Eerste Wereldoorlog in Flanders Fields, een deel van de voormalige Westerse frontlijn waar vroeger de "poppies blow, between the crosses row on row" (John McCrae), is een complex stukje geschiedenis waarbij de gehele maatschappij van gewone inwoner, van soldaat tot leidinggevende toen betrokken was. Dit vertaalde zich in een divers landschap waarbij elke individuele beslissing wel een bepaald impact had op het verdere vormen van het landschap. Dit boeiend landschap kan beter begrepen worden in teamverband waarbij verschillende disciplines betrokken zijn. Bedankt aan de GOA-groep, Timothy, Nicolas, Birger en Wouter, om samen dit interessant en bewogen stukje geschiedenis in het landschap van Vlaanderen samen te begrijpen en te verkennen. Ook bedankt aan Jean, Marc en Veerle, om het team te begeleiden door de jaren heen. Dit doctoraat werd tijdens de eindfase kritisch gelezen door de examencommissie. Bedankt aan prof. dr. Marc Antrop, prof. dr. Jean Bourgeois, prof. dr. Keith Lilley, dr. Andreas Aagaard Christensen en prof. dr. Ben Derudder om tijd te besteden aan dit doctoraat en om mij waardevol advies te geven.

Dit onderzoek werd uitgevoerd in de wereld van de geografie, waarbij de S8 in deze wereld altijd wel de thuishaven was. Echter werd de thuishaven menig maal verlaten waarbij ik op verkenning ging in andere landen. De vele congressen hierbij lieten me toe om gestaag de wereld te verkennen en om menig mensen te ontmoeten die net zoals ik geïnteresseerd waren in 'den oorlog'. Bedankt Veerle om mij als promotor in deze trips én op de thuishaven te begeleiden, en om mij een kans te geven dit doctoraat te verwezelijken.

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Hanne Van den Berghe
September 2019
Gent

Childhood memories,
formed in a everyday landscape,
in Diksmuide,
(un)knowingly linked with the First World War,
mostly unknowingly,
transformed completely now,
nothing seems that it is:
The First World War and its militarised landscape.

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Summary

The First World War (WWI) had a notable influence on the landscape at the former Western Front in Flanders, Belgium. The landscape of Flanders represents the scenery of the war, whereby warfare and human experiences are related to and influenced by the landscape and its features. Consequently, these features can change from the combat its activities resulting in another war environment with adapted or new landscape features. One can conclude that the former WWI landscape in Flanders Fields was one of the largest conflict sites in the world stretching from the North Sea to the French border in a south-west direction. As a result of the influence of the conflict, a militarised landscape was created by both temporary and permanent impact both in the material and cultural sense. In the material sense, a dense network of military constructions such as trenches, shelters and military roads developed in the area. Additionally, also military destructions took place during the consecutive battles by intense artillery shelling. Because of the static war, the same area was repeatedly shelled destroying everything. In the cultural sense, the war also left its mark on society's culture and policies of Flanders. The war left a deep wound into the local mind and memory. Therefore, it can be concluded that the WWI did not only change the landscape of Flanders Fields, hence it became the landscape; even until today. When studying the current landscape, one can conclude that this is the last witness whereby the conflict its tracks are still visible. Research on a landscape scale in a holistic manner is necessary to understand the destructive and constructive impact of the war and its consequences for the post-WWI landscape. Therefore, the main research question is: How does the landscape tell the story of the First World War?

This dissertation focused on the changing landscape of three study areas located at the former front line. Going from north to south in Flanders Fields, the Nieuwpoort, Ypres and Kemmel region were investigated. These study areas include each different landscape characteristics which led to the development of specific military strategies during WWI and also a different evolving landscape in the post-WWI period. Landscape changes were more specifically studied in this multi-site case study approach from a bird's eye perspective by means of historical aerial photographs (WWI and WWII) and contemporary orthophotos. The military historical landscape characters have been defined based on the principles of the Historical Landscape Characterisation and Landscape Change Trajectory Analyses (chapter 2). The location and nature of these historical landscape landscapes were further studied in the remainder of this dissertation in order to tell the story of the First World War in the landscape from a holistic perspective.

First, hundred years after the start of WWI, there are still WWI remains in Flanders (e.g. mine craters, bunkers, graves, trenches). These are obvious or 'hidden' WWI remains are still present in the landscape. Therefore, a landscape trajectory analysis and impact analysis was conducted that investigated the possible preservation of WWI relics in the present-day landscape (chapter 2). Second, since earlier shelling still left its imprint on the microtopography of the landscape one hundred years later, the reason for the preservation of these shell holes have been investigated (chapter 3). Third, landscape patterns were investigated and provided additional knowledge of the post-war militarised landscape. Understanding these geometrical dynamics give a more profound (qualitative) evaluation of the changing processes that occurred in the area (chapter 4). Fourth, since it is still unclear why some WWI remains are still preserved, disappeared or were demolished in the past century, an actor analysis was performed. Human decisive forces were investigated that explain the resulting militarised landscape of today by using a relational approach. Political, economic and socio-cultural actors were studied (chapter 5).

Results show that the story of the war can be told by assembling all the results of the landscape change analyses and by approaching the landscape as a system, in which all parts are connected in time and space. The results are useful for a sustainable heritage management and for further interdisciplinary research.

Samenvatting

De Eerste Wereldoorlog (WOI) had een opmerkelijke impact op het landschap aan het voormalige Westelijk Front in Vlaanderen, België. Het landschap stelt het decor voor van de oorlog, waarbij oorlogsvoering en menselijke ervaringen beïnvloed worden door het landschap en zijn kenmerken. Vervolgens kunnen deze landschapskenmerken veranderen door de uitgevoerde gevechtsactiviteiten, wat kan resulteren in een andere oorlogsomgeving met aangepaste of nieuwe landschapselementen. Men kan concluderen dat het voormalige WOI-landschap in de Vlaamse Velden één van de grootste conflictgebieden ter wereld was, dat zich uitstrekte van de Noordzee tot de Franse grens in zuidwestelijke richting. Door de invloed van het conflict ontstond een gemilitariseerd landschap waarbij tijdelijke en permanente gevolgen merkbaar waren, dit in een materiële en culturele zin. In het gebied onstond namelijk een dicht netwerk van militaire constructies zoals bijvoorbeeld loopgraven, schuilplaatsen en militaire wegen. Daarnaast vonden ook militaire verwoestingen die veroorzaakt werden door bijvoorbeeld intense artilleriebeschietingen tijdens de opeenvolgende gevechten. Door de statische oorlog werd hetzelfde gebied herhaaldelijk gebombardeerd, waardoor alles volledig werd vernietigd en er een maanlandschap ontstond. De oorlog heeft ook zijn stempel gedrukt op de toenmalige en hedendaagse samenleving en het beleid in Vlaanderen. De oorlog liet namelijk een diepe wond na. Er kan geconcludeerd worden dat de Eerste Wereldoorlog niet alleen het landschap veranderde, maar dat het ook het landschap werd, tot op de dag van vandaag. Bij het bestuderen van het huidige landschap kan men concluderen dat dit de laatste getuige is waarbij sporen van het conflict nog zichtbaar zijn. Om de destructieve en constructieve impact van de oorlog en de gevolgen ervan voor het naoorlogse landschap te begrijpen, is een holistisch onderzoek op landschappelijke schaal nodig. De onderzoeksvraag van dit doctoraat is dan ook: Hoe vertelt het landschap het verhaal van de Eerste Wereldoorlog? Deze vraag wordt ingevuld aan de hand van analyses die zich specifiek focussen op waargenomen veranderingen in het landschap.

Dit proefschrift richtte zich op het veranderende landschap van drie studiegebieden aan de voormalige frontlinie. Van noord naar zuid werd de regio te Nieuwpoort, Ieper en Kemmel onderzocht. Deze studiegebieden omvatten elk verschillende landschapskenmerken die geleid hebben tot de ontwikkeling van specifieke militaire strategieën tijdens de Eerste Wereldoorlog en ook een verschillend evoluerend landschap in de naoorlogse periode. Landschapsveranderingen werden in deze multi-site casestudie benadering meer specifiek bestudeerd vanuit vogelperspectief aan de hand van historische luchtfoto's (WOI en WOII) en hedendaagse orthofoto's. De zichtbare informatie op deze foto’s vormde de basis van deze studie. Met deze informatie vanuit te lucht werden militair historische landschapskarakters gedefinieerd waarbij de methode van een Historische landschapskarakterisatie werd gevolgd (hoofdstuk 2). De locatie en de aard van deze historische landschapskarakters werd in de rest van dit proefschrift verder bestudeerd om het verhaal van de Eerste Wereldoorlog in het landschap vanuit een holistisch perspectief te begrijpen.

Honderd jaar na de Eerste Wereldoorlog zijn er nog steeds restanten van de Eerste Wereldoorlog te vinden (vb. mijnkraters, bunkers, graven, loopgraven). Deze zijn duidelijk zichtbaar of 'verborgen' in het landschap. Daarom werd als eerste in dit onderzoek een landschapstraject- en impactanalyse uitgevoerd die de plaatsen van een mogelijke bewaring van WOI restanten in het huidige landschap aanwees (hoofdstuk 2). Ten tweede, aangezien eerdere beschietingen honderd jaar later nog steeds hun stempel drukken op de microtopografie van het landschap in de vorm van kraters, werd de reden voor de bewaring van deze kraters onderzocht (hoofdstuk 3). Ten derde werden landschapspatronen onderzocht die aanvullende kennis hebben opgeleverd over het naoorlogse gemilitariseerde landschap. Inzicht in deze geometrische waarden geeft een meer diepgaande kennis van de veranderende landschapsprocessen die zich in het gebied hebben voorgedaan (hoofdstuk 4). Ten vierde, aangezien het nog onduidelijk is waarom sommige resten van de Eerste Wereldoorlog nog steeds bewaard zijn gebleven, verdwenen of gesloopt zijn in de afgelopen eeuw, werd een

actorenanalyse uitgevoerd. Menselijke actoren werden onderzocht aan de hand van een relationele benadering. Deze actoreanalyse verklaart het gemilitariseerde landschap dat we vandaag kennen. Politieke, economische en sociaal-culturele actoren werden bestudeerd (hoofdstuk 5).

De resultaten tonen aan dat het verhaal van de oorlog verteld kan worden door alle resultaten van de analyses van de landschapsverandering samen te brengen en door het landschap te benaderen als een systeem, waarin alle delen van dit systeem in zowel de tijd en ruimte met elkaar verbonden zijn. De resultaten zijn nuttig voor een duurzaam erfgoedbeheer en voor verder interdisciplinair onderzoek.

CHAPTER 1 – INTRODUCTION

"Those of Ypres think that all of World War I took place with them"

(quote from Sandy Evrard, headline of a news article in Het Nieuwsblad, 16 April 2014, p. 10)

1.1 Prologue

This particular quote from the mayor of Mesen was published as the headline of a newspaper article in the months leading up to the centenary of the First World War (2014-2018) in the Westhoek, a region located on the former World War One (WWI) frontline in Flanders (Figure 1-1). This statement came in response to the extensive attention paid to the numerous touristic preparations executed in Ypres for the WWI-centenary. "Ypres attracts too often the attention when it comes to commemorating the First World War" (Het Nieuwsblad, 2014, p. 10), argued the mayor of Mesen. An example is the introduction of a special WWI-touristic bus line introduced by the city Ypres – which was according to the mayor his proposal - that stopped on several WWI-sites in the Westhoek. However, the established bus line would not stop in Mesen, which displeased the mayor. He noticed that bus stops were only 'granted' to cities with the same political colour (cf. christen democratic party), whereof Mesen is not part of (cf. local liberal party). Jan Durnez, the mayor of Ypres, responded on the accusations and urged other municipalities "not to wage complete nonsensical wars about the commemoration plans" (Het Nieuwsblad, 2014, p. 10).

This article was not the only published newspaper article discussing the commemorative plans of Ypres. Other newspaper articles appeared in the years before the centenary describing in a less accusatory manner towards Ypres the current state of the remembrance policy. According to these, it was the inevitable truth that most of the attention went to Ypres and much less attention was paid to other municipalities which have also a rich WWI history (Het Laatste Nieuws, 2014b; Het Nieuwsblad, 2013). Published headlines such as "Will Barack Obama come to Ypres?" and "Chinese show interest in Ypres" only reinforced the self-fulfilling truth (Het Laatste Nieuws, 2011, p. 15, 2014a, p. 19). owever, it is generally understood amongst other municipalities that it is simply a historical fact that most soldiers died on Ypresian grounds during the war. Approximately 450,000 soldiers fell in the Ypres Salient. Consequently, this area is saturated with interesting WWI relics and monuments to visit, such as the famous Menin Gate (Het Laatste Nieuws, 2014). Consequently, the Ypresian landscape is sacred in Belgium, this certainly for (mostly) the British and for other nationalities (Het Nieuwsblad, 2013).

This attention for Ypres which reinforced towards the centenary, increasingly side lined the other municipalities. As a result, they feared that fewer tourists would visit their less abundant – though not less historically important – WWI related monuments and relics. They felt themselves forgotten – both financial and cultural seen - argued the mayor of Koksijde Marc Vanden Bussche, a coastal city with has also a rich WWI-history. However, he and the mayor of Diksmuide, a city North of Ypres, argued that it is not correct of other municipalities to be jealous. Ultimately, it is not possible to change the historical facts in order to attract more tourists, argued the mayor of Poperinge, a municipality located West of Ypres (Het Nieuwsblad, 2013).

As a solution, the war should be commemorated in an appropriate way in all municipalities by organizing unique and different commemoration spatial plans and events, so that other municipalities are also worth a visit. For instance, the city of Nieuwpoort - another coastal city - established a unique visitor centre that tells the story of a striking historical event, namely the inundation of the area by the opening of the sea locks that unmistakably determined the further course of the war and stopped the German troops during their invasion in Belgium during the Battle of the Yser (18 - 31 October 1914) (Vandenbohede, 2016). Geert Vanden Broucke, the current mayor and the former head of Culture and Commemoration of Nieuwpoort, argued that the city would be taken seriously by this centre and the unique story by all other partners and tourists (Het Nieuwsblad, 2013).

The board of De Panne, another coastal city located approximately ten kilometres southwest of Nieuwpoort, suggested as another solution the cooperation between the neighbouring coastal cities (Nieuwpoort, Veurne and Koksijke) “to form a ‘front’ against Ypres” and “to ‘fight’ with Ypres for the commemoration of the Great War”, as it is not possible as a solitary municipality to compete with the city of Ypres. Only by profiling the coastal cities as a group that support each other’s activities can a counterbalance be offered against the tourist appeal of Ypres, argued Bram Degrieck, the recently elected new payer and former head of tourism. He considered the biggest Belgian military cemetery located in De Panne, as an attractive touristic attraction which would provide a counterbalance with the help of the other municipalities (De Standaard, 2013).

However, it should be noted that also Ypres foresaw problems regarding its popularity amongst tourists. Therefore, neighbouring municipalities of Ypres worked closely together with the city to prepare the centenary. Dirk Cardoen, the former mayor of Zonnebeke, stated for instance that Zonnebeke and Ypres had to try to be “as complimentary as possible” (Het Nieuwsblad, 2013, p. 17), by cooperating together and by selecting different complementary storylines in the museums to be found on both territories. Also the neighbouring villages Langemark-Poelkapelle and Poperinge worked closely together with Ypres (Het Laatste Nieuws, 2014).

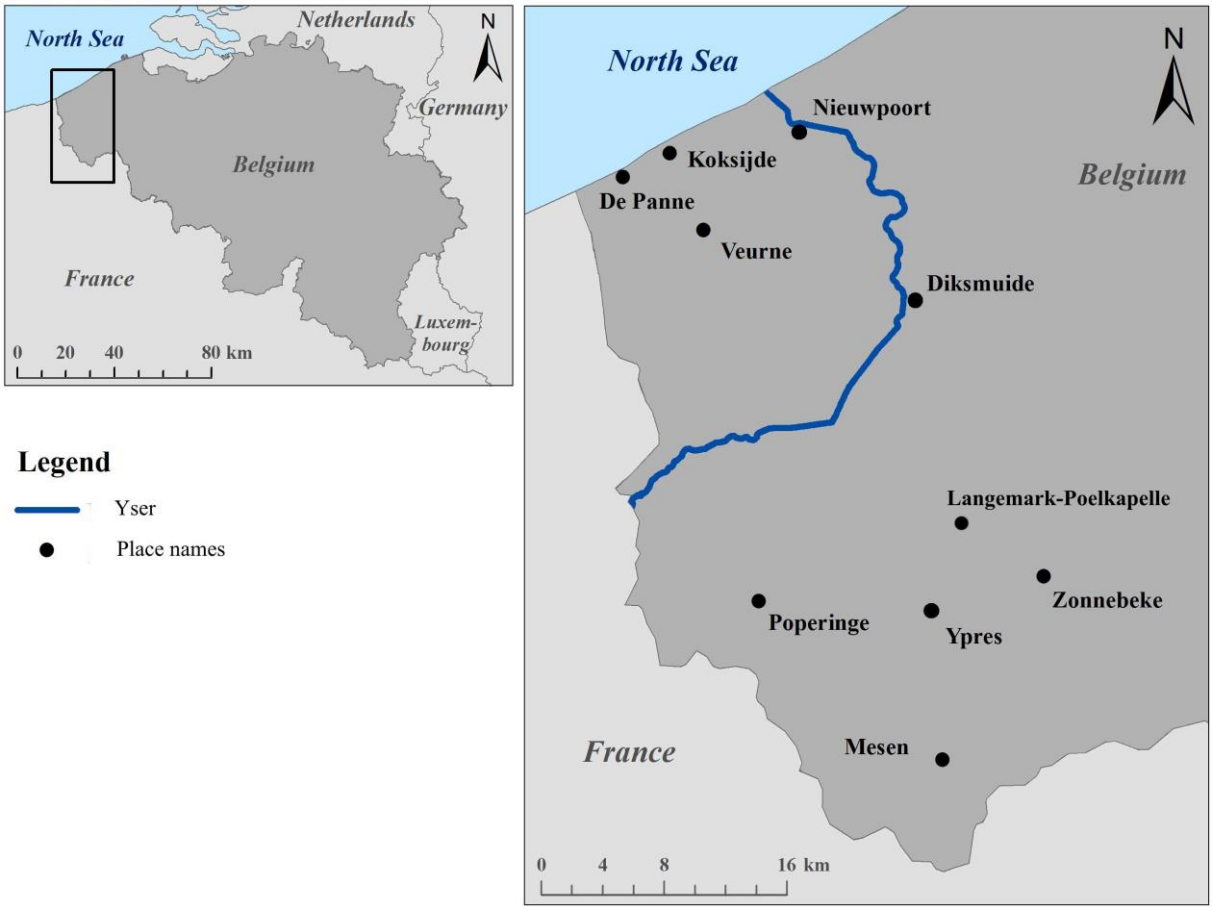

Figure 1-1 Mentioned place names in the prologue

The financial aspect of these discussions was one of the driving forces behind these discussions. To realize unique projects and plans related to centenary tourism, municipalities in the Westhoek could apply for financial support. Grants were given for scientific research, cultural-historical valorisation, educational purposes and public relations as well as for the (re)development, care and restorations of war monuments and sites. This funding was generally provided by the provincial (e.g. Province West-Flanders), regional (e.g. Toerisme Vlaanderen) or European level (e.g. project funds). However, not all municipalities have received the same subsidies. The southern part of the Westhoek with Ypres as the main city, obtained higher grants than the northern part of the Westhoek with the previously discussed (displeased) coastal cities (Figure 1-2). This imbalance in funding between the two regions is the result of many more applications from the southern part of the Westhoek, since it was argued that tourism in this area has greater economic importance than the municipalities in the north (Netwerk Oorlog en Vrede in de Westhoek, 2013). Indeed, according to a local entrepreneur of Ypres who organises battlefield tours, "the half of the city Ypres would go bankrupt if the British tourists would stay away" (Gazet van Antwerpen, 2003, p. 10). These unbalanced grants enhanced on the hand the urge and 'battle' for attracting tourists and on the other also the previous mentioned discussions between the villages and cities (Netwerk Oorlog en Vrede in de Westhoek, 2013)[1].

[1] For more information about the conducted spatial plans with these provided funding (e.g. Masterplan), see Chapter 5

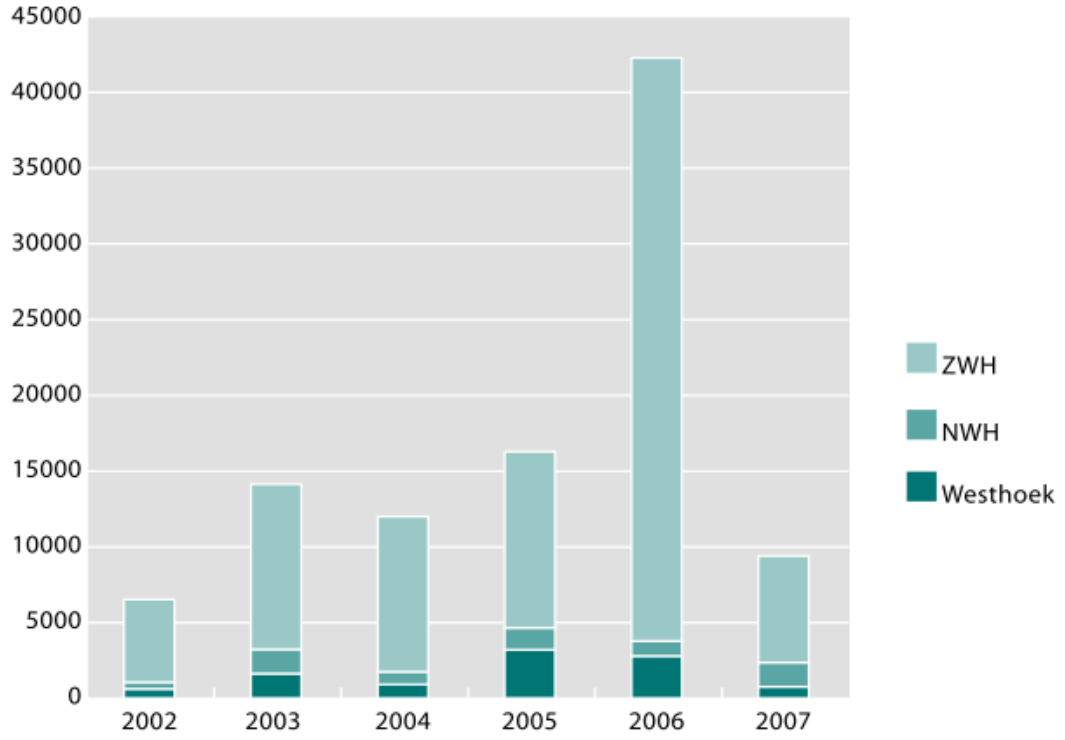

Figure 1-2 Overview provincial grants 2002-2007 illustrated per region (ZWH = Southern part of the Westhoek, NWH = Northern part of the Westhoek, Westhoek = grants in favour of both the northern and southern part of the Westhoek) (Netwerk Oorlog en Vrede in de Westhoek, 2013)

1.2 Theoretical concepts

Although the previously discussed newspapers articles in the light of the centenary primarily dealt with the distribution of public resources and the attractiveness of tourism for the local economy, one should not forget the core of the story in which the 'use' of the landscape to achieve these goals plays a central role. In order to fully understand and learn from these discussions, one must therefore understand how these stories (i.e. economy, tourism, 'equal' share of means) are linked to the landscape and to WWI, the headline of this dissertation. To dive into this, I will introduce different theoretical concepts that will be applied for the research in this dissertation.

The core in this dissertation is 'landscape', which I first need to conceptualise more precisely since this commonly used term has multiple meanings (e.g. territorial identity, expression of human beliefs and thoughts) depending on the context in which I use it and depending on the background of the user (e.g. scientist, lay people) (Antrop, 2013). Also the situation in which I used it changed constantly in the history until today (Tress & Tress, 2001).

In everyday language, the word has a rich multilingual background with subtly different meanings in each language. For instance, Dutch, American or British English, French and Spanish variants exist, making the significance of it a complex given (Antrop, 2013). Several researchers from different disciplines (e.g. humanistic geographers, landscape architects, philosophers) tried to define and understand the term more (Cosgrove, 1984; Lörzing, 2001; Olwig, 2002). They found that the Dutch term originated in Germanic languages with the oldest written evidence in the thirteenth century (Antrop & Van Eetvelde, 2017; Olwig, 2002). Words as '*lantscaf*' or '*lantscaft*' referred to an area, a territory or a region. Since then, this term has evolved gradually (Tress & Tress, 2001).

Paintings with a 'pure' focus on landscapes were first made in the Renaissance, suggesting that since then people had at least a conscious perception of the landscape (Antrop & Van Eetvelde, 2017; Olwig, 2002, 2004). Later between the 15th and 18th century, the exploration of the world - partly influenced by the cartographic developments – enhanced systematic descriptions of landscapes (Schroevers, 1982), making the landscape a well-observed phenomenon. Between the 17th and 18th centuries the concept of landscape was first introduced in science by Johann Wolfgang von Goethe (1749-1832), by Alexander von Humboldt (1769-1859), and Carl Ritter (1779-1858), amongst others scholars (Tress & Tress, 2001). Following the interpretation of Zonneveld of Von Humboldt's historical writings for instance[2], he mentioned that Von Humboldt described the landscape as "[…] *der Totalcharakter einer Erdgegend*" (the total character of a place at the earth) (Zonneveld, 1996, p. 12)[3]. This description sees the landscape as a holistic phenomenon that is an expression of the regional diversity perceived by humans (Nicholson, 1995).

After the introduction of the term in science, the meaning of the term 'landscape' was further clarified. This was for example done by adding adjectives to the term that more accurately represents the perspective of the observer (Antrop, 2013; Antrop & Van Eetvelde, 2017). For instance, the 'cultural' landscape was introduced by Friedrich Ratzel (1848-1904) in 1890 as a *Kulturlandschaf*t (cultural landscape) (Mathewson, 2011). This landscape was seen as a transformed *Naturlandschaft* (natural landscape) by human activity. Also the 'rural' and 'urban' landscape were later formulated and defined (Antrop, 2013). The rural landscape, was seen as a cultural landscape consisting of agricultural functions with the exclusion of cities and municipalities (Claval, 2004). The urban landscape[4] is an area with human agglomerations (Seto, 2013). Another way of clarifying the described landscape without the use of adjectives was for instance possible by complementing the following sentence: "A landscape seen as a..." (Howard, 2011, p. 309).

This short summary of the evolution of the term 'landscape', describes only a small part of the wide range of interpretations that have successively appeared in the past upon today[5]. The wide variety of sources and interpretations of the concept required a generally accepted international definition of the concept to conduct policy which are based on conventions (Antrop, 2013; Antrop & Van Eetvelde, 2017). An example is the definition of the 'cultural landscape' that resulted from the UNESCO World Heritage Convention which was since 1992 the first international legal instrument that recognises and protects cultural landscapes (UNESCO, 1992). Following Article 1 of this convention, a cultural landscape represents the:

> *"Combined works of nature and of man" and "embraces a diversity of manifestations of the interaction between humankind and its natural environment" (UNESCO, 1992).*

[2] I specifically mention this description because it will be discussed later in the introduction (section 1.2.2.2).
[3] Von Humboldt never used the term 'landscape' in his writings. However, the term 'landscape' became related to Von Humboldt, because Zonneveld interpreted his writings in a certain way (Antrop & Van Eetvelde, 2017).
[4] Different interpretations and definitions exist of a rural and urban landscape (Antrop & Van Eetvelde, 2017, pp. 45-46).
[5] For an extensive overview of historical definitions and interpretations related to 'landscape' see Antrop (2013) and Antrop & Van Eetvelde (2017, p. 35-60).

Another example of a landscape definition originates from the Council of Europe (2000), a result of the European Landscape Convention (ELC) organised in Firenze in 2000. This was the first international treaty including all the aspects of the landscape (e.g. landscape protection and management[6]) (Déjeant-Pons, 2006). The composed definition of the landscape goes as follows:

> *"Landscape is defined as an area, as perceived by people, whose character is the result of the action and interaction of natural/or human factors" (Council of Europe, 2000, p. 2)*

In other words, following Howard's predetermined sentence to describe and clarify a discussed landscape more profoundly, "the landscape is seen as" (Howard, 2011, p. 309): A territory or land unit as seen by people, being unique and having a particular identity, which is a dynamic and always changing phenomenon expressed by actions and interactions between natural and human processes (Antrop & Van Eetvelde, 2017). The latter indicates that the landscape is the result of constant changes in the past and will always change in the future (Déjeant-Pons, 2006).

In this dissertation, the landscape will be approached following the definition of the Council of Europe, with the main focus on the ongoing (i) changing landscape, expressed by (ii) the action and interaction between natural and human factors, forming an (iii) unique character. Because the subject of this dissertation is WWI I will apply this definition to a particular form of landscape, namely the militarised landscape within the context of the discipline of geography. This will be further elaborated in following sections.

1.2.1 Action and interaction between natural and human factors

In this section, military geography, the militarised landscape and the 'warscape', are discussed. This more specifically in the context of the action and interaction between natural and human factors (Council of Europe, 2000).

1.2.1.1 Military geography

Geography is about:

> *"(…) writing the earth, and that writing necessarily requires us to document what is there and what is where. This is an important task in its own right, but also has its limits. Description of what is where doesn't automatically bring with it an explanation of what happens as a consequence of things being where they are. Explanation follows from description – the 'why?' of 'where?'. This involves explanation of location and explanation of process and change" (Woodward, 2004, p. 8).*

Military geographies - being one field of research in geography - "[…] are everywhere; every corner of every place in every land in every part of this world of ours is touched, shaped, viewed and

[6] Landscape management is used to describe the policy and regulation of the landscape.

represented in some way by military forces and activities'' (Woodward, 2005, p. 719). Indeed, if one would attentively look outside, militarised elements can be recognised everywhere.

The reason behind the abundant military findings is due to the fact that the militarisation of a space – as the (mis)use of it as a military 'tactic' or aim - is historically seen a popular phenomenon and is visible in an area through the remains of different layers of history. Militarisation processes head (at least) back to the Persian-Scythian War of 512 BC, where crops and food were completely destroyed by the Scythians when they gave up their land for the advancing Persian army. By doing so, they hinder the advancing Persians who have to adapt the destroyed landscape in order to survive (Ross, 1992). Also, the Punic War (149-146 BC), the sacking of Rome (455), Thirty Years' War (1618-1648), US Civil War (1861-1865) and the War of the Triple Alliance (1864-1870) amongst others, also changed the environment for military purposes (Westing, 1980).

Because of the extensive use of military strategies in history, many studies analysed one particular aspect of the conflict that focuses on either human or natural topics (e.g. politics, economy, culture, psychology, ecology, environment) (see examples in Feaver, 1999; Finer, 2002; Gal & Mangelsdorff, 1991; Gupta et al., 2001; Kier, 2017; Rosen, 1991; Singer, 2003; Stepan, 1988). Military geography brings both aspects together and studies the specific relationship between humans in conflict and the environment. To survey the military aspects, this research field uses geographical techniques (e.g. mapping, surveying). This worldwide practised field of research in geography is often involved in military affairs in the service of the state or the empire to provide military power and control (Woodward, 2005).

Military geography studies the earth by focusing on specific defined spatial units such as military spaces, places, environments, and landscapes. The study of military spaces that includes specific locations defined with geographical coordinates (Matthews & Herbert, 2013), investigates the military control in the space, both of foreign and domestic armed forces. This study also researches the needed space for military activities and the transparency of the military land use towards the public by means of available and reliable data (such as maps, documents) (Woodward, 2004). The study of military places that are bounded areas or territories (Matthews & Herbert, 2013), focuses on the (un)measurable effects of military presence and control of the place, for example from a social and economic point of view (Woodward, 2004). The study of military environments tries to understand the effect of military activities on the environment (Matthews & Herbert, 2013), how this process went gradually, and how the environment influenced the military activities. Military pollution and environmental modifications are two of the studied subjects amongst others. Last, the study of military landscapes discusses military ways of seeing, reading and representing the landscape as a totality (see 1.2.1.2) (Woodward, 2004), including space, place and the environment (Matthews & Herbert, 2013).

The study of spaces, places, environments and landscapes can be approached by three different 'types' of military geography: traditional, political or critical (Woodward, 2005). First, the traditional approach considers itself as 'applied' geography by using geographical applications and techniques in the military context to survey and analyse one of the defined spatial units (Palka & Galgano, 2000; Woodward, 2005). The use of geographical techniques for warfare is a well-documented topic (Woodward, 2014). However, the two leading techniques are remote sensing (e.g. aerial photographs) and Geographical Information Systems (GIS), that became better developed because of military interests (Cloud, 2002). Second, war-related political or geopolitical approaches focus on the study of the causes and spatial and territorial consequences of the conflict (Mamadouh, 2005). For instance, changing patterns of human settlement or social polarisation related to terrorism are studied subjects (Gramah, 2004). Thirdly, the critical military approach has developed in response to the traditional approach described above. Following the critical approach, the traditional approach focused only on the efficiency of military actors and actions ignoring the broader framework of

warfare (Woodward, 2014). Therefore, this 'beyond armed conflict' approach studies the totality of the conflict and its related military activities. Following Woodward (2005), "[…] the actual pursuit of armed conflict is only a part of the conflict" (p. 730). In other words, military influences reached further than the actual conflict. Consequently, all the aspects related to the conflict are from importance (Russell, 2010); this economic, political, cultural and social seen. The military space, place, environment or landscape can be seen and studied in different 'modes of visibility' (e.g. invisible and visible military elements) and also in a 'more-than-visual-mode' (e.g. habits and feelings of civilians toward the conflict) (Woodward, 2014, p. 49). This approach first sees the spatial unit as a place without military interference in land uses. Afterwards, military influences occur because of military presence and change, this besides the spatial patterns and land uses of the region and also other related political, economic, cultural and social aspects. This approach therefore examines the spatial unity from different angles and interests (Woodward, 2005). This is necessarily an issue that requires interdisciplinary cooperation to fill the gaps in knowledge, as a range of methodological approaches from different disciplines contributes to the understanding of the whole military process (Woodward, 2014).

Indeed, the landscape is a boundary-crossing subject (Antrop & Van Eetvelde, 2017; Tress et al., 2003). The critically examined military geography is defined as:

> *"The study of the geographies of militarism and military activities that is capable of understanding their full geographical constitution and expression" (Woodward, 2005, p. 720).*

Geographies of militarism are the "patterns of material entities and social relations across space shaped by the production and reproduction of military capabilities" (Woodward, 2005, p. 271), in order to promote or preserve the armed forces of a nation to be prepared for potential future events (e.g. attacks or national events) (Vagts, 1959). An example of this is an annual parade to profile the nation as a superpower. Geographies of military activities are the military activities that shape civil space and social relations through military objectives, rationalities and structures that deliberately focus on military influence in civilian areas or as a by-product of those military processes (Johnson, 2005; Woodward, 2005). The difference with the geographies of militarism is that the geographies of military activities are set up to create the means that a nation really needs for defence (Vagts, 1959). Examples of military activities are the implementation of strategies and tactics and the setting up of organisational structures or land or air forces (Woodward, 2005). In order to understand the full geographical constitution and expression of both the geographies of militarism and military activities, critical military geography studies the influence of the physical and cultural environment on military activities, plans and programs on divers geographical scales (global, regional and local level) (Collins, 1998); examined for both historical or contemporary conflicts according to the interests (Woodward, 2005). The determined physical and cultural factors of influence are represented in Table 1-1 (Caldwell et al., 2004; Collins, 1998; Rech et al., 2015; Woodward, 2005).

Table 1-1. Geographic physical and cultural factors of influence on military activities (Collins, 1998)

Physical factors	Cultural factors
Spatial relationships	Racial and ethnic roots
Topography and drainage	Population patterns
Geology and soils	Social structures
Vegetation	Languages and religions
Oceans and seashores	Industries and land use
Weather and climate	Transportation networks
Daylight and darkness	Telecommunications
Gravity and magnetism	Military installations

1.2.1.2 Military landscape research

As previously mentioned (section 1.2.1.1), military geographers can specifically focus on the impact of military activities on the landscape (Woodward, 2004). The focus on the landscape as the main study subject contributes to the interests formulated by the previous discussed critical military geography. These military landscape studies are:

> *"The key insight […], to show how military power is spatially and temporally constituted. […] The study of landscape brings to critical military studies an appreciation of textured, spatialized, placed, experimental and embodied nature of militarism and militarization, its origins and its consequences made visible and tangible. […] It raises questions of temporality, of the reach of military power across time (environmental change, memorial practices, and the celebration of redundant sites as heritage are examples), and of the repetition of militarizing practices across space and time. It also raises questions of scale and connectivity between local individual sites, subnational or regional practices of defence, and national military and defence policies, all within the context of global geopolitical relations" (Woodward, 2014, p. 41).*

In other words, landscape studies increase the insight into the operational military forces in a region, paying attention to the actions and interaction between nature and human aspects in the landscape that are associated with the conflict (Daly et al., 2018; Woodward, 2014). By studying both aspects in an integrated manner, both physical and human dimensions reveal the dynamics of the militarised landscape (Matthews & Herbert, 2013). Landscape approaches specifically related with militarised environments, define the 'landscape' as:

> *"Landscape which reflects in their constitution and expression the imprint of military activities, militarism and militarization" (Woodward, 2014, p. 41).*

The landscape is described as the 'stage' or scenery of a conflict (Pearson, 2012), characterised by human and natural factors (Figure 1-3, A), which can be described as the socio-cultural and biophysical factors. In this scener - which is first in 'peace' - human mobilise[7] in function of the conflict and have an effect upon the biophysical conditions and change it (Figure 1-3, B), either temporal or permanent. On their turn these changes or adaptations have an effect upon the following human actions of the conflict and thus people will adapt their behaviour according to the different biophysical conditions (Figure 1-3, C) (Pearson et al., 2010), as warfare and human experiences are namely influenced by the biophysical context and its features. Consequently, adapted combat and related activities change again the environment, etc. In this ongoing reciprocal relationship characterised and lead by the conflict (Coates et al., 2011), we cannot consider anymore "war and landscape as separate realms" (Pearson, 2012, p. 1). They are inseparable connected with each other, like 'Siamese twins' (Larsen, 2004, p. 468).

[7] Mobilisation in this context is defined as "the action of organizing and encouraging a group of people to take collective action in pursuit of a particular objective" (Oxford Dictionary, 14 June 2019). The objective in this dissertation is conducting war.

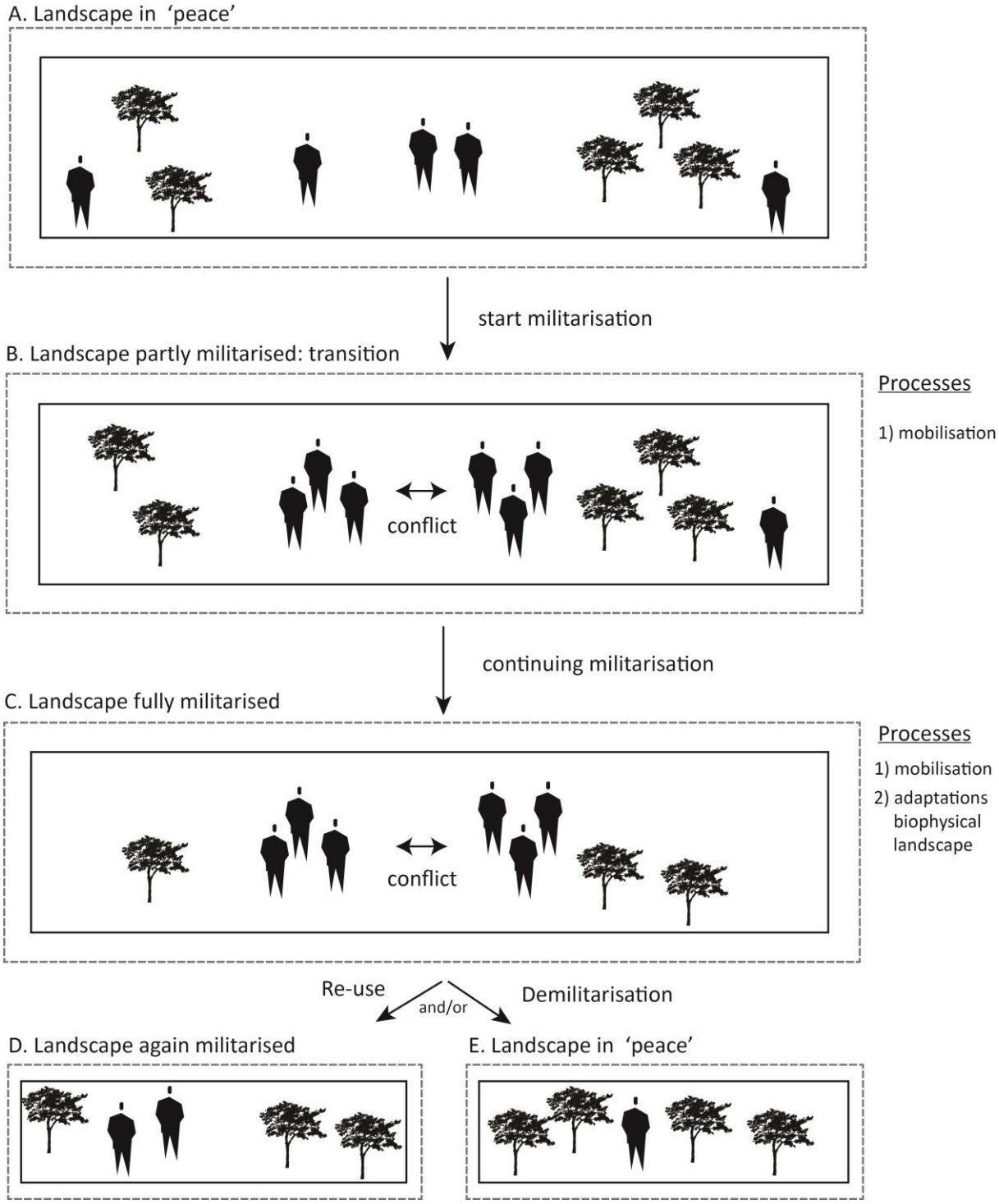

Figure 1-3. Process of militarisation in a landscape towards a militarised landscape with the action and interaction between natural and human factors (source: author, according to the interpretation of multiple theoretical concepts) (Note: (Inter)actions between human and natural factors already happened in the pre-existing non-military phase. Hence, this figure only represents war-related (inter)actions)

Landscapes are directly intended to be partly or fully mobilized for military purposes, which can be divided into three specific main objectives (Pearson, 2012). As the first military purpose, landscapes are mobilised before the physically executed battlefields in order to prepare the war. For instance, woodland is exploited for weapons, training areas are selected (Bušek & Reif, 2017), soldiers are recruited or weapons are tested on suitable bare and empty ground depending on the type of

weapon. In the case of heavily destructing weapons, landscapes are completely 'sacrificed' for the national interests (Kuletz, 1998). As the second purpose, landscapes are being mobilised for the battlefield. In the battlefield, combats are fought "in and against the landscape'' (Warnke, 1994, p. 61). This quote from Warnke (1994) represents the battles that take place in the landscape (O'Sullivan & Miller, 1983), since all landscape features form the scene of the battle. On the other hand, it emphasises the battle against the landscape. The physical terrain and climate for instance are often seen as an 'enemy' and need to be taken into account by adjusting combat strategies. In addition to the struggles against terrain and climate, also struggles take place against vermin (e.g. insects and rats) (Jansen, 2000; Russell, 2001). On the contrary, the environment and its terrain are also often seen as a 'friend' to warfare. For instance, appropriate weather conditions can aid in the success of a military operation or can delay the approaching enemy (Keegan, 1993; Winters, 2001). Animals living in the environment, such as carrier pigeons, hungry cats chasing mousses and spying marine mammals (Hediger, 2012) are also sometimes useful. The latter was recently confirmed in newspapers with the story that Russia uses intelligent white dolphins for espionage purposes (De Standaard, 2019b). Lastly, as final purpose, landscapes are also mobilised in the related home front of combatants and have an impact upon non-combatting people and their environment (Tucker & Russell, 2004; Westing, 1980). For instance, the home front is responsible for the manufacture of weapons and for the supply of food or the people their political attitude can change (Pearson, 2012). This impact not necessarily needs to be negative and can also have a positive effect on societies, such as when supply shortages in wartime lead to a programme to combat waste in favour of the environment by sorting, recycling and reusing waste (e.g. recycled paper and textiles) (Cooper, 2007).

The three previously mentioned military objectives can be regarded as part of the process of 'militarisation' that is defined as:

> *"A process that occurs through, and leaves its marks on societies, economies, cultures and political structures. It also operates through landscape, which it changes or maintains, in both physical and cultural sense" (Pearson et al., 2010, p. 3).*
>
> *"The multi-faceted set of social, cultural, economic and political processes by which military approaches to social problems and issues gain both elite and popular acceptance" (Woodward, 2014, p. 41).*

The process of militarization creates a militarised landscape (Pearson, 2012) or military landscape (Woodward, 2014) including both natural/biophysical and human factors, which is defined as:

> *"Simultaneously material and cultural sites that have been fully or partially mobilized for military purposes" (Coates et al., 2011, p. 458).*
>
> *"Sites that are partially or fully mobilized to achieve military aims, including both military bases and battlefield" (Pearson, 2012, p. 2)*

This process of militarisation leading to a military landscape must be approached in the broadest sense of the word. Firstly, this process is often of longer duration and is spread over larger areas than the actual well-known battlefields. These battlefields are often geographically and temporarily well-

defined events with a rapidly and dramatically changing landscape, usually described in detail in historical sources (Pearson, 2012). However, militarisation knows a longer aftermath on a larger area. Therefore, the first-impulse concept needs to be extended and reformulated into the expanded concept (Table 1-2) (Russell, 2010). For example, there are benefits rather than only damage to a militarised landscape, such as the preservation[8] of habitats and species at military secret training sites, by keeping agriculture and urbanism away (Blacksell & Reynolds, 1987; Bušek & Reif, 2017). Secondly, in addition to the intentional actions, the militarisation of the landscape can also produce unintentionally indirect changes in the landscape. For instance, warfare has a devastating effect on common practices that have had a negative impact on the environment (e.g. industry, vehicles pollutions), resulting in improved air quality (Reuveny et al., 2010). Also the ecological values of a natural park and its habitats close to war material producing factories can be influenced by the pollution of this war industry. Thirdly, the militarisation of a landscape is not often completed for all the aspects of a landscape (human and natural factors). The intended destruction of an environment during a battle, for example, often does not fully succeed because there is still life in nature such as birds that are not affected. Fourthly, militarised landscapes cannot be unambiguously defined for all people whereby the defined landscape sometimes overlaps with non-militarised civilian landscapes as each person looks differently to the militarised landscape. For soldiers, for example, see the militarised landscape differently than civilians because they automatically select only characteristics of interest in the landscape in order to survive (Pearson et al., 2010; Woodward, 2004, 2010).

Table 1-2. Features and concepts linked with militarised landscapes (after Russell, 2010)

Feature	First-impulse Concept	Expanded Concept
Time	Wartime	Continuous
Space	Battlefronts	Anywhere
Actors	Armed forces	Potentially anyone
Type of action	Combat	Combat, plus the more lasting impacts from manufacturing, agriculture, weapon testing and other activities that support armed forces
Type of effects	Harm	Harm and benefit
Visibility of effects	Obvious	Obvious to invisible

Notably, after the conflict can also landscape demilitarisation processes (Figure 1-3, E) occur as the militarisation of the landscape is not the main objective anymore. This demilitarisation process can provide costs (e.g. costs to remove military features) or benefits (e.g. higher employment) (Woodward, 2014). Besides or together with the demilitarisation, also the re-use of a militarised landscape can occur (Figure 1-3, D). This re-use can be performed in the context of a new conflict whereby old military remnants are recuperated or can be executed by civilians that have to live in a militarised landscape and have to re-develop the military areas (Jauhiainen, 1997).

[8] When 'preservation' is used in this dissertation, I refer to an object, remnant or other that is being preserved specified by a degree of preservation (Oxford Dictionary, August 2019)

1.2.1.3 The 'warscape'

One might consider if the landscape with military influences and that in turn influences warfare, can be described as a 'warscape' instead of a 'militarised landscape'. This use of the term 'landscape' in a less strict sense is not new and can be demonstrated with three different cases with each a different purpose. Firstly, the term 'landscape' has been widely used in recent decades as a metaphor for other studied phenomena. Some examples are: the 'political landscape' that describes the politic discourses and narratives in a community, the 'media landscape' that clarifies the variety of media types, and the 'bodyscape' that is a metaphor for the body-language (Antrop, 2013; Hjarvard, 2010; Johnson & Orbach, 2002; Krackhardt, 1991; Porteous, 1986). However, these metaphors do not represent or analyse delimited areas of research, which makes these vague and unsuitable for scientific purposes. Secondly, another variant is the combination of the term 'landscape' with the phenomenon being studied in the landscape, such as the 'heritage-scape' that the study of heritage in a landscape suggests (Elerie & Spek, 2010), or an 'ethno-scape' that represents the study of emigrations and their established cultures in the landscape (Nordstrom, 1997). Lastly, the concept is often emerged with the methodology being used for the analysis of the landscape, creating new '-scapes' such as the 'air-scape' that represents the study of the landscape from the sky, or the 'motion-scape' that analyses the movements of human in the landscape (Derui et al., 2016).

It can be concluded that the 'warscape' is a compilation of the terms 'landscape' and 'war', that emphasizes and summarizes the phenomenon under study in the landscape - namely the war - into a single word that is similar to the case of a 'heritage-scape' and 'ethno-scape'. However, the term 'warscape' is not new and was already introduced in 1997 by the anthropologist Carolyn Nordstrom (Korf et al., 2010). This term is used to describe the study of the war in the landscape by analysing actions of human actors such as armies, soldiers, refugees and other interest groups. (Inter)national entrepreneurs and policymakers are also involved in the (post/pre-) war network by supplying goods or pursuing war-related policies. All these groups continuously act and interact with each other, creating a cultural construction or living world caused by the conflict. This construct is a complex and dynamic given which is constantly reconfigured across time and space (Nordstrom, 1997). These dynamic changes of social actors in the 'war landscape' forge alliances or cause fear against the enemy. This gives rise to war strategies such as innovations in communication and the technical capacity and development of weapons that are useful for warfare (Hoffman & Lubkemann, 2005). To summarize, the study of the 'warscape' analyses historical and contemporary anthropological trajectories in the landscape related to war events.

Following the definition of the Council of Europe (2000), we can conclude that the study of the 'warscape' from anthropological studies does not include all aspects of the landscape formulated by the official definition and cannot be used to discuss the studied WWI landscape as a totality. However, this term does include part of the definition of the term 'landscape', namely the "[…] actions of human factors" in the landscape (Council of Europe, 2000, p. 2). Subsequently, when in this dissertation the term 'warscape' is used, I refer to the actions and network of human factors in the landscape (Chapter 5).

1.2.2 Changing landscape and unique character

1.2.2.1 Military landscape dynamics

Change is "the difference of the state of an object, place or area between at least two moments in time" (Antrop & Van Eetvelde, 2008, p. 185). Change is also an inherent characteristic of the landscape (Baker, 1989; Bürgi et al., 2004), which is defined as a different perceivable form of the landscape seen from different moments in time[9] (Antrop, 2003; Van Eetvelde & Antrop, 2009), resulting from the previous discussed ongoing reciprocal military "interaction between natural processes and human activities" (Antrop & Van Eetvelde, 2008, p. 183; Forman & Godron, 1986; Pearson et al., 2010). These interactions that cause changes are also called the driving forces (Bürgi et al., 2004), keystone processes (Marcucci, 2000) or drivers of change (Wood & Handley, 2001). Analysing these driving forces is complex as they form a network of dependencies, interaction, feedback loops on several temporal and spatial levels, which can be according to Bürgi et al. (2004) divided into socio-economic, political, technological, natural and cultural driving forces.

The nature of changes in the landscape differs in time and space (Antrop, 2003, 2005). Generally, change has six dimensions which can also be recognised in the landscape (Table 1-3): frequency or rhythm of changes, speed of change, the magnitude of change, reversibility, cause of change and impact (Antrop & Van Eetvelde, 2008). For example, land cover may change into a new type caused by different successive land use practices (e.g. demanding larger areas, removal of hedgerow) (Antrop, 2003). When changes gain outstanding speed and scale, there is a possibility that the continuity of the landscape - which is the "way each historical period inherits characteristics from the previous ones" - becomes broken (Antrop, 2003, p. 5-6). In the event of a break, a visible 'fracture' can occur with the past because new landscape elements and structures are introduced and are not integrated with the former landscape, but are superimposed over the former landscape elements. These changes happen (more or less) simultaneously, generating an overall transformation of the landscape in many of its components (Antrop, 2003).

Table 1-3. Dimensions of change (after Antrop & Van Eetvelde, 2008)

Factor	Examples
Frequency	Regular, common, 'normal', exceptional
Speed	Gradual evolution, catastrophic event
Magnitude	Area, spatial extent, nature, affected features
Reversibility	Cyclic, irreversible
Causes	Nature and/or human
Impact of change	On everything, on some specific features
Frequency	Regular, common, 'normal', exceptional

Military landscapes are also the result of changes in landscapes, caused by the process of militarisation during the conflict or other post-war natural and/or human processes (Pearson et al., 2010; Woodward, 2014). These military landscapes "are always shifting and changing" (Woodward,

[9] Perceivable differences or changes in the landscape are strongly dependent on the studied time frame and on the type of visualisations or documents being used for analysis. These are not comparable or can differ in the level of detail (e.g. old maps versus remote sensing data) (Antrop, 2003).

2004, p. 9). For instance, military establishments can change into civilians facilities (cf. impact of change) or patterns of military residences may change constantly (cf. frequency) (Woodward, 2004).

1.2.2.2 Military characters

According to the Oxford dictionary, the term 'character' is defined as "the distinctive nature of something" or as "the quality of being individual in an interesting or unusual way", applied to people and objects (www.oxforddictionaries.com, 7 May 2019). In this context, landscapes can also differ from each other and have also a distinctive nature or character.

Already in the beginning of the 19th century (1807)[10], the term 'character' was related to a landscape when von Humboldt[11] described a landscape as "*der Totalcharakter einder Erdgegend*" (the total character of a region) (Hard, 1970; Schmithüsen, 1964, p. 157; Zonneveld, 1995). With these words he illustrated that the landscape must be approached and described in the broadest sense (Antrop & Van Eetvelde, 2017), by seeing and describing the landscape as a 'whole' (Cosgrove, 1998; Council of Europe, 2000b) and thus defining its total character.

This idea of Humboldt joins the concept of 'holism', which forms the basis of the identification of a landscape character (Antrop & Van Eetvelde, 2017). "Holism is […], a dimension which is not captured by the mere enumeration of constituent parts" (Cosgrove, 1998, p. 28). This implies that all the landscape elements only mean something by linking them to their context and to their unique position in the 'whole' (Antrop, 1998). Indeed, each element gets its meaning by connecting it to the surrounding elements. When changing one element, the 'whole' will change in some way (Antrop, 2000). To study this 'whole' or 'totality' (Cosgrove, 1998), collaborations between different interdisciplinary approaches can help (Palang & Fry, 2003). This makes it possible to define the uniqueness of a landscape (Antrop & Van Eetvelde, 2017).

The complex and region-specific action and interaction of natural and human activities – as described in 1.2.1 – creates the landscape character (Council of Europe, 2000b). The extent to which human and natural processes interact or have interacted with each other than determines the character. Therefore, all the landscape elements (e.g. buildings, infrastructure) and components (e.g. terrain, parcelling), should be linked and studied in relation with each other. Thus, a landscape character can be seen as a 'profile' of the land "in terms of climate, geomorphology, topography, soils and the associated natural vegetation and land use" (Wascher, 2004, p. 238).

Defining a landscape character can be done in several ways that have developed over time. In the late 1980s in the UK, the Landscape Character Assessment (LCA) developed and is a methodology that classifies characteristics of the landscape in order to describe the character by focussing on the biophysical part of a landscape. In this approach, however, the role of human processes and the historical evolutions in the forming of the character of a landscape was underestimated. Therefore, the Historical Landscape Characterisation (HLC) was established in 1990s and addressed these shortcomings. This methodology adopted the LCA approaches but adapted these (Fairclough, 2003;

[10] The term 'character' knew an evolution in history. Also other authors were studying and describing this concept.
[11] See also footnote 3.

Turner, 2006). Consequently, the emphasis of the HLC was more put on the historical aspects of human interaction with nature; this both in a historical and archaeological sense.

In this methodology, landscape characters are defined by analysing landscape attributes that include aspects of both the natural and built environment (e.g. current and past land use, place names, geology, soil, field morphology,…) (Clark et al., 2002). Afterwards, these attributes are hierarchically grouped by assessment and interpretation (Herring, 2009). In the end, the historic landscape character types (HLC types) are formed (e.g. woodland, settlements, water bodies, …) that can be subdivided into subtypes (e.g. HLC type water bodies with HLC subtypes drinking pool and fishery lake). HLC types offer the understanding of the time depth of a landscape which is useful for planning processes or spatial development (Fairclough, 1999, 2003). Notably, this methodology fits well with the concepts of the ELC (see 1.2) as on the one hand the character is approached by natural and human factors and on the other hand the methodology helps to demonstrate that the landscape is and has always been a dynamic feature (Herring, 2009; Historic England, 2019; Turner, 2006).

The historical character of a landscape can also be defined as a 'military character'. This military HLC type was for instance defined in Cornwall (Devon, UK) by the Cornwall County Council in 1998. The county located military sites and defined other military influences in the landscape by using aerial photos and thematic maps. The attributes used in this HLC type were on the one hand defined and perceived as extensive modern military complexes that are safely fenced and on the other hand disused airports of the Second World War (WWII). The following subtypes were identified: WWII military airfields, barracks, artillery complexes and military communications. Sometimes the military complexes were too small in size to be part of this HLC-type or they were not seen as primary military structures. These areas were linked as a secondary subtype to another HLC type. After defining the military HLC type, the historical, communal and aesthetical value was studied and recommendations were made to protect this type (Clark et al., 2002; Cornwall Council, 2019; Cornwall County, 2011; Herring, 1998).

Another example of a defined 'military character' comes from the characterisation carried out in the North West of England. This character includes WWII military camps, buildings, and barracks. In the accompanying characterisation report, possible change scenarios (e.g. abandonment, modernisation) and their effect on the character (a negative or positive effect) were discussed (Natural England, 2010).

1.3 The study area of the former front zone in Flanders (Belgium)

The former WWI landscape in Flanders Fields was one of the largest conflict sites in the world stretching from the North Sea to the French border in a south-west direction (Figure 1-6) (Chielens et al., 2006). After the Battle of the Yser (18–31 October 1914) and the First Battle of Ypres (19 October – 22 November 1914), the same area was shelled for four years as the front line became largely static[12] (Doyle, 2014; Fitzgerald, 1934). Consequently, on the one hand, a dense network of military constructions such as trenches, shelters and military roads developed in the area (Figure 1-4). On the other hand, military destructions took place during the consecutive battles by intense artillery shelling (Figure 1-5). Because of the static war, the same area was repeatedly shelled destroying everything (Van Hollebeeke et al., 2014). This militarised landscape still has – even after a hundred years – an abundance of (in)visible WWI remains in the current landscape. Moreover, the war not only caused physical damage to the landscape, but also left a deep wound into the local mind and memory. Therefore, we can conclude that the WWI did not only change the landscape of Flanders Fields, hence it became the landscape; even until today (Miles, 2016).

Figure 1-4 German trench map of Ypres with British military constructions saturating the area indicated by red marks (April 1918) (Bracke et al., 2018)

[12] The following quote represents the situation during the static war: "See the little stream – we could walk to it in two minutes. It took the British a month to walk to it – a whole empire walking very slowly, dying in front and pushing forward behind. And another empire walked very slowly backwards a few inches a day, leaving the dead like a million bloody rugs" (Fitzgerald, 1934, pp. 84-85).

Figure 1-5 View on the destructed landscape with a shell hole in the front with temporary graves of the 'missing' at Sint-Juliaan, northeast of Ypres (Verdegem et al., 2018)

To be able to study the relation between war and landscape in the vast area of the former front zone, three transects (or study areas) are selected that cover the frontline and the hinterland of both the Allied and German forces[13] (Figure 1-6). These were selected from north to south each including different landscape characteristics on the former frontline. There is an undeniable relationship between the military features and landscape characteristics (Chielens et al., 2006; Johnson, 1917), which led to the development of specific military strategies in each study area adapted to the corresponding landscape features (Doyle, 2014). This multi-site case study approach - or also called the collective case study approach - has the advantage that the research questions of this dissertation (section 1.5) can be investigated within different contexts where after results can be compared (Mills et al., 2009).

[13] These areas were selected as part of an interdisciplinary project and were useful for the objectives of each discipline (see more in section 1.6).

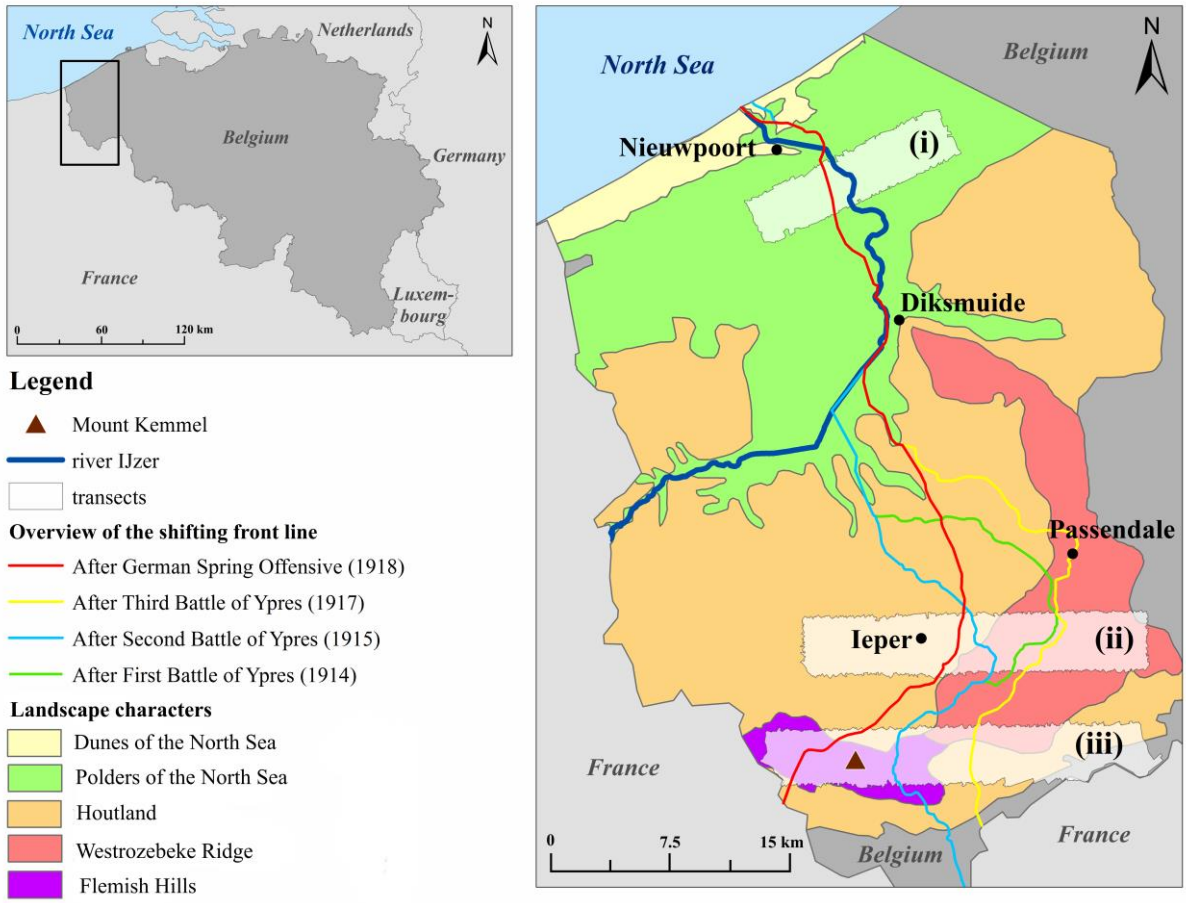

Figure 1-6 Transects and the associated landscape units

The most northern study area (i) covers the area (43.4 km^2) southeast of the city of Nieuwpoort and is intersected by the Yser river. This area is part of the flat low-lying coastal plain of Flanders region (Bertrand & Baeteman, 2005). Before the 12th century, this plain was a flood plain that jeopardized civilization as the floods steadily extended further into the inland (Tavernier et al., 1970). Therefore, from the 12th century onwards, the region was transformed by locks, dikes and drainage ditches into artificially drained areas or 'polders', making it habitable and dry (Vandenbohede, 2016). Small-scale drainage projects were first mentioned in literature in 1142, which were mainly the work of abbeys. These abbeys started to drain areas alongside the most important rivers such as the Yser river. In the years that followed, the number of areas drained steadily increased (Tavernier et al., 1970) (Figure 1-7).

Figure 1-7 Study area Nieuwpoort with the Yser river (left) and the 'Polders' (right) (source: author, 11 August 2017)

In the beginning of the war, most of Belgium was taken in by the German Army. However, attempts were made to stop these advancing troops in the last unoccupied area near the coast, which resulted in the Battle of the Yser (18 - 31 October 1914) (Vandenbohede, 2016). During this battle, the Allies inundated large parts of the 'polders' with up to 1 m of seawater by opening the locks of the Yser river in the coastal city of Nieuwpoort (Barton, 2008). To do so, an extensive knowledge of hydrology was required to carefully control the inundation. Experts decided that the 'polder' area between the left bank of the Yser river and the elevated Nieuwpoort-Diksmuide railway embankment was the perfect area to flood. The inundation started in October 1914 and lasted until 1918 (Figure 1-8) (Vandenbohede, 2016). By causing this inundation, the Belgians and Allies succeeded in effectively stopping the German offensive (Barton, 2008). Consequently, throughout the rest of the war, German troops were located on the right bank of the Yser river and Belgian and Allied troops were positioned west of the railway. Notably, both sides had installed a number of outposts on topographical elevated areas in the inundated area (e.g. Stuivekenskerke) (Vandenbohede, 2016).

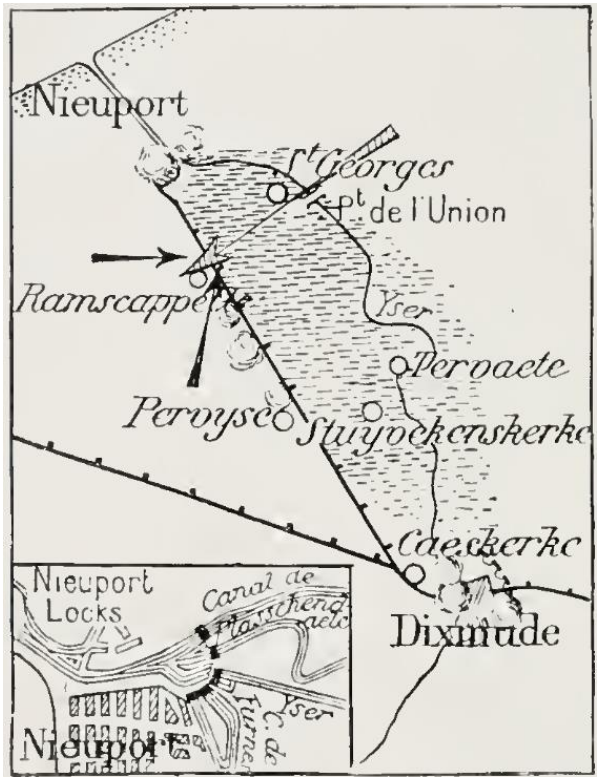

Figure 1-8 The inundated area between the Yser river and the railway (Michelin and Cie, 1919)

The second study area (ii) extends over the area (81.6 km^2) around the city of Ypres and is part of the clay plain of Flanders region (Doyle et al., 2002) (Figure 1-9). The area consists of heavy Ypresian clay ('blue clay') and sand deposited by erosion of surrounding land masses when Belgium partly formed an inland sea during the beginning of the Tertiary (Broothaers, 2013; Steurbaut & Nolf, 1986). A dominant landscape feature within this study area is the 'Westrozebeke Ridge' which starts northeast of the city of Ypres and deflects to the southwest (Antrop, 1989), stretching over a length of 25 km (De Vos et al., 2014). The ridge covers the Ypresian clay and sand and has a fluvial origin as it used to be a riverbed later in the Tertiary (Antrop et al., 2006; Rose & Mather, 2012). Due to gravel deposits coming from the river, this riverbed became resistant and preserved in the landscape. The ridge formed later the watershed between the Yser and Leie rivers. Consequently, the ridge became irregular in shape because on both sides of the ridge many small streams developed that found their way to one of the two nearby rivers (Antrop et al., 2006). Today, the ridge has an average height of approximately 50 m (Doyle, 2014; Doyle et al., 2001).

The population growth starting in the Middle Ages caused an expansion of the rural landscape in this area. This reclamation is marked by territories and farmsteads that were closely surrounded by hedges and tree rows, forming the typical Flemish '*bocage*' landscape (or landscapes of '*Houtland*', hedgerow landscapes) (Antrop, 2006) (Figure 1-9). During WWI, this landscape was completely destroyed (Chielens et al., 2006) due to the First (October-November 1914), Second (April-May 1915) and Third Battle (July-November 1917) of Ypres (Doyle et al., 2001). After the first attempt of the German forces to pierce the front near Ypres during the First Battle of Ypres, the war of movement changed into a stalemate in the trenches (Stichelbaut, 2011). The extensive trench system was especially developed on the higher ridge, the so-called 'Ypres Salient' (Doyle et al., 2001). The trenches that were constructed in the heavy impermeable Ypresian clay or sand, were unstable and needed wattle, sandbags or sheet iron and if possible a drainage system (Doyle, 2014). During the Second Battle of Ypres, asphyxiating gas and mines were used for the first time (Michelin and Cie, 1919) and later during the Third Battle of Ypres, tanks or 'landships' were introduced (Stichelbaut et al., 2018).

Figure 1-9 Study area Ypres with traces of the hedgerow landscape (left) and the and the notable altitude difference caused by the Tertiary riverbed (source: author, 11 August 2017)

The third and most southern transect (iii; 83.6 km^2) covers a part of the 'Messines-Wytschaete ridge' (Doyle et al., 2002), a southern extension of the 'Westrozebeke Ridge' (Antrop, 1989). More towards the west, the ridge evolves further into the Flemish Hills with Kemmel Hill as the highest point (156 m) (Figure 1-10) (De Vos et al., 2014). Kemmel Hill is one the Flemish Hills that are located on the former coastline during the Late-Miocene (Tertiary). During this geological time period, the very strong tidal currents deposited iron-rich sands on this former coastline ('*Zanden van Diest'*). This sand oxidized and became strong iron sandstone that is not sensitive to erosion and weathering. Consequently, remains of these sands can still be found and form today the Flemish Hills (Broothaers, 2013). Kemmel Hill and its surroundings played an important role in history, exemplified by Middle and Upper Palaeolithic, Mesolithic and Neolithic artefacts, and particularly the late Iron Age antiquities of a Celtic settlement (Van Doorselaer et al., 1987). During WWI, when the German forces were occupying the higher positions on the 'Messines-Wytschaete ridge', Kemmel Hill remained in Allied hands serving as an important observation point. To gain terrain, the Allies started to undermine the enemy lines by digging tunnels and installing explosives (Barton, 2008). At the start of the Battle of Messines in June 1917 - one of the biggest coordinated actions of the underground war - 24 mines were placed (Institution of Royal Engineers, 1922) after which the Messines-Wytschaete Ridge was conquered from the German army (Gheyle et al., 2016). After the Third Battle of Ypres, the German forces made their way through the Allied line and took Kemmel Hill. In August 1918, the Allies reconquered the area again (Barton, 2008).

Figure 1-10 Study area Kemmel with a view on the southeast (left) and southwest (right) side of Kemmel Hill (source: author, 11 August 2017)

1.4 Studying the militarised landscape of Flanders Fields and problem statement

The WWI in Flanders Fields is the study subject of different disciplines. Many initiatives and research projects developed in the last decades – some even already during wartime – studying Flanders Fields. The interest only grew more in the light of the WWI-centenary (2014-2018) (Saey et al., 2015). The journal 'First World War One Studies' has also focused specifically on the First World War since 2010 and includes transnational and multidisciplinary studies (First World War Studies, 2019). Combined perspectives and different disciplines worked together to understand this complex international and worldwide war.

For instance, geologists researched how the terrain and the geology was related to WWI warfare. Gellasch (2004) for instance analysed how geologists located groundwater – the most important resource in wartime – by deep drilling in the hinterland to supply water for soldiers and animals. Other geologists compared how British and German geologists gained knowledge of the front area with their characteristic geological techniques. This to build shelters and dugouts at the right locations (Rose et al., 2000). Brooks (1920) studied the role of American geologists on the Western Front since the influence of geology on military operations was enormous. Others explored how military geological knowledge was used to built trenches or they examined the conducted field assessment required before carrying out military operations such as the analysis of ground conditions and resources (Doyle & Bennett, 2002).

Others disciplines such as archaeology excavated many sites in the region to discover the material remnants of the war (Bracke et al., 2018; Dewilde et al., 2017; Kaimaris, 2011; Van Hollebeeke et al., 2014). Others studied the fragile WWI remains in Kemmel by use of Digital Terrain Modeling (Stal et al., 2010). Geoarchaeologists[14] described the geomorphology in order to understand the military tunneling war and the inundation of the Yser plain (Heyse, 2013, 2014). Landscape archaeologists researched WWI in Comines-Warneton with the combination of the analysis of aerial photographs and soil sensing techniques. They investigated the preservation state of WWI military remains in the

[14] Geoarchaeology studies environmental information in order to interpret archaeological remains (Thornbush, 2012). Any earth-science that can give information to the understanding of the archaeological record fits in this research field, such as geologists and geographers (French, 2003). So several disciplines are consulted in addition to archaeology (the human past) (Thornbush, 2012).

present-day landscape such as shelters, trenches and gun emplacements (Gheyle et al., 2016). Others investigated the Bellewaerde Ridge, east of Ypres. Trail trenching, geophysical research, aerial photos and trench maps were combined to survey the WWI remnants of the conflict landscape (Dewilde et al., 2016). Stichelbaut & Chielens (2016) have researched the scientific value of WWI historical aerial photographs for archaeological purposes which were also used as a manner to tell the story of WWI in a museum; this by providing a view on the historical conflict landscape from above.

Historians and architects used their insights to understand the post-war reconstruction (Cornilly et al., 2009; Duvosquel et al., 1985; Uyttenhove, 2003). The historian Demasure (2014) on his turn studied the agricultural economy during and after wartime, while Claeys (2017) combined spatial perspectives with historical knowledge to understand the reconstruction of Flanders Fields in the countryside. Heyde et al. (2015) focused on the destruction and reconstruction procedures specifically linked with Flemish castle parks. Others studied the specific architectural trends and styles of rebuilt buildings specifically related to the reconstruction period (Duvosquel et al., 1985; Uyttenhove, 1990, 2003).

As the last mentioned discipline, WWI belongs also to the studied list of conflicts by geographers (Westing, 1980). Fundamentally, WWI is seen as a modern industrialised and globalised conflict that created and destroyed more than any former conflict prior to 1900, both cultural and natural seen (Saunders, 2004). Historical geographers examined, for example, the way British soldiers changed the French and Flemish place names on the Western Front and how they gave nicknames to regions by linking them to life on the front line (Wilson, 2011). Others focused on researching old British historical WWI maps because the impact of the war on evolutions in British cartography was great (Heffernan, 1996; Lilley, 2017; Lilley et al., 2015). Also the British survey techniques on the Western Front were researched (Winterbotham, 1919). Physical geographers studied the influence of topographical characteristics of Flanders Fields on warfare such as Johnson (1917, p. iii). According to him, the landscape was the “theatre of warfare” with specific topographical features which contributed to a militarised action of failure or victory. Other physical geographers investigated the relationship between military structures and the terrain, allowing the construction of specific terrain-based military structures, such as deep WOI dugouts used as underground shelters (Brooks, 1920). Others examined the post-war development of the soil on the WWI battlefield of Verdun (France) (Hupy & Schaetzl, 2008). They also investigated the influences of ‘bombturbation’ (creation of shell holes) in the soils where layers in the soil became mixed (Hupy & Schaetzl, 2006). Military geographers (critically approached), studied the evolution of policy during and after WWI (Murphy, 1990). Others studied the geography of memory, a type of research that studies places with an unfortunate history. In these places different spatial processes can occur, such as sanctification (which makes the area a sacred place) or rectification (restoration and reuse of a place) (Hartmann, 2014). Landscape-specific studies analysed the management of the cultural heritage of the WOI militarised landscape in Antwerp by collaborating with archaeologists (Gheyle et al., 2013). In the same region, the landscape dynamics and militarised landscape were analysed in the past century by using WWI aerial photographs and other historical photos, to formulate an area-specific spatial vision for the future (Dossche et al., 2013). Last, Van Driessche (2014) studied WWI-remnants in the landscape of three villages located on the former frontline, that he saw as places of remembrance.

Only with this brief review[15] of WWI studies in Flanders Fields, it can already be concluded that WWI is a much-discussed topic that is "gradually becoming an 'overbooked' war" (Knack Historia, 2014, p. 14). The N-gram represents the extensive amount of literature related to WWI from 1900 to 2017 (Figure 1-11). In this N-gram[16], the search formula was: "First World War, Great War, World War One ,WWI". Additionally, the English corpus[17] (cf. English books in the google books library) was used to make this N-gram. As a result, the English studies that wrote about Flanders Fields and other regions that were related to WWI are presented. It can be noticed that before WWII the word 'Great War' was mostly used to describe the history. After WWII, this changed into 'The First World War'. The reason behind this change is related to a linguistic change that occurred in between WWI and WWII. Before WWI, the authors did not know yet that there was going to happen a second war a few decades after WWI. Therefore, to make the distinction in between both wars, the concept the 'First World War' saw the light after WWII (Michel et al., 2011).

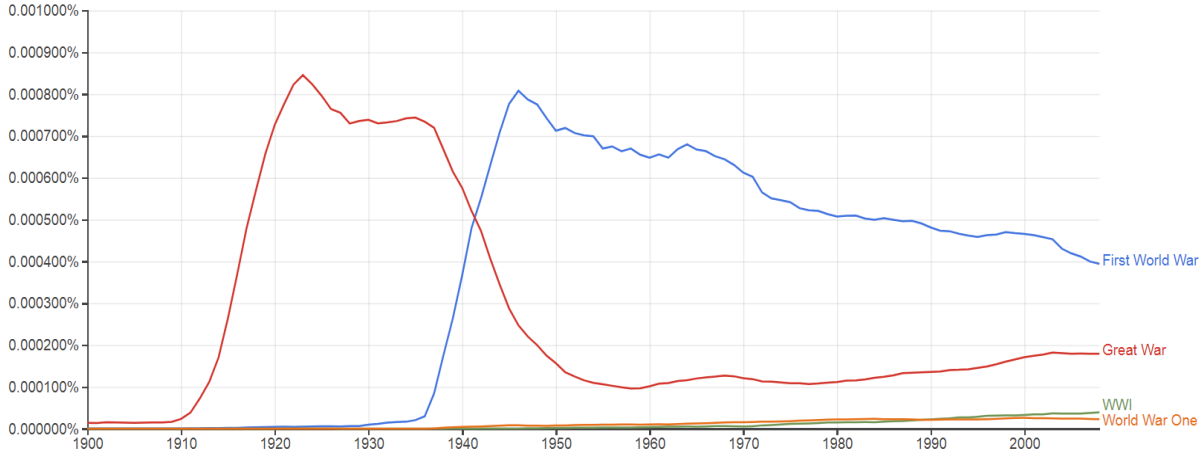

Figure 1-11 N-grams of literature about the "First World War", "Great War", 'World War One" and "WWI" for the last century with the English corpus. The x-axis represents the relative frequency and the y-axis time (Google N-gram viewer, 2019)

What emerges from this brief review is that most of the WWI studies focussing on Flanders Fields have in common that they do not study the landscape (cf. landscape research[18]). They only approach one specific aspect of the conflict (e.g. war remains, geology) and do not see the landscape as the nexus between the natural environment and human factors that creates the specific military

[15] This overview is not complete, as there are many more studies related to WWI. However, our attempt is not to give a complete overview, but only to introduce and get familiar with a number of research domains related to WWI in Flanders

[16] A n-gram is "a string of elements (e.g. words) that appears within a longer sequence". The 'n' stands for an unspecified number and the 'gram' stands for something that is recorded (Oxford Dictionary, https://www.lexico.com/en/definition/n-gram, 14 June 2019).

[17] In this dissertation, only the English corpus is represented. However, WWI was an international war with also other languages and related literature. Hence, this is not discussed in this dissertation.

[18] The term landscape research in this dissertation is used to describe the disciplines that are related to the study of the landscape (Antrop, 2013).

character (Woodward, 2014). This is because the study of the landscape as the research 'lens' for the analysis of WWI only recently became the subject of scientists (Daly et al., 2018).

Attempts that use this particular research 'lens' were already made by the disciplines landscape archaeology[19] and previous discussed military landscape research that houses in critical military geography (see 1.2.1.2) (French, 2010; Stichelbaut & Cowley, 2016; Woodward, 2010). These divers approaches – sometimes also encouraged by the centenary which reconceptualised the war in time (e.g. wartime to present-day) and space (e.g. local to global) – provoked a wider interest in the growing field of 'landscapes of WWI' (Daly et al., 2018).

Since there are not many research examples that analyse the WOI militarised landscape in Flanders Fields with the landscape as the 'lens' of the research, the aim of this dissertation is to make a contribution in this research area. Our assumption is that one should perceive 'landscapes of WWI' as a totality of elements (cf. holistic) (Antrop, 2000). As stated above (section 1.2), this has the advantage of being able to fully understand the militarised landscape in all its aspects and not just a small part of it (Woodward, 2005). This should be performed by analysing the landscape with expanded concepts as predetermined in the critical military geography which analyses the militarised landscape (see Table 1-2) (Russell, 2010). This militarised landscape is formed by the (inter)action of both natural and human factors and is dynamical by nature (Coates et al., 2011; Council of Europe, 2000b; Pearson et al., 2010). This unique (inter)action between both factors creates a unique militarised landscape character (Natural England, 2010). Moreover, horizontal and vertical relations[20] can often be found within the landscape (Antrop & Van Eetvelde, 2017). This approach of the militarised landscape contributes to the studies of the landscape in the light of the ELC definition (section 1.2) (Council of Europe, 2000b).

[19] Landscape archaeology focuses on the role of humans in the landscape and encompasses the symbolic meaning of places and the way in which people organise themselves in the geographical and social space. Landscapes are studied as areas of human involvement, as physical environmental contexts of human behaviour shaping their lives, and as the object of representation (e.g. landscape art, literature) (David & Julian, 2008a). The focus on the continuous interaction (Greene, 1995) – this between people and the physical environment or natural world - characterizes how people occupied and used places in the past (David & Julian, 2008a; Russell, 2008). In order to study this relationship, landscape archaeology carries out large-scale research across a broad region and sees the landscape as the unifying concept (Darvill, 2008), whereby humans are placed into this broad context and are studied by an 'off-site' approach (David & Julian, 2008b). Since the late 1990s, the sub-discipline conflict archaeology developed which focusses specifically on the archaeology of conflicts (Hesse, 2014). This sub-discipline approaches conflicts in the broadest possible sense by analysing several concepts (e.g. origins of conflict, battlefields, commemoration, human rights) (Pollard & Banks, 2005). Since the late 20th century, in this sub-discipline developed an academic field of research that focuses only on conflicts of the 20th and early 21st centuries (e.g. WWI, WWII), which is called 'modern conflict archaeology'. The perspectives of this field of research are closely related with landscape archaeology. Past and past-in-present landscapes, the materiality of conflict, and the related commemoration afterwards are the objects of study (Stichelbaut & Cowley, 2016).

[20] Horizontal (e.g. sequence of land cover) and vertical relations (e.g. relation between the land cover and soil type) are concepts of 'order' (Antrop & Van Eetvelde, 2017).

1.5 Research objectives, methodological aspects and outline of the dissertation

1.5.1 Research objectives

This dissertation makes a contribution to the study of the WWI-militarised landscape of Flanders Fields. The main research question is: *How does the landscape tell the story of the First World War?* Answering this question requires empirical work that analyses the dynamic aspect of the landscape with both natural and human factors (Figure 1-12).

In this dissertation, five research objectives are addressed belonging to five research questions, which are described in the next paragraphs. Answering these questions contribute to addressing the main research question of this thesis. Each question handles a specific theme in how the landscape 'tells' the story of WWI. These themes were chosen in the light of the main landscape story and each fills in a part of the story of the landscape from a spatial point of view.

RQ 1 What military landscape characters does the current cultural landscape in Flanders Fields has today?

Objective 1: Composing the historical landscape characters with landscape information of 1914 until today.

When the option for analysing a historical landscape upon today from a landscape perspective occurs (cf. human and natural factors, see section 1.2), a method should be selected to analyse this particular landscape under study. To do so, (non-)spatial and/or other landscape data has to be collected. Analysing these data with suitable methods consequently reveals information about the dynamical and historical aspect of the landscape. Therefore, the first objective is to develop a methodology that is on the one hand suitable for collecting landscape information of Flanders with a focus on WWI and on the other hand is taking into account the consecutive objectives of this dissertation (objectives 2, 3, 4 and 5). I decided to collect and process landscape data in a spatial-temporal database in order to determine the historical landscape characters of the three studied areas. Each character illustrates an area with different aspects of the militarised landscape in a natural, cultural and archaeological sense (Fairclough, 2003), making the use and interpretation of these characters suitable for the consecutive objectives. Consequently, this dataset which was the lion's share of this dissertation, forms the base of this dissertation and provides an explorative overview of the changing historical militarised landscape upon today.

RQ 2 What is the (degree of) preservation of the WWI elements in the present-day landscape?

Objective 2*:* Indicating the (degree) of preservation of WWI relics in the present-day landscape by analysing landscape dynamics of the last century.

Hundred years after the start of WWI, there are still WWI remains in Flanders (e.g. mine craters, bunkers, graves, trenches). These are obvious due to the care and management (e.g. Commonwealth, locals), heritage policy (e.g. protections) or the size of the war-remains (e.g. mine craters) amongst others. Hence, undiscovered or 'hidden' WWI remains are still present in the landscape. These consist both of above- and belowground remains. In addition to the detailed and large-scale studies at site level in the front zone that reveal the history and associated WWI remains, it would be interesting to carry out a methodology that examines the possible preservation of the remains on a landscape scale taking into account the spatial context of the individual sites. Therefore, this objective can be researched by the use of the previous established spatio-temporal database resulting from the first objective. While carrying out this objective, it shows how the spatio-temporal database can be used as a predictive and explorative tool.

RQ3 Why are WWI shell hole landscapes (not) visible in the landscape of Flanders Fields?

Objective 3: Explaining the preservation of shell hole landscapes of WWI by analysing landscape dynamics.

Billions of shells were fired on all the fronts during WWI. The front zone in Flanders was one of the most shelled areas during the war (Pearson et al., 2010), making this one large archaeological site. However, after the war the landscape was completely cleaned and levelled with the help of many stakeholders. Nevertheless, earlier shelling still left their imprint on the microtopography of the landscape one hundred years later. After drawing up a general picture of the degree of preservation of all different types of war-remnants during the second objective, the third objective is focusing on this specific WOI remnant in the landscape. In this objective, insights are given on how the same spatio-temporal database from objective 1 can provide useful information on why some shell holes have or have not been preserved until today.

RQ 4 How can a landscape pattern analysis provide additional knowledge of the post-war militarised landscape?

Objective 4: Investigating dynamic landscape patterns from 1914 towards today to provide new insights into the dynamics of the WWI militarised landscape.

While landscape dynamics occur as a result of the action and interaction between both human and natural factors, the landscape pattern is changing (composition and configuration). Understanding these geometrical dynamics give a more profound (qualitative) evaluation of the changing processes that occurred in the area. These understandings are important towards ecological and esthetical aspects of the landscape and for future developments. In addition to the 'first information layer' of a landscape obtained by visual analysing the landscape (e.g. spatial plans, observations) or by thematic analysing the landscape (e.g. landscape characterisation during objective 1), the description of landscape patterns provides a 'second information layer' (Bartel, 2000). This 'layer' helps us to understand the relationship between historically changing spatial patterns and related processes in Flanders on the former front zone. Therefore, the fourth objective investigates the changing landscape patters from 1914 upon today with a focus on the post-war landscape.

RQ 5 Which (human) actors caused that the WWI-militarised landscape still persists today, 100 years later?

Objective 5: Analysing the responsible stakeholders for the observed landscape dynamics in the militarised landscape during the last century.

Allied and German forces battled four years, transforming the pre-war landscape with scenic views into a destroyed landscape fully covered with craters. Afterwards, the landscape was entirely reconstructed by the help of local initiatives and by national and international policy amongst others. Hence, who is behind these forces, initiatives and policy (cf. actors) and what where their actions that had an influence on the changing militarised landscape? From this question follows the last objective, namely the analysis of the responsible stakeholders for the observed landscape dynamics related with the militarised landscape of the last century. By discussing the stakeholders or the 'warscape' (section 1.2.1.3), both aspects of the landscape – human and natural factors - come together and close the empirical part of this dissertation.

1.5.2 Sources, techniques and software

In this dissertation, several sources, techniques and software are applied to address the predetermined research objectives. Table 1-4 represents these per chapter. Notably, these have always an (in)direct relationship with GIS which makes GIS the main software used in this dissertation. In the discussion (section 6.1.2), more details of this overview can be found..

Table 1-4 Overview sources, techniques and software with the associated subdisciplinary or interdisciplinary relation or subfield

Sources	Chapter
Historical and contemporary aerial photographs	2
LiDAR	3
Shell hole map	3
Literature	5
Techniques	**Chapter**
Historic Landscape Characterisation (HLC)	2
Landscape Change Trajectory analysis (LCTA)	2
Modifications of LULC	3
Landscape biography	5
'Relational approach'	5
Software	**Chapter**
Fragstats	3
Geographic Information Systems (GIS)	2,3,4,5

1.5.3 Outline of the dissertation

The objectives are discussed and analysed in the following chapters of the dissertation. Chapter 2 handles objective 1 by establishing the spatio-temporal database. This database encompasses the landscape characters containing information about historical LULC and linear structures of the past century for the three study areas. As the established spatio-temporal database forms the base of this dissertation and will particularly be applied in several manners to address the other objectives, I also already approach objective 2 as well in this chapter. To address this objective, the spatio-temporal database is applied in two different analyses: A Landscape Change Trajectory Analysis (LCTA) and a Military Impact Analysis. Results of both analyses respond to objective 2. In this chapter, all the three study areas are used for analysis. This chapter is based on a paper entitled 'Using the past to indicate the possible preservation of relics in the present-day landscape: The Western Front of the Great War in Belgium', which has been published in Landscape Research.

Chapter 3 deals with objective 3 by investigating the consecutive landscape changes in the spatio-temporal database in the light of specific information on the visible preservation of shell holes. This is performed by linking the information of the spatio-temporal database on the one hand with a shell hole density map of 1918 (start of preservation) and on the other hand with the present-day preserved craters visible on high-resolution airborne laser scanning (LiDAR) (end of preservation or actual state). In addition, the spatio-temporal database will be approached in another way by linking the database to the historical management in the area that reflects the changes in modification of land use. The understanding of historical management is a fundamental aspect to examine the (former) preservation conditions of the shell holes. Notably, since the analysis of LiDAR data is on the hand labour-intensive and because on the other the shell hole density map only exists for the southern part of the Westhoek, this chapter will only analyse the spatio-temporal data of research area three. This chapter is based on a paper entitled 'Revealing the preservation of First World War shell hole landscapes based on a landscape change study and lidar', which has been published in the Danish Journal of Geography.

Objective 4 is discussed in chapter 4 that explores the LULC changes from the spatio-temporal database in another manner by first creating binary maps and a change matrix. Afterwards, trends are surveyed in the changing landscape patterns for the three study areas. The spatial composition and configuration of the landscape are observed by focussing on the post-war reconstructed landscape. Furthermore, the relation between the degree of military impact during the war and the observed patterns in the reconstructed landscape is studied. The chapter is based on a paper entitled 'Understanding the landscape dynamics from a devastated to revived cultural landscape: The case of the First World War in Flanders through the lens of landscape patterns', which has been accepted with minor revisions in Land Use Policy.

Chapter 5 ends the empirical work by addressing objective 5, this applied to the three study areas. An actor analysis (or 'warscape' analysis) is carried out that attempts to explain all previously observed spatial changes in the landscape of the previous chapters (Chapters 2, 3 and 4), whereby in these chapters the previously set objectives (objectives 1, 2, 3 and 4) were discussed. By examining the actors, both aspects that are responsible for landscape change – human and natural factors – are analysed in this dissertation. The chapter is based on a paper entitled 'The First World War landscape of Flanders: A geographical interpretation of human actors', which has been submitted in Applied Geography.

In chapter 6, I will reflect back on the methodologies and techniques executed in function of the main research question of this dissertation. Furthermore, I will discuss possibilities for future research and I will explain the usefulness of the carried out methods and analyses by means of other conflicts of interest. Afterwards, I will summarize the findings in the conclusion in chapter 7 and I will answer the main research question.

After chapter 7, the dissertation ends with the appendices. These appendices represent additional information and data that belongs to the chapters and are numbered according to the chapters. In each chapter there are cross references to these appendices.

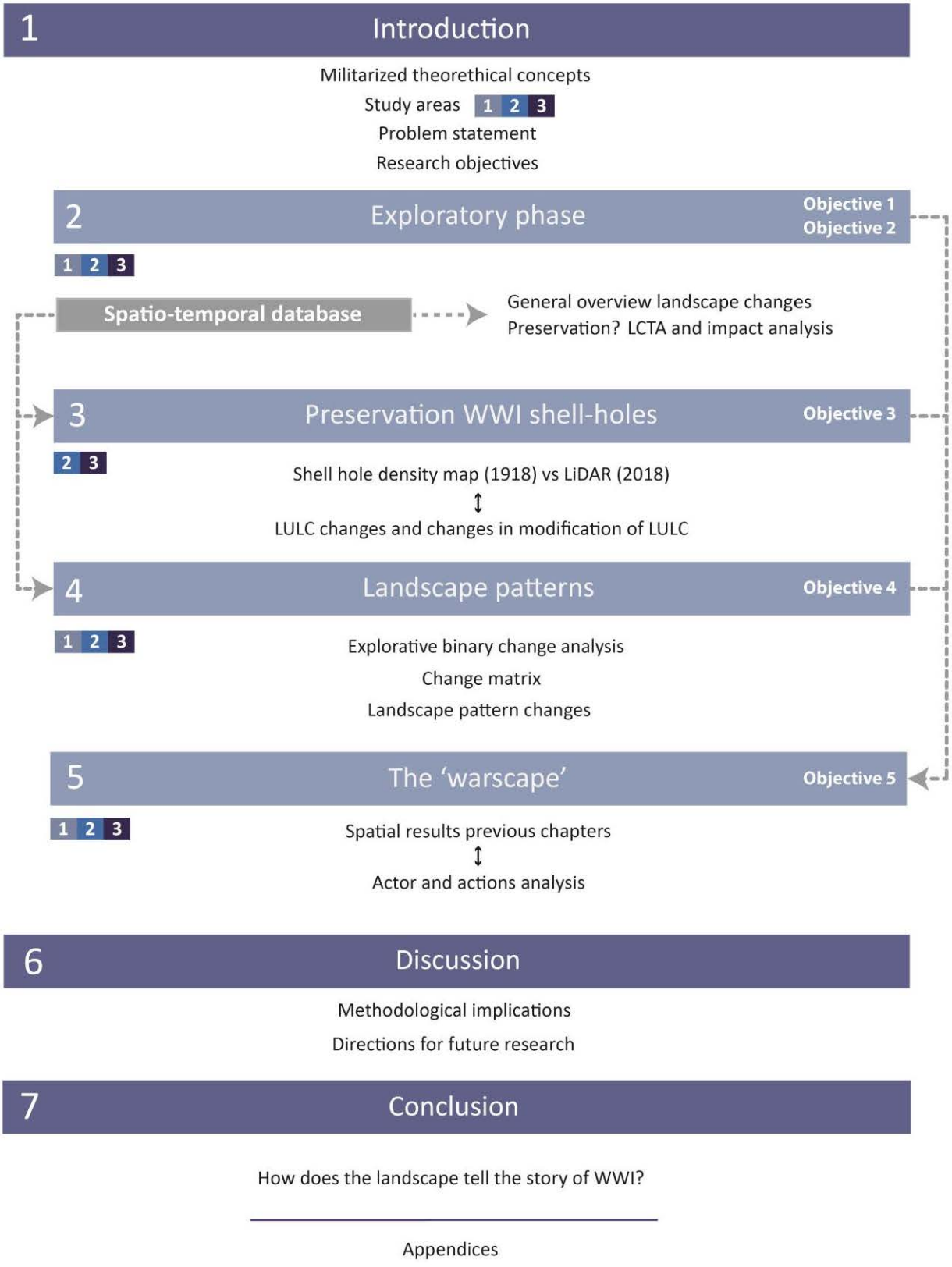

Figure 1-12. Outline of the dissertation

1.6 Context of the research

1.6.1 Visual methodologies of landscape research

Following literature, the landscape can be analysed from several perspectives such as by microscopes, by the eye of the perceiver in the direct landscape or by using other sources to look at (Wylie, 2007). In this context, Cosgrove argues that the "landscape is a way of seeing" (Cosgrove, 1985, p. 55). This 'way of seeing' refers to the visualisations of a landscape that I chose to look at in order to gain information of the landscape. Therefore, it is not "about what we see but about how we look" to the landscape (Wylie, 2007, p. 7). The eye of the landscape observer determines and choses how he or she wants to analyse the landscape features of interest.

This dissertation chose also to determine the militarised landscape of Flanders Fields from several perspectives. More specifically, several (historical) sources were selected that delivered information in the context of the predetermined research questions. The used sources to study the landscape can be compared to a 'veil', a 'text' or a 'gaze' (Wylie, 2007). Firstly, the militarised landscape is studied as a 'veil' by using (historical) aerial photographs as main source. These photos provide the view on the landscape of a specific time period and place and contributed to the collection of the necessary information. Hence, this 'way of seeing' shows only the elements on the photos and hides the meaning behind these observed landscape features. Secondly, the landscape is studied as a 'text'. In this context, the landscape is seen as a 'text' whereby the 'authors' of the landscape are the human actors (Samuels, 1979; Cosgrove, 1985; Kolen, 2005). While they write the landscape, the text becomes longer and more complex. Within this dissertation, the 'text' of the landscape of Flanders Fields is more specifically studied by analysing (historical) literature. While reading this literature, one is able to 'brake through' the veil and to understand more the meaning behind the 'veil'. Thirdly, the landscape in this dissertation is also studied as a 'gaze' in the meaning that only one specific subject is studied in the landscape. In this dissertation, the main subject and focus is the First World War (Wylie, 2007).

1.6.2 Role of dissertation within interdisciplinary project

As stated above, the just ended current commemoration of the First World War has led to a growing number of initiatives and research projects, in several topics and disciplines (Saey et al., 2015). In this context, the University of Ghent also launched a project in the year before the commemoration. This Ghent University's 'Non-Invasive landscape archaeology of the Great War'-project (2014-2018; BOF research fund: grant number 01G00214)[21] aimed to study the Western front of Belgium. This former front with unique characteristics (e.g. human remains, unexploded munition) was before rarely investigated in an integral manner. Therefore, the project aimed to study WWI-remnants with non-invasive techniques on a regional scale. The extent and nature of this heritage was unknown. In order to achieve this goal, different disciplines participated in this project that continuously combined aerial photography, geophysical scans and airborne laser scanning. This dissertation is part of this project whereby the geographical perspectives are practiced. Particularly historical aerial photographs and airborne laser scanning are analysed to study WWI in a non-invasive manner. The

[21] See also the website of the project: https://www.greatwar.ugent.be/.

analysis of the war with these techniques took place within the framework of landscape research (Department of Geography) which analysed the landscape following the ELC definition (see section 1.2). Results and established methodologies of this landscape research were in constant interaction with findings and techniques from the other two sections in the projects, namely remote sensing archaeology (Department of Archaeology) and geophysical soil sensing (Department of Environment).

The archaeologists were particularly interested on the one hand in WWI-elements (e.g. trenches, craters, bunkers) that are visible on historical aerial photographs. The structure and evolution of these during the conflict is analysed. On the other hand, these scholars are interested in the remnants of these WWI-elements in the present-day landscape. In order to understand the present status of buried WWI remains, the geophysical soils sensing group 'maps' the underground of the present-day landscape. Because these research groups are either studying the situation during the war or the situation today, results of landscape research fills in the 'gap' between the war and the situation today by analysing the historical dimension of the militarised landscape. This gap is filled in by studying different landscape features with a wide range of techniques and methodologies whereby the knowledge and results are combined together with the results of the other research groups. By doing so, the evolution of the militarised landscape becomes more understandable and is explored. The landscape is namely a dynamic system in which every element studied in time and space is important to 'grasp' the evolution of the landscape in the past century (Figure 1-13).

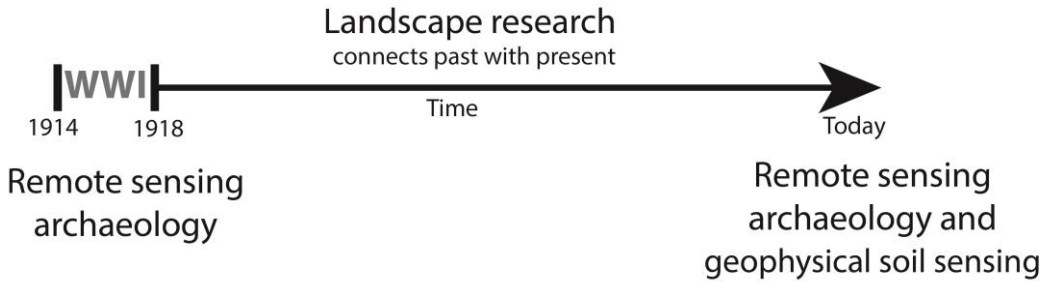

Figure 1-13 The role of landscape research in the project represented on a timeline going from WWI until today

A difference between the archaeologists and the geophysical soil sensing group within the project on the one hand and the landscape research approach fulfilled in this dissertation on the other hand, is that landscape research analyses the militarised landscape on a smaller scale. In other words, the landscape is approached as a whole whereby the landscape system as mentioned above, is composed by the combination of elements rather than only the studied elements on a parcel level. Notably, some aspects and methods of the archaeologists were also analysed from a landscape scale. These methodologies and perspectives are more related to the sub-discipline landscape archaeology.

1.6.3 Statement contribution of academic papers

Within this dissertation, several academic international peer reviewed papers were used as the basis of the chapters (Chapters 2, 3, 4 and 5). These were compiled within the interdisciplinary project whereby several co-authors are listed per article. Hence, the presented academic papers in this dissertation were written by the author of this dissertation, as these papers relied on geographical perspectives. As previous mentioned, the geographical part was in the project filled in by the author of this dissertation. Within these papers, the co-authors gave supportive advice from their disciplinary perspective.

At the beginning of each chapter which was based on an academic paper, it is stated that each of these is ‘modified’. This means that each paper is adapted compared to the original paper which was already published, in review or submitted. Modified means that footnotes, cross references and extra figures and paragraphs were added in order to better connect the chapters in this way on the one hand, and to discuss some methods or thoughts more clearly on the other hand.

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CHAPTER 2 – USING THE PAST TO INDICATE (THE DEGREE) OF PRESERVATION OF RELICS IN THE PRESENT-DAY LANDSCAPE: THE WESTERN FRONT OF THE GREAT WAR IN BELGIUM

"Time is stitched into […] any landscape as measured by many different clocks"
(Pavord, 2016, p. 206)

Modified from:

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ABSTRACT The First World War (WWI) had a notable influence on the landscape at the former Western Front in Belgium. Research on a landscape scale is necessary to understand the destructive and constructive impact of the war and its consequences for the post-war landscape in a holistic manner. This paper focuses on the trajectory and impact analysis of three study areas with different landscape characteristics and aims to indicate possible preserved military relics today. Therefore, landscape changes are studied using historical aerial photographs (WWI and WWII) and contemporary orthophotos. A military landscape characterisation is made based on land use/land cover and associated linear structures that were mapped throughout time. Specific landscape trajectories could be designated as areas with a possible degree of preservation of WWI heritage, with a related military impact degree. The results are useful for sustainable heritage management and for further interdisciplinary research on WWI heritage, by providing a broad knowledge of the area.

KEYWORDS WWI aerial photography; Historic Landscape Characterisation (HLC); Landscape Change Trajectory Analysis (LCTA); WWI heritage

2.1 Introduction

The current commemoration of WWI has been causing a growing amount of initiatives and research projects. Different types of research occur in several disciplines with diverse topics (e.g. heritage, geology, geography) (Doyle, 2014; Lilley, 2017; Miles, 2016). This paper applies a holistic landscape approach to investigate the military impact[22] on the landscape during WWI in Flanders. A militarised landscape was created by both temporary and permanent impact in a material and cultural sense (Pearson et al., 2010). The main idea is that war and landscape are associated with each other (Pearson, 2012), like 'Siamese twins' (Larsen, 2004, p. 468). The landscape represents the scenery of the war, whereby warfare and human experiences are (amongst other things) related to and influenced by the landscape and its features. Consequently, these features can change from the combat its activities resulting in another war environment with adapted or new landscape features (Pearson, 2012). When studying the current landscape, one can conclude that this is the last witness whereby tracks are still visible (Chielens, 2009). In this context, I demonstrate that analytical landscape methods are an important support for archaeological remote sensing and geophysical soil sensing (Saey et al., 2013) to observe WWI relics as the last indication, in a non-invasive way (see section 1.6). The impact of former war activities is still visible in the current landscape indicated with destructive (e.g. bomb craters, ruins) and constructive (e.g. trenches, bunkers) military landscape remains.

This paper focuses more specifically on landscape changes of the past hundred years by studying four different time phases (1915, 1918, 1940 & 2012), starting with WWI as a momentum. Change is an ongoing aspect of the landscape and can be defined as a different perceivable form of the landscape between two different time stages (Antrop, 2003; Van Eetvelde & Antrop, 2009). Several driving forces are inducing change (Bürgi et al., 2004), which are considered as the "interaction between natural processes and human activities" (Antrop & Van Eetvelde, 2008, p. 183). Well-known examples are industrialization, globalization (Bürgi et al., 2004) and unpredictable disasters (Antrop, 2005). Each region has its own biography with unique drivers, leaving obvious scars (e.g. deforestation, desertification) in the landscape (Antrop, 2007). Thus WWI – like other military conflicts - can be seen as a particular event or cultural calamity with a destructive effect along the front line. The pre-war landscape abruptly changed into a lunar-like scenery (Pearson et al., 2010; Stichelbaut et al., 2016), peppered with shell-holes and a plethora of military field defences and infrastructure (Van Hollebeeke et al., 2014). Pearson et al. (2010) pointed out that this destruction was one of the "most striking examples of the war's environmental consequences" (p. 3).

Landscape changes have extensively been studied with a variety of techniques in several disciplines (for examples in landscape ecology, see Svenningsen et al., 2015; Turner & Gardner, 2015); in geomorphology, see Higgitt & Lee, 2001; and in climatology, see Oliver & Morecroft, 2014). This paper applies historical and contemporary aerial photographs as a basis for the evaluation of changes. This large set of photographs is analysed and processed, combining two different approaches. First, the Historical Landscape Characterisation (HLC) is used, which was introduced in the United Kingdom and has an origin in historical geography and landscape archaeology. This method investigates the historical dimension of the landscape (Clark et al., 2004; Fairclough, 2003). A

[22] 'Military impact' in this dissertation will be used to refer to the 'Impact analysis' in this chapter (section 2.3.3.3).

recent study of Gheyle et al. (2013) provided a holistic perspective on the changing landscape, by using also the concepts of the HLC and by applying these on aerial photos. The time depth and change in frequency were analysed (Gheyle et al., 2013; Van Eetvelde & Antrop, 2009). Second, the Landscape Change Trajectory Analyses (LCTA), which often lean on the interpretation of land use/land cover to demonstrate the path of a changing landscape, are other ways to gain new insights in the changing landscape (Gheyle et al., 2013; Käyhkö & Skånes, 2006). The presented research is the first attempt to combine the ideas and principles of both the HLC (Fairclough, 2003) and LCTA (Käyhkö & Skanes, 2006; Langran, 1993) in the WWI context of Flanders. This approach creates unique insights into the WWI-related landscape dynamics. The combination of these two methodologies fit well together, since they both aim to classify or generalize the landscape area in a holistic manner by analyzing historical maps, aerial photos, records or other sources from several time periods; this to obtain historical knowledge of the past landscape that resulted into the present-day landscape. In other words, both methods go back in time to understand the present by reconstructing the past[23]. Additionally, they both aim to share this historical knowledge of the present-day landscape for future planning; cf. conservation[24], management, rural development, etc. (Fairclough, 2003; Käyhkö & Skanes, 2006).

To summarize, this chapter aims to investigate landscape changes during and after WWI by processing historical and contemporary aerial photographs. With an extensive and profound knowledge of the changing landscape, the possible location of WWI relics today can be more understood and supported. First, I aim to (i) create a spatio-temporal database based on the interpretation of aerial photographs from different time phases to identify landscape characters. Second (ii), a landscape trajectory analysis will be carried out to define different military landscape evolutions. Third (iii), I want to perform an impact analysis of the disturbed landscape. Fourth (iv), both analyses (trajectory and impact analysis) will be compared to indicate the possible preservation of WWI relics (constructive and destructive military elements) in the present-day landscape.

2.2 Study areas

The main research area is the former Western Front in Belgium. The three already before introduced transects (or study areas) (section 1.3), cover both the frontline and hinterland (Figure 1-6). There is an undeniable relationship between the military features and landscape characteristics (Chielens et al., 2006; Johnson, 1917), so each transect had related military strategies that were adapted to the corresponding landscapes and geology, creating a unique story (Doyle, 2014).

The most northern transect (i) covers the area (43.4 km^2) southeast of the city of Nieuwpoort and is intersected by the river Yser. This area is part of the flat coastal plain of Flanders (Bertrand & Baeteman, 2005). The second transect (ii) extends over the area (81.6 km^2) around the city of Ypres and is part of the clay plain of Flanders (Doyle et al., 2002a). The area consists of heavy Ypresian clay ('blue clay') and sand (Steurbaut & Nolf, 1986). A dominant feature of this transect is the 'Westrozebeke Ridge' east of Ypres (Antrop, 1989). The sandy ridge with fluvial origin has maximum

[23] This is called the 'retrospective method' that starts with the present and goes back in time to reconstruct the past; this in context of the present-day landscape (Antrop & Van Eetvelde, 2017; Rippon, 2004).
[24] When 'conservation' is used in this dissertation, it is used in the context that should be preserved and is therefore a subject for conservation.

peaks of 50 m covering the Ypresian plain (Doyle, 2014). The third and most southern transect (iii; 83.6 km^2) covers a part of the 'Messines-Wytschaete ridge' (Doyle et al., 2002b), a southern extension of the 'Westrozebeke Ridge' (Antrop, 1989). More towards the west, the ridge evolves into the Flemish Hills with Kemmel Hill as the highest point (156 m) (De Vos et al., 2014).

2.3 Material and methodology

The methodology is divided into three phases: data collection, processing and analysis (Figure 2-1). The methodological steps in the three phases are set up to be able to observe and evaluate both the WWI destructive and constructive landscape elements.

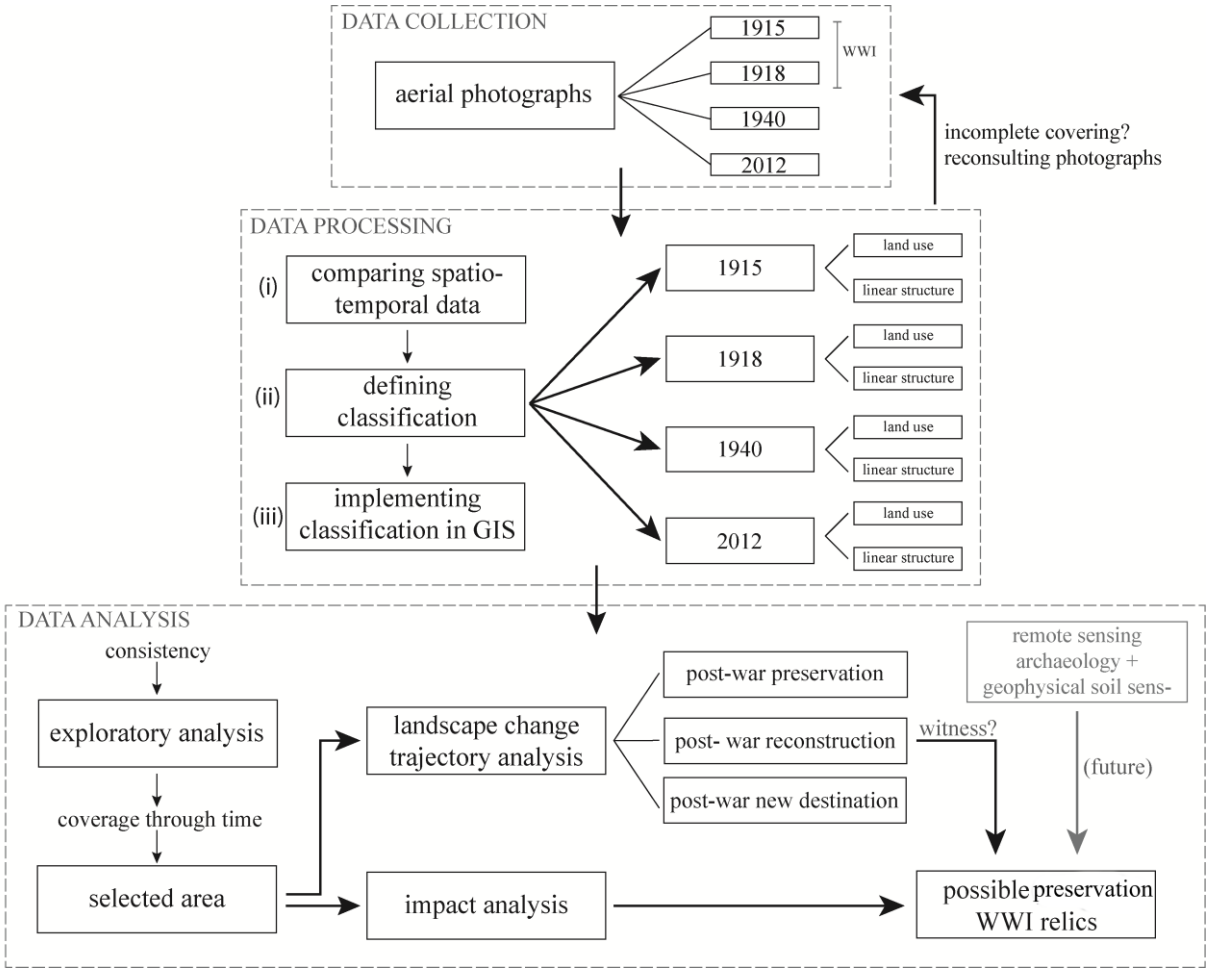


Figure 2-1: Methodology to indicate the possible preservation of WWI relics

2.3.1 Step 1: Data collection and background

Aerial photographs were selected as a main source of information. Other than historical maps, aerial photos provide a holistic perspective of the landscape (Troll, 1966), by giving information about land use, topography and context and their mutual relations as well (Cowley & Ferguson, 2009). The collected photos date from 1915, 1918, 1940 and 2012. Firstly, the choice for these periods relied on relevant information: the observed differences between the landscape in the beginning (1915) and the end (1918) of WWI showed the extent of military influences; the period after the war (1940) represented the reconstructed post-war landscape; last, the period towards the commemoration of WWI (2012) showed the remaining traces in the contemporary landscape. Secondly, as the

digitisation of polygons (see section 2.3.2) will be carried out on these photographs, these time phases were chosen to keep the workload of the digitalisation process in this thesis realistic. Notably, the observed landscape in the beginning of 1915 gives a good indication of the pre-war landscape as the landscape information is still visible through possible military destructions (Chielens et al., 2006; Doyle, 2014; Stichelbaut, 2011). The current commemoration (2014-2018) was not included as no current photographs were available yet at the start of this research (2014)[25]. Hence, the changes associated with the commemoration do not have a big impact on the changes between 2012 and today. On the one hand, these recent adaptations took mainly place locally on already existing WWI-sites by redesigning and strengthening specific commemoration sites as '*lieux de mémoires'* (places of memory). The landscape formed the main theme in these plans whereby sites became connected with information panels, cycling routes, vista's and other small adaptations that cannot be observed on aerial photos (Flemish Heritage Agency, 2012). On the other hand, if changes occurred between 2012 and 2019 related with the commemoration, the classification of historical landscape characters (see section 2.3.2) was made by generalising visible landscape information on the aerial photographs with the photos of WWI as the most general ones. Because of this, changes related to the commemoration would not be visible in the in the results between 2012 and 2019, as these types of changes do not occur in the defined historical characters.

The collected photos originated from different sources and were selected to encompass the complete study areas (or transects) (Table 2-1). The photographs from 1915 - already georeferenced into a Geographic Information System (GIS) by previous research (Stichelbaut, 2011) - were taken by various combatting nations and covered the front line and the hinterland as well (Stichelbaut & Chielens, 2013; Stichelbaut, 2011). According to General Duval, they were 'the eyes of our armies' for espionage (Défense Nationale, 1925b). The photos from the 1940s belong to the former Aerial Reconnaissance Archive (TARA), which is now the National Collection of Aerial Photography (NCAP) (http://ncap.org.uk/). This archive houses WWII photographs that were collected by the Allied Central Interpretation Unit (ACIU). This unit had an important role in planning and executing missions for the Allies (Cowley et al., 2012). The photos from 2012 belong to the 'Informatie Vlaanderen Agency' that manages geographical data from Flanders. These photos were taken in May 2012 (http://www.vlaanderen.be/informatievlaanderen).

[25] The project started in 2014 (see section 1.6).

Table 2-1 Data sources

Period	Original scale	Aerial images	Source
World War One (1915 – 1918)	Different scales	Black and White near vertical aerial photography	- Royal Museum of the Armed Forces and Military History in Brussels (KLM-MRA) (Belgium) - In Flanders Fields Museum (IFFM) (Belgium) - Belgian Military Archive (part of Intelligence and Security Staff Department of the Belgian army or SGRS-S/A) (Belgium) - Bayerisches Hauptstaatarchiv (Germany) - Australian War Memorial (AWM) (Australia) - Imperial War Museum (IWM) (United Kingdom)
1940 - 1945	1: 5,000	Black and white vertical aerial photography	- National Collection of Aerial Photography (NCAP) (United Kingdom)
2012	1: 1,000	Coloured orthographic photography	- Informatie Vlaanderen Agency' (Belgium)

2.3.2 Step 2: Data Processing with the creation of the spatio-temporal database

The second step discusses the combination and evaluation of the aerial photographs, followed by the development of the classification which is based on the visible information on the photos. Afterwards, the database was compiled in GIS by digitising the images. These steps were based on the principles of the HLC (Clark et al., 2002) and on the preparing phases for the LCTA (Käyhkö & Skanes, 2006)

2.3.2.1 Combination and evaluation of the sources

First, the combination and evaluation of the sources was based on the LCTA concepts. Following this methodology, heterogeneous sources in time and space should be carefully compared prior to combine the landscape information of these sources as this step directly influences the landscape classification. The combination can be performed with a generalization of landscape information based on relations between the sources (Käyhkö & Skånes, 2006; Petit & Lambin, 2002).

Due to the chronological differences and rapidly evolving photographic techniques, the sources were not uniform in resolution and image quality (Figure 2-2). The greyscale photos from WWI were not-systematically recorded because they were taken by a wide range of aerial photography units which had widely varying recording techniques and platforms (Stichelbaut, 2011), which made the collected photos laborious to analyse. Also the WWII photos were not systematically recorded (Cowley et al., 2012), although they had already a sharper resolution. At last, the recent orthophotos were systematically taken in colour and had the sharpest resolution. As the WWI photos were the less detailed photos, they determined the detail of the classification (minimum mapable unit of the polygons) (see classification in section 2.3.2.2). For instance, no observed differences could be made in between types of woodland which meant woodland had to remain a general information unit over time in the classification. However, the level of detail on the WWI photos was still suitable for the detection of a wide range of constructive and destructive military elements and other landscape features such as arable land, civil houses and trees.

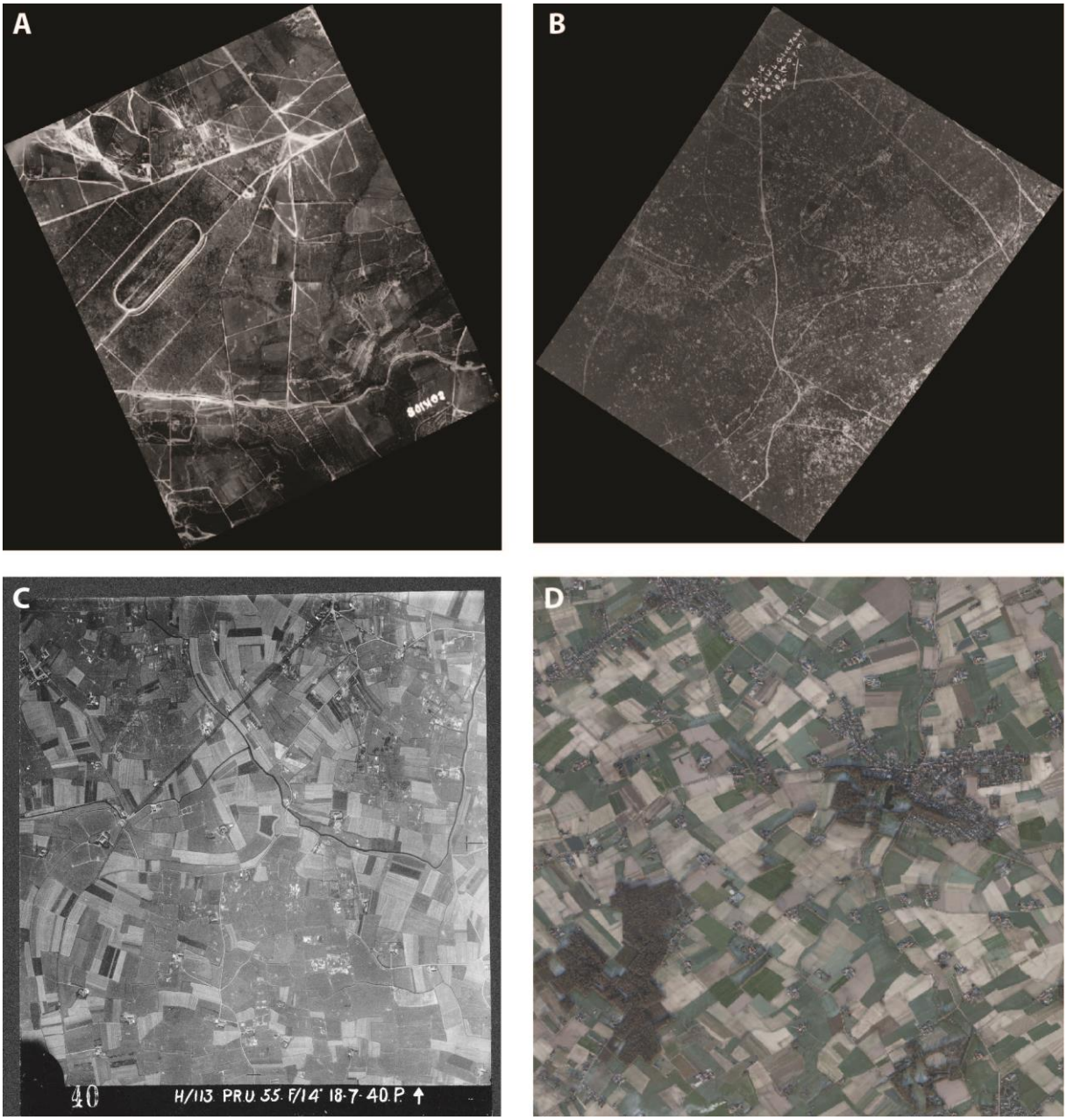


Figure 2-2 Four examples of the consulted historical aerial photographs per studied time phase; A: 1915, B: 1918, C: 1940, D: 2012 (sources according to Table 2-1)

2.3.2.2 Defining the classification

The classification of the visible landscape information on the photos was based on the HLC concepts[26] (Fairclough, 2003). According to this method, descriptive attributes (e.g. visible field borders, lines of roads, destruction degree) were selected by generalising perceivable landscape information on the collected photographs for all the time phases (Rippon, 2004). (Rippon, 2004).

[26] These concepts were already briefly described in the introduction (section 1.2.2.2).

These attributes were land use/land cover[27] (attribute 1) and the military influence[28] (attribute 2). The former was analysed by looking to the landscape features (e.g. visible crops, grass, houses, cows, ponds). The latter was determined by analysing both military constructions and destructions in the landscape and could be subdivided into a different degree of military influence in the landscape characters (cf. with a few military traces or completely destructed by military influence). Additionally, the analysis of digitized linear structures[29] (Table 2-2) aided in the interpretation of the attribute land cover/land use. For example, the presence of brooks at the edges of a field were mostly linked with arable land and the presence of tree rows were mostly related with pasture. Afterwards, different landscape character types were identified (Table 2-3) by combining these attributes in a systematic and holistic way (Van Eetvelde & Antrop, 2009), which represented the four time phases. Each character illustrated an area with different aspects of the landscape in a natural, cultural and archaeological sense (Fairclough, 2003)[30]. With this classification, it is possible to make various analyses of the present and past landscape throughout the dissertation. These analyses not only explore morphological aspects (e.g. landscape patterns of each time phase) but also archaeological (e.g. the understanding of the location of WWI remains in the pre-centenary landscape) and historical aspects (e.g. evolution of landscape patterns through history) (Fairclough, 2003). These applications fit well within the scope of the project (section 1.6)[31]. For example, the historical landscape types with a military influence ('i' in Table 2-3) can be analysed (see impact analysis in section 2.3.3.3).

[27] Land use represents how people use the land (e.g. recreation). The land cover is the physical land type resulting from natural and human processes (e.g. forest, open water), thus also from the land use (Özyavuz, 2012).

[28] 'Military influence' in this dissertation is only used to refer to the influenced state 'i' in the landscape. This cannot be confused with military destruction (cf. a part of the determined influenced state besides the military constructions) or military impact (cf. military impact analysis with military impacts in chapter 2).

[29] These classified linear structures can later be used as an overlay on the landscape character maps (see further).

[30] The composition of the landscape character types following the HLC is closely related with the LCTA methodology that also aims to establish a hierarchical classification from landscape information in the past. In the LCTA methodology, the classification of landscape elements (comparable with the landscape attributes following the HLC) for all time phases is carried out to achieve landscape units (comparable with the landscape characters following the HLC) that represent historical information in the present-day landscape. Hence, as I aimed to analyse also the linear structures to help to classify the landscape information, I can refer to the landscape classification carried out in this dissertation more correctly as a classification of characters (HLC) instead of entities (LCTA). Notably, the HLC methodology aims to include even more information to determine the overall character such as narratives, old maps, etc. (Fairclough, 2003).

[31] This classification was in addition to the objectives of this dissertation also established in function of the objectives of the project, cf. the analysis of the remains in the present-day landscape (section 1.6).

After the compilation of the classification, a field survey (February, 2016) was executed to assess the accuracy of the classification (Brandt et al., 2002; Käyhkö & Skanes, 2006). Therefore, the level of detail of the characterisation - which resulted from the generalisation of information on the photographs and was also determined by the oldest photographs - was examined in the current landscape. It was examined whether each particular defined landscape element in the classification (LULC and linear structures) represented representative surfaces in the landscape. This quality assessment is needed to appoint realistic research areas with possible military WWI relics in the present-day landscape. It could be concluded that the level of detail was adequate, since the classification was mainly based on areas with a different land use/land cover.

Table 2-2 Linear structures

Linear structures	***Label***
Hedgerow, tree row, …	1
Civil paved or unpaved roads	2
Civil or military railway	3
Waterway	4
Road going across fields and connected with civil roads	5

Table 2-3 Landscape character types based on land use/land cover (attribute 1) and military influence (attribute 2) ('o' means original state, 'i' means influenced state)

HLC-Types	***Label***	***o***	***i***
Arable land without any war traces	1.1	X	
Arable land with traces of war activity (bunker, shell hole, …)	1.2		X
Disturbed arable land, although still recognizable arable land	1.3		X
Pasture without any war traces	2.1	X	
Pasture with traces of war activity (bunker, shell hole, …)	2.2		X
Disturbed pasture, although still recognizable pasture	2.3		X
Woodland without any war traces	3.1	X	
Woodland with traces of war activity (bunker, shell hole, …)	3.2		X
Disturbed, although still recognizable woodland	3.3		X
Civil houses	4.1	X	
Garden/orchard belonging to civil houses (more than 3/5 of parcel)	4.2	X	
Destructed civil houses, fabrics or other buildings	5.1		X
Ruin and destructed surroundings with traces of war activity (bunker, shell hole, …)	5.2		X
The castle with its surrounding park	6.1	X	
The castle with its surrounding park with traces of war activity	6.2		X
Civil cemetery	7.1	X	
Military cemetery WWI	7.2	X	
Military monument WWI	7.3	X	
Golf course, playground, football field	8.1	X	
Fabric, warehouse	9.1	X	
Water in the shape of a pond or lake	10.1	X	
Disturbed land with both constructive and destructive elements, although parcel boundaries are still recognizable (though recognizable land use	10.2		X
Craters, completely destroyed landscape (no recognizable land use)	11.1		X
Military airplane	11.2		X
Military station with train rails	11.3	X	
Shunting station	11.4	X	

The landscape characters extracted from the photos were following the LCTA methodology retrospectively digitised in a spatio-temporal database by using GIS (see Figure 2-3 for the example of 2012) (Northon, 1998). The youngest classified objects aided in the interpretation of the sometimes less identifiable older objects (Käyhkö & Skånes, 2006), especially on the WWI photos. In the case of overlapping photographs within one timeframe, the youngest image with the best quality was selected. In case parts were not covered with photographs, other photographs had to be consulted to complete the coverage of the study areas or transects. The process is entirely manual and is performed with a critical eye which made the digitising time-consuming and the lion's share of the dissertation.

Figure 2-3 Example digitalisation for time phase 2012 whereby the landscape characters 1.1, 1.2, 4.1, 7.2 and 10.1 are digitised

2.3.3 Step 3: Data Analysis of the Overall Changes in the Landscape

2.3.3.1 Consistency, no data and common coverage through time

Prior to the analyses, the consistency of the digitalisation in the different time phases was evaluated. Some areas in each study area could have a non-consistent interpretation, showing differences between neighbouring landscape information along the edge of the individual photographs. This was

caused by the use of older images – in this case showing a different moment in the war and thus a different degree of destruction – when photographs for a certain moment were not available[32]. These areas were inappropriate for further analyses and obtained the label 'no consistency' in the resulting maps. The same was applied for the areas without a complete coverage of aerial information in each time phase due to a lack of photographs, which were labelled as 'no data'.

For the following quantitative exploratory analyses (cf. the landscape change trajectory analysis and impact analysis), only the areas that were commonly covered with information for all the time phases were selected. Those selected areas covered 1915, 1918, 1940 and 2012 and are used to compare the four time phases.

2.3.3.2 Exploratory analysis: qualitative and quantitative

In the exploratory analysis, the changing landscape in the last hundred years was studied to get a first understanding of the transformations happened in this time span. The analysis can be divided into a qualitative and quantitative exploratory analysis, which are simultaneous executed because of the complementary information. In the qualitative analysis, the most significant patterns were described for each time phase (1915, 1918, 1940 and 2012) with the aid of the resulting maps of each considered phase. Concerning the quantitative analysis, landscape changes between the four time phases were quantified and listed in a table.

2.3.3.3 LCTA and impact analysis

The in this chapter executed LCTA investigates the possible preservation of constructive WWI remains both below- and underground (e.g. WWI trenches, bunkers and dug-outs). The analysis is based on landscape change dynamics and gives an indication of the relations between the past and present landscape. Landscape change trajectories describe the overall spatio-temporal changes of the landscape (Käyhkö & Skanes, 2006; Vuorela & Toivonen, 2001). Following from literature - already described in the introduction (Chielens et al., 2006; Doyle, 2014; Stichelbaut, 2011), we know more about the destructive effects of WWI on the landscape. Therefore, we want to investigate to what extent the landscape was reconstructed, preserved and what kind of new destinations were introduced in the post-war landscape (1940) compared to the pre-war situation (1915). As mentioned before, the state of the landscape in 1915 will be considered as an illustration of the pre-war landscape since WWI destructions were limited in that period. However, WWI military constructions were already present. The latter follows from literature (Chielens et al., 2006; Doyle, 2014; Stichelbaut, 2011) and also from results of the exploratory analysis (see further).

Three trajectories were defined (Figure 2-4) (Baeyens et al., 2014): post-war preservation, post-war reconstruction and post-war new destination. These represented the evolution of the landscape characters (original state 'o' in Table 2-3) between 1915, 1918 and 1940; this without the incorporation of military influences (cf. military influenced state 'i' in Table 2-3). If no changes occurred between 1915, 1918 and 1940, the landscape character knew a post-war preservation. A post-war reconstruction means that the pre-war landscape character (1915) was reconstructed after

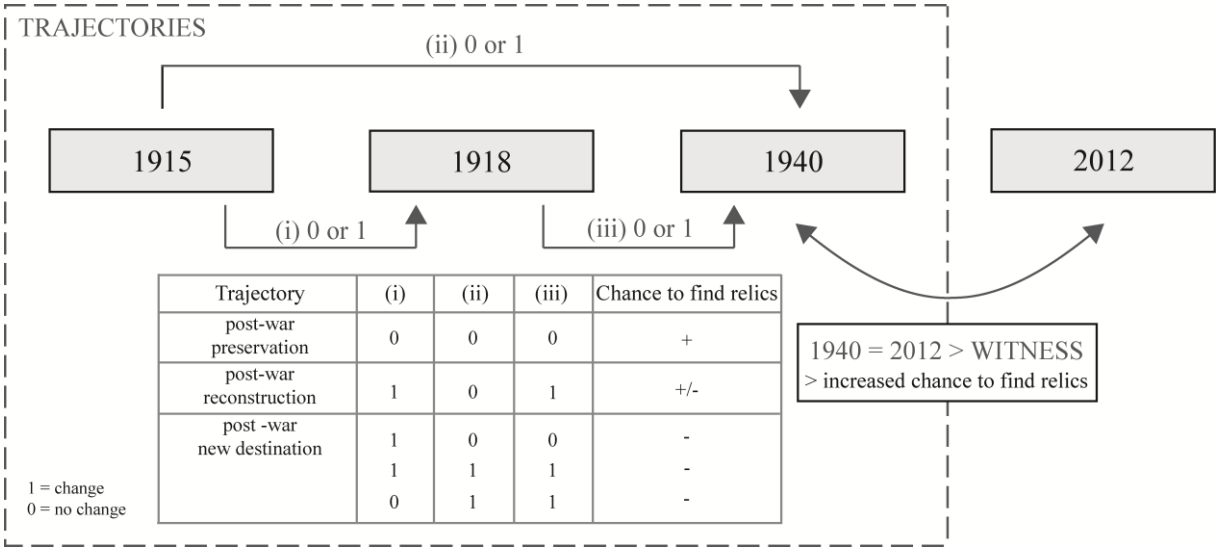
[32] For a visual representation of non-consistent areas, see the results (section 2.4.1).

the war (1940) with a change in between (1918). In case the landscape character changed after WWI (1940) compared to the pre-war landscape (1915), the type of evolution is defined as post-war new destination[33].

In between each time phase, the change of a historical landscape character type was labelled by '1' and no change by '0', giving a unique three-digit code that stands for a particular trajectory with a corresponding estimation of the possible preservation of military relics today. Each defined post-war trajectory is linked with a certain estimation of the preservation of constructive WWI remains towards today. In case the landscape knew a post-war preservation during and after wartime, I estimate the preservation of WWI remains towards today high since no heavily destructions and changes in the landscape character occurred destroying WWI constructions. If the landscape character knew a post-war reconstruction, I estimate the preservation lower as we assume that heavily destructions occurred in the area, destructing the WWI constructions. However, the degree of preservation is higher than a post-war new destination, since in the latter we estimated the WWI remains to be completely wiped out by both WWI destructions and by severe changes in the landscape character (e.g. pasture with WWI remains (1915), craterland (1918), housing (1940)).

Furthermore, it is also important to illustrate which landscape characters are still visible in the current landscape by making the comparison between 1940 and 2012. If the character types were the same in between 1940 and 2012, a 'witness' of a certain landscape character was observed towards today. In other words, there is a witness of a post-war preservation, post-war reconstruction or post-war new destination. A 'witness' increases the degree of preservation on finding a WWI relic towards today as the landscape characters did not change anymore in between 1940 and 2012. In case the landscape character changed between 1940 and 2012 there is no witness of a certain post-war trajectory.

[33] Lot of new elements were probably planned for the reconstruction, but were maybe located differently compared to the pre-war landscape (e.g. houses that are re-located next to the old locations due to an impossible reconstruction resulting from severe destructions). These are also seen as a new destination.



Trajectory	(i)	(ii)	(iii)	Chance to find relics
post-war preservation	0	0	0	+
post-war reconstruction	1	0	1	+/-
post -war new destination	1	0	0	-
	1	1	1	-
	0	1	1	-

Figure 2-4 Post-war trajectories (between 1915, 1918 and 1940) and witness (between 1940-2012) with the determined possible chance to find relics

As mentioned before, the changing level of military influence associated with the landscape character types ('i' in Table 2-3) is not considered as a change in the LCTA. This military influence was used in a complementary impact analysis to generate an extra indication for the possible preservation of military constructive and destructive WWI remains today. Therefore, the levels of impact are processed by integrating all time phases. Each landscape character with a 'i' in the characterisation obtains a related impact factor (IF) (Table 2-4). For each historical landscape character type with an associated destruction degree of military influences, an appropriate rank number was given (0 to 4) that stood for the impact factor (Table 2-4, IF). Hence, these numbers were rescaled and normalised between 0 and 1 in order to obtain more easily interpretable impact factors (Table 2-4, Normalised IF).

Table 2-4 Impact factor (IF) related to the historical landscape character types. The impact factor was normalised between 0 and 1.

IF	Normalised IF	Historical landscape character types
0	0	1.1, 2.1, 3.1, 4.1, 4.2, 6.1, 7.1, 7.2, 7.3, 8.1, 8.2, 9.1, 10.1, 11.3, 11.4
1	0.25	1.2, 2.2, 3.2, 6.2, 10.2
2	0.50	1.3, 2.3, 3.3, 5.1, 5.2
3	0.75	11.1
4	1	11.2

Afterwards, each polygon in the trajectory map gets a general impact factor based on the sum of the assigned impact factors of the four time phases (1915, 1918, 1940 and 2012).

SUM IF = (IF 1915) + (IF 1918) + (IF 1940) + (IF 2012)

A high IF sum indicates more and longer military influences during and after WWI and therefore increases the preservation of WWI relics today. This assumption is based on already existing

literature whereby it was proven that the higher the military destruction was because of shelling, the more military shrapnels could be found in the landscape of today (Note et al., 2018).

In the final step of the methodology, the results of the LCTA and impact analysis were combined to make a general judgement of the possible preservation of WWI relics; this combination was tested with a correlation analysis (Spearman correlation)[34] (Kutner et al., 2005).

2.4 Results

2.4.1 Consistency, no data and common coverage

All the transects appeared to have consistent interpretations, except for the area on the left bank of the river Yser in transect Nieuwpoort in transect one (19.7 km^2 or 45.4 % of the total area; Table 2-5). This can be explained by the inundated area and realistic demarcated lines and thus cannot be used for analyses (Figure 2-5) (Appendix 2A).

[34] The Spearman correlation was used because the dataset consisted of categorical data (Kutner et al., 2005). The post-war trajectory type was indicated in the spatio-temporal database by '1' (post-war preservation), '2' (post-war reconstruction) or '3' (post-war new destination). If a witness was present towards 2012, this was indicated by '1' (witness) and '0 '(no witness). The impact factor (IF) had also five categories whereof the sum was made to make an overall assessment of military impact (sum IF).

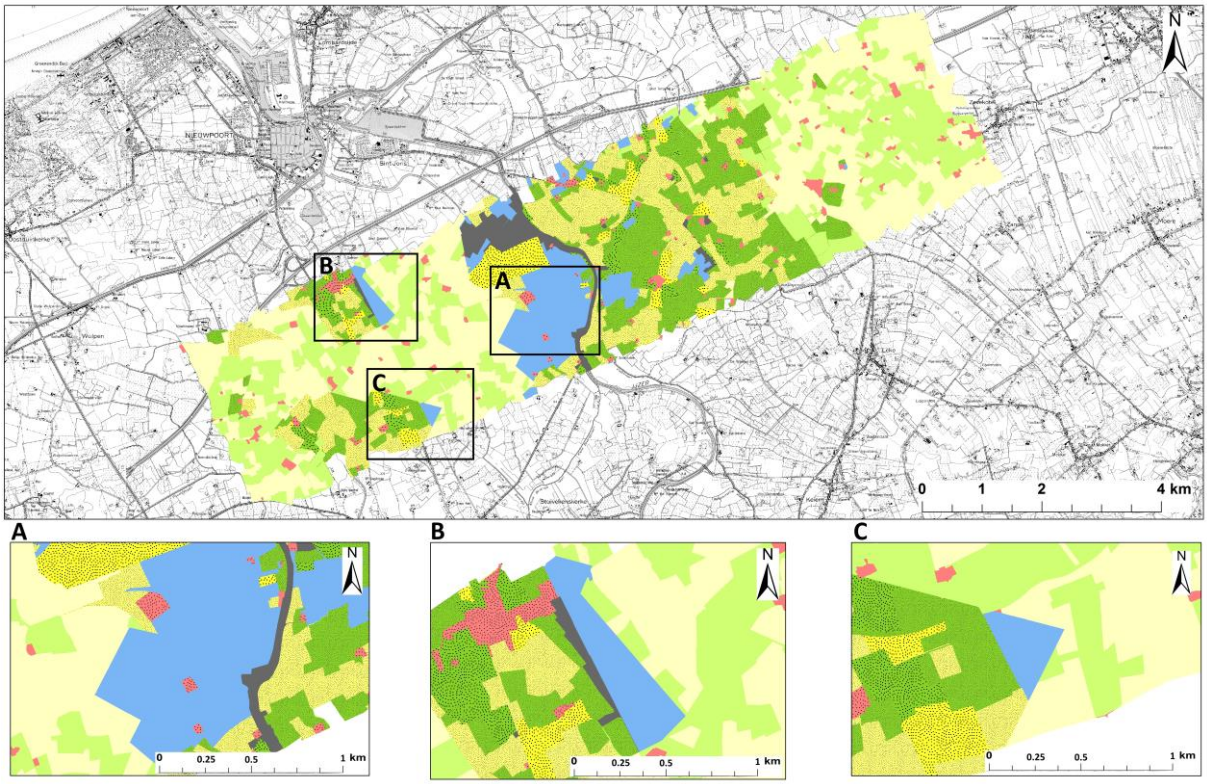


Figure 2-5 Inconsistent digitized areas in transect Nieuwpoort (1915)

Concerning the data coverage of the transects for each separate time phase, the transect Ypres and Kemmel could not be completely digitised because of a small lack of aerial photographs in 1940 and 1918, and a larger shortage of photos in 1915 (see details in Table 2-5). No additional photographs were found to cover the whole areas (Appendices 2B and 2C). The lack of data is mostly visible on the eastern and western edges of both transects, which represent the hinterland with less aerial surveillance during WWI.

To analyse the four time phases, only the common covered areas were used. In total 53.9 km^2 (66.1 % of the area) was analysed in transect Ypres and 66.1 km^2 (79.1 % of the area) in transect Kemmel. The transect Nieuwpoort was completely covered except for the previous mentioned non-consistent area (23.7 km^2 or 54.6 % of the area) (Table 2-5).

2.4.2 Exploratory Analysis

During the first year of WWI (1915), the landscape was already disturbed. For the transect of Nieuwpoort (43.4 km^2) (Appendix 2A), the before-mentioned inundation is noticeable on the left bank of the river Yser. Despite the military influence, the land use/land cover could still be recognized in the non-inundated zones, which gives an idea of the pre-war landscape. In 1918, the inundation was located between the left bank of the river Yser and the elevated railway. In 1940, quite logically, the inundation disappeared completely. Today (2012), there is a notable increase in arable lands and a decrease in pastures with fewer ditches and other waterways. The qualitative described results can also be viewed in Table 2-5.

The transects of Ypres (81.6 km^2) and Kemmel (83.6 km^2) have a similar discussion (Appendices 2B and 2C), which is however very different than the northern transect. In 1915, there was already a heavier impact than in the surroundings of Nieuwpoort: more fields had had a bigger disturbance degree. Also later, at the end of WWI (1918), the impact on the landscape was clearly bigger whereby an enormous area was wiped out and changed into craterland (label 11.2) or had no

recognisable land use/land cover anymore (label 11.1) (Table 2-5); 67.6 % of the area in the transect Ypres and 78.2 % of the area in the transect Kemmel]. The area with craterland follows the 'Westrozebeke Ridge' and the Flemish Hills and is marked by the repeatedly shifting front lines resulting in consequent periods of destruction. This front zone is connected with many military roads (label 5; almost 30.0 % of the total length of linear structures in both transects), reaching far into the hinterland. The situation of 1940 suggests a spectacular reconstruction of the destructed landscape. When comparing this with 1915 (indication of pre-war situation), many differences can be identified (Table 2-5 and Appendix 2A). Firstly, there is a decrease (from 58.7 % to 55.9 % of the area) of arable lands (label 1.1, 1.2 and 1.3) in the transect Ypres, which was replaced by housing (label 4.1) especially due to a growth of the city Ypres (Appendix 2B). The area around Kemmel shows the same phenomenon (from 70.3 % to 66.8 % of the area) (Appendix 2C). Secondly, it is clear that the parcel/field boundaries consisting of tree rows or shrubs (label 1) in the transect Kemmel decreased (from 40.8 % to 31.9 % of the total length of linear structures). By contrast, an increase (from 18.2 % to 27.2 % of the total length of linear structures) has been noticed in the transect Ypres. Thirdly, the comparisons of the street patterns of the Ypres city are very similar and thus reconstructed but new elements have been introduced (e.g. the garden city 'Kalfvaart') (Dendooven, 2009). Finally, the pre-centenary situation (2012) has indicated a growth of cities and industry in both transects since 1940.

*Table 2-5 Land use/land cover (km²) and linear structures (km) (*within the transect, only the percentages can be compared with the other time periods)*

	Transect Nieuwpoort (*)								Transect Ypres (*)								Transect Kemmel (*)							
Land use/land cover	**1915**		**1918**		**1940**		**2012**		**1915**		**1918**		**1940**		**2012**		**1915**		**1918**		**1940**		**2012**	
	km²	%	km²	%	km²	%	km²	%	km²	%	km²	%	km²	%	km²	%	km²	%	km²	%	km²	%	km²	%
1.1	6.2	26.2	4.4	17.2	23.1	48.5	36.0	78.7	-	-	-	-	42.4	52.0	39.	42.8	7.5	11.4	0.0	0.0	54.9	66.5	50.3	62.9
1.2	4.6	19.2	5.8	12.2	-	-	-	-	29.5	51.6	9.7	12.8	2.8	3.9	0.1	0.1	36.8	55.7	6.3	0.6	0.3	0.3	0.0	-
1.3	0.6	2.4	5.3	14.1	-	-	-	-	3.9	7.1	6.0	3.7	-	-	-	-	2.1	3.2	13.3	12.7	-	-	-	-
2.1	4.7	20.0	3.1	11.9	18.8	48.1	4.7	14.3	0.0	0.0	-	-	11.1	15.0	18.	22.1	2.2	3.3	0.2	-	14.9	18.1	16.3	20.6
2.2	5.5	23.2	5.1	13.2	-	-	-	-	12.0	21.4	4.7	6.2	7.2	9.1	0.6	0.9	11.1	16.8	1.4	0.3	3.6	4.7	0.0	0.0
2.3	0.5	2.1	6.0	17.2	-	-	-	-	1.7	3.0	4.3	3.1	-	-	-	-	0.6	0.8	4.6	5.6	-	-	-	-
3.1	-	-	-	-	0.01	-	0.05	0.1	0.1	0.2	-	-	2.5	3.9	2.9	4.8	0.8	1.2	-	-	2.5	3.2	2.8	3.4
3.2	-	-	-	-	-	-	-	-	1.9	3.5	0.2	0.0	0.5	0.9	0.0	0.1	1.6	2.4	0.2	0.2	0.2	0.3	-	-
3.3	-	-	-	-	-	-	-	-	1.2	2.2	0.7	0.9	-	-	-	-	0.1	0.1	0.5	0.7	-	-	-	-
4.1	0.5	2.0	0.4	1.2	1.4	3.3	2.1	4.9	0.1	0.2	0.1	0.1	6.2	9.4	13.	20.0	1.4	2.1	1.1	0.1	5.0	4.8	9.3	8.9
4.2	-	-	-	-	0.0	0.0	0.3	1.2	0.0	0.1	-	-	1.4	2.2	1.3	1.9	0.3	0.4	0.0	0.0	1.5	1.2	1.8	1.9
5.1	0.1	0.6	0.7	1.5	-	-	-	-	2.8	5.1	2.6	3.9	-	-	-	-	0.7	1.0	1.0	1.2	-	-	0.1	0.1
5.2	-	-	-	-	-	-	-	-	0.7	1.3	0.1	0.1	-	-	-	-	0.3	0.5	0.1	0.1	0.0	0.0	-	-
6.1	-	-	-	-	-	-	-	-	-	-	0.0	-	0.4	0.5	0.8	1.2	0.1	0.1	-	-	0.2	0.2	0.3	0.5
6.2	-	-	-	-	-	-	-	-	0.7	1.3	0.3	0.5	0.4	0.8	-	-	0.1	0.1	-	-	0.2	0.2	-	-
7.1	-	-	-	-	-	-	0.0	-	0.0	0.1	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	-	-	0.0	0.0	0.0	0.0
7.2	-	-	-	-	-	-	-	-	0.0	0.0	0.0	0.0	0.1	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2
7.3	-	-	-	-	-	-	-	-		-	-	-	0.0	0.1	0.0	0.1	-	-	-	-	0.0	0.0	0.0	0.0
8.1	-	-	-	-	-	-	-	-	0.0	0.0	-	-	-	-	0.8	1.3	0.0	0.0	-	-	-	-	0.5	0.4
9.1	-	-	-	-	-	-	0.1	0.3	0.0	0.0	-	-	0.3	0.4	1.9	2.9	-	-	-	-	-	-	1.6	0.8
10.1	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.4	0.6	1.1	0.6	1.0	0.6	1.1	0.9	1.5	0.1	0.1	0.2	0.2	0.2	0.3	0.2	0.3
10.2	0.7	2.8	7.2	2.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11.1	0.3	1.5	5.3	8.8	-	-	-	-	0.9	1.6	20.0	15.6	0.2	0.4	-	-	0.5	0.8	27.3	37.2	-	-	-	-
11.2	-	-	0.1	0.0	-	-	-	-	-	-	31.6	52.0	-	-	-	-	-	-	27.2	41.0	-	-	-	-
11.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11.4	-	-	-	-	-	-	-	-	-	-	0.0	0.1	0.0	0.0	-	-	-	-	0.0	0.1	-	-	-	-
no data/no consistency	19.7		-		-		-		27.7		0.7		5.3		-		17.5		0.1		0.0		-	
common coverage	23.7	100	23.7	100	23.7	100	23.7	100	53.9	100	53.7	100	53.7	100	53.7	100	66.1	100	66.1	100	66.1	100	66.1	100
transect area	43.4		43.4		43.4		43.4		81.6		81.6		81.6		81.6		83.6		83.6		83.6		83.6	
Linear structures	**1915**		**1918**		**1940**		**2012**		**1915**		**1918**		**1940**		**2012**		**1915**		**1918**		**1940**		**2012**	
	km	%	km	%	km	%	km	%	km	%	km	%	km	%	km	%	km	%	km	%	km	%	km	%
1	41.5	10.9	19.3	5.1	42.4	8.7	78.0	18.1	89.5	18.2	50.5	12.8	117.9	27.2	74.	18.6	332.2	40.8	92.1	16.6	176.3	31.9	126.9	23.9
2	75.3	19.7	157. 4	25.2	120. 8	18.4	162. 9	33.6	229.2	46.7	162.5	41.3	257.2	59.4	275 .5	68.6	308.5	37.9	238.6	43.1	282.2	51.0	313.0	58.9
3	0.4	0.1	3.1	-	3.1	-	0.0	-	14.7	3.0	45.5	11.5	12.1	2.8	10.	2.5	7.4	0.9	20.5	3.7	7.4	1.3	7.4	1.4
4	264.7	69.3	360. 4	69.6	476. 0	72.9	216. 4	48.4	30.1	6.1	17.5	4.5	46.1	10.6	41. 5	10.3	66.7	8.2	44.2	8.0	87.2	15.8	84.1	15.8
5	-	-	1.1	-	0.0	-	0.0	-	127.0	25.9	117.5	29.9	-	-	-	-	100.2	12.3	157.8	28.5	-	-	-	-
no consistency	399.4		-		-		-		-		-		-		-		-		-		-		-	
total length	381.9	100	345. 5	100	376. 2	100	268. 7	100	490.5	100	393.4	100	433.2	100	401 .9	100	815.1	100	553.1	100	553.2	100	531.5	100

2.4.3 Landscape Change Trajectory and Impact Analysis

The landscape change trajectories presented in Figure 2-6 visualise the different trajectories for each parcel, indicating areas with or without witnesses towards 2012. Figure 2-8 (A) which represents the corresponding numerical values of the landscape change trajectories per transect, shows that in the transect Nieuwpoort (transect 1) 43.9 % of the analysed area was preserved in 2012 with a witness to 1940. These territories are fragmented in the area. The transects Ypres and Kemmel (transects 2 and 3) have less preserved parcels with a witness (14.8 % and 10.8 % of the analysed area), and these are particularly located in the hinterland. Instead of the preserved parcels, 51.1 % of the transect Kemmel (transect 3) and 29.3 % of the transect Ypres (transect 2) have been reconstructed.

Regarding the impact analysis, Figure 2-8 (B) which represents the corresponding numerical values of the impact analysis per transect, indicates that the majority of the transect Ypres (transect 2) (36.2 % of the analysed area) and transect Kemmel (transect 3) (32.0 % of the analysed area) has an impact factor of 1.25. This is represented by the highest point in the trendline. These territories are principally located along the front line (see Figure 2-7[35]). In the transect Nieuwpoort (transect 1), the majority of the parcels shows a lower impact, namely 0.75 (27.5 % of the analysed area) which is also represented by the highest point in the trendline.

In general, results of both analyses (including the three transects) can be combined to obtain an overall assessment of the possible preservation of relics in the landscape. As shown in Figure 2-8 (C) (this represented without the 'witness' towards 2012), the preserved areas (post-war preservation) are regions with less military impact observed in 1915, 1918 and 1940 as the highest point in the trenline is positioned at the lower impacts. A relation can also be noticed for the parcels with post-war reconstruction that have a moderate impact degree as the highest point of the trendline is positioned among the moderate impacts. Last, the parcels with a new destination are characterised with a high impact degree as the highest point of the trendline is positioned above the high impact factors. The previous interpretation was tested with a Spearman correlation, whereby a small significant relation was observed (.148) between the trajectory types and impact factors (two-tailed, $p < 0.01$, H0: no relation can be found between the impact factors and trajectory types). This rather small correlation means that it appears to be more 'visually' correlated in Figure 2-8 (C) instead of shown by statistics. As this relation is rather small, one can conclude that both analyses have complementary information whereby they each delivered valuable unique information which cannot be replaced by the other analysis. Both have to be interpreted simultaneously to make a final judgement of the possible preservation of relics in an area. The small Spearman correlation between impact and post-war trajectories can also separately be found within the transects ($rs = .04$ in transect 1, $rs = .10$ in transect 2, $rs = .13$ in transect 3; two-tailed, $p < .01$).

[35] The map classification was chosen between zero and two as the sum of the impact factors lied within this range. This map classification was based on an equal interval classification in order to be able to compare the three different areas.

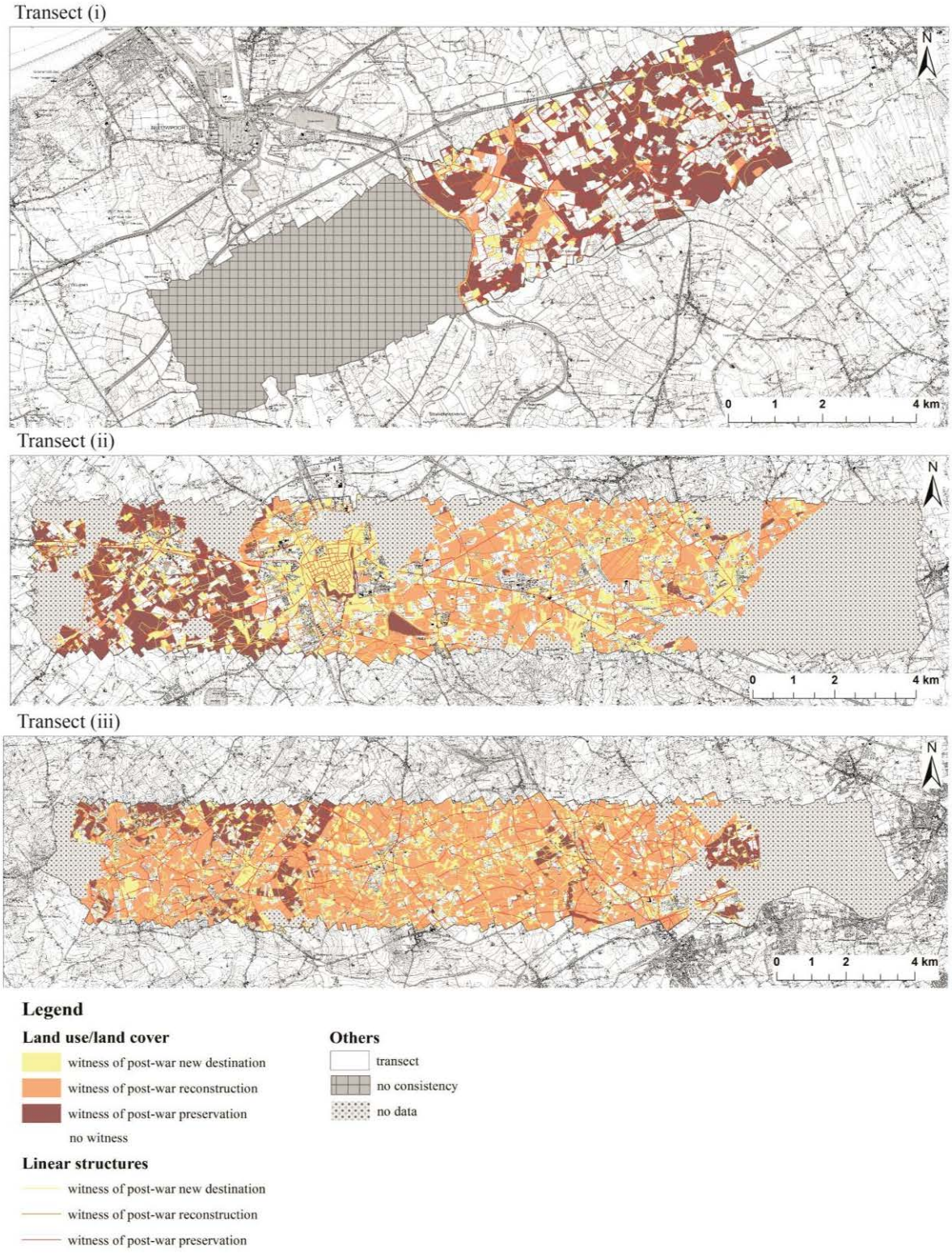


Figure 2-6 Post-war trajectories transect Nieuwpoort, Ypres, Kemmel and witness

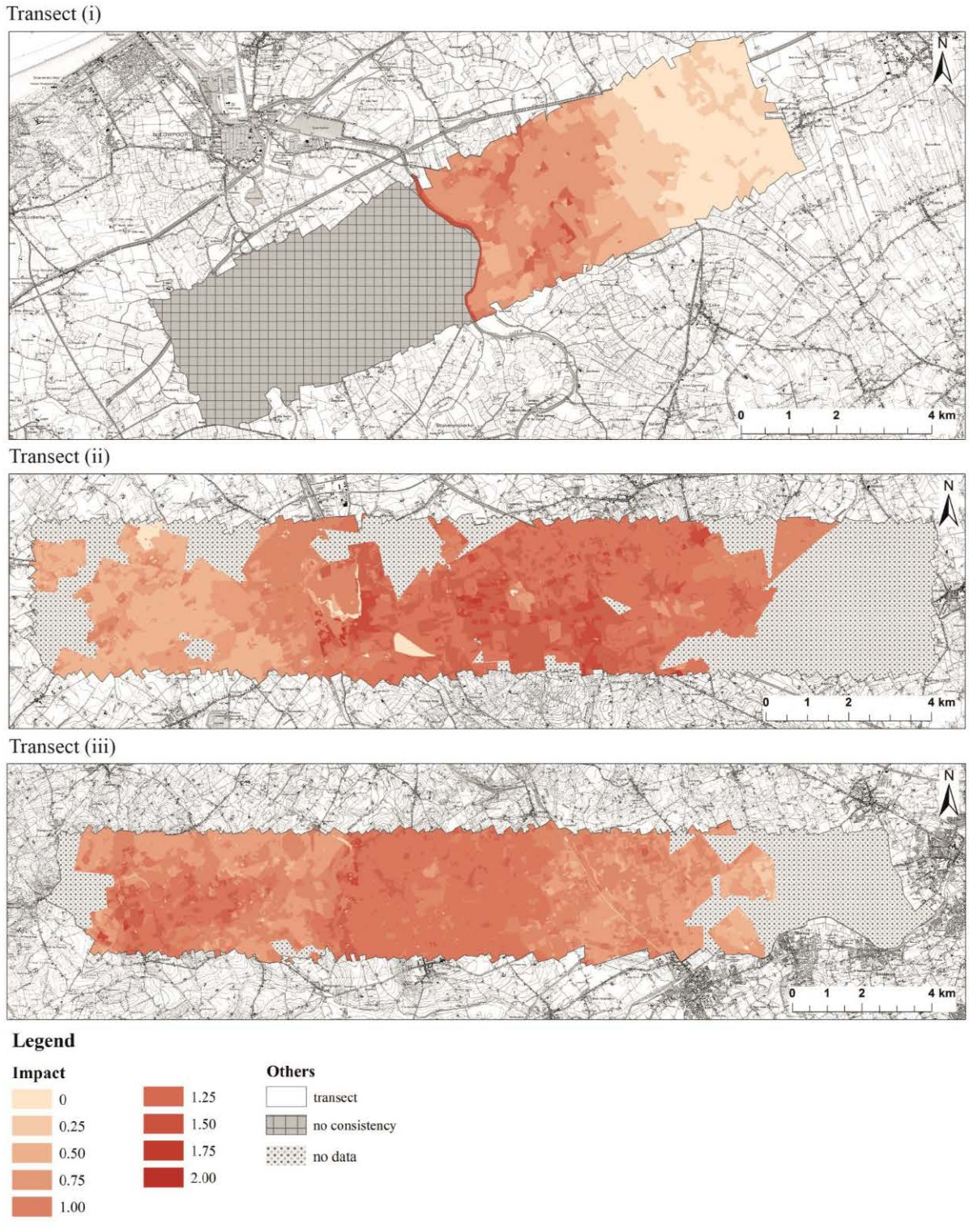
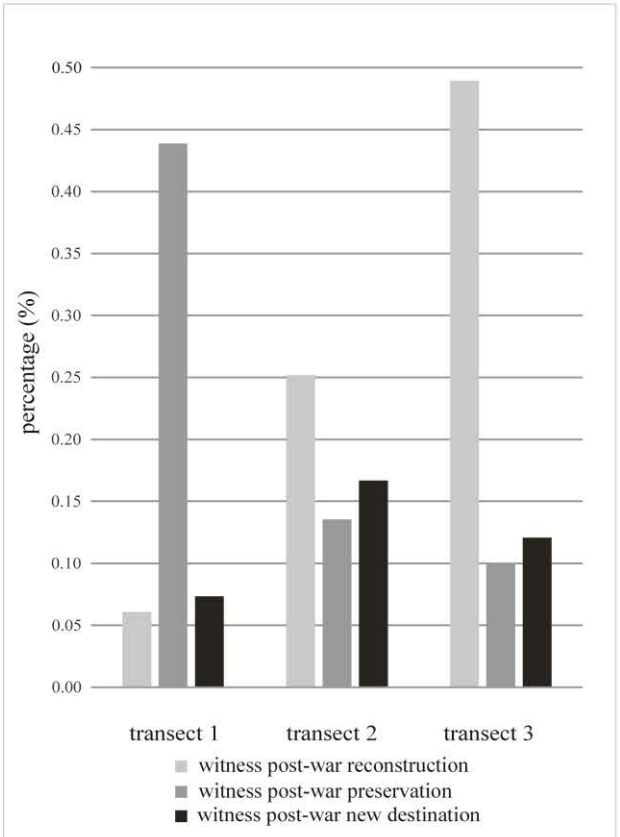
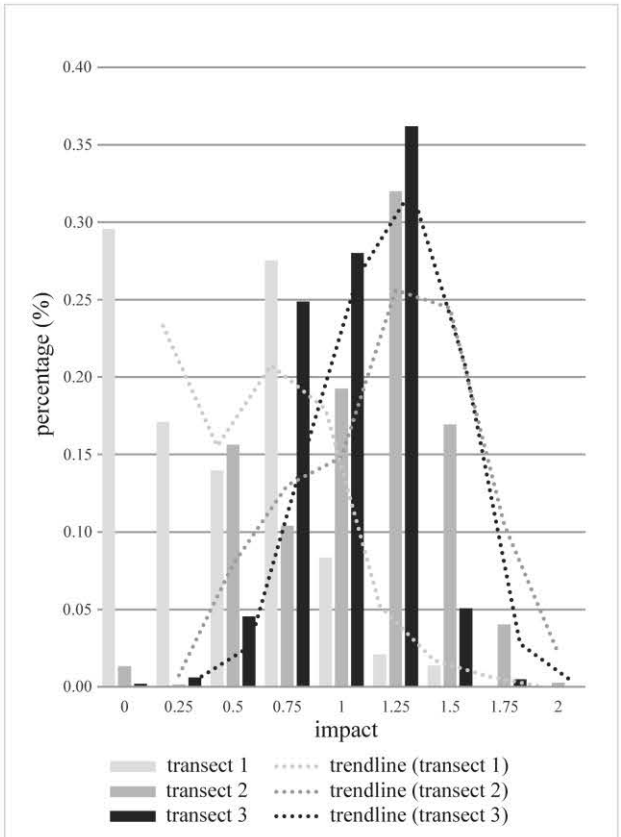
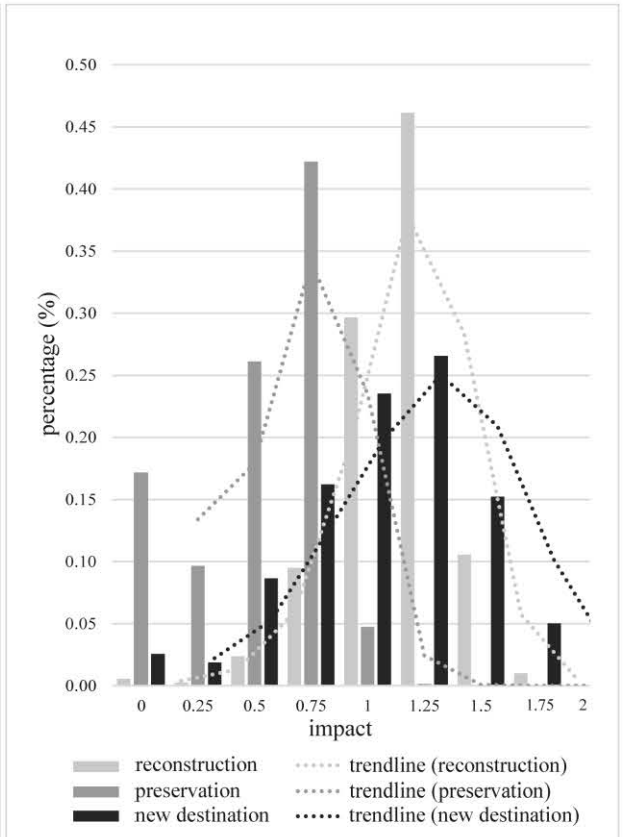


Figure 2-7 Impact factor transect Nieuwpoort, Ypres, Kemmel







	transect 1		transect 2		transect 3	
	km²	%	km²	%	km²	%
witness post-war reconstruction	1.4	0.06	13.6	0.25	32.4	0.49
witness post-war preservation	10.4	0.44	7.3	0.14	6.6	0.10
witness post-war new destination	1.7	0.07	9.0	0.17	8.0	0.12
no witness	10.1	0.43	24.0	0.45	19.2	0.29
sum	23.7	1.00	53.9	1.00	66.1	1.00

	transect 1		transect 2		transect 3	
	km²	%	km²	%	km²	%
impact 0	7.0	0.30	0.7	0.01	0.1	0.00
impact 0.25	4.1	0.17	0.1	0.00	0.4	0.01
impact 0.50	3.3	0.14	8.4	0.16	3.0	0.05
impact 0.75	6.5	0.28	5.6	0.10	16.4	0.25
impact 1.00	2.0	0.08	10.4	0.19	18.5	0.28
impact 1.25	0.5	0.02	17.2	0.32	23.9	0.36
impact 1.50	0.3	0.01	9.1	0.17	3.4	0.05
impact 1.75	-	-	2.2	0.04	0.3	0.00
impact 2.00	-	-	0.1	0.00	0.0	0.00
sum	23.7	1.00	53.9	1.00	66.1	1.00

	reconstruction		preservation		new destination	
	km²	%	km²	%	km²	%
impact 0	0.4	0.01	6.6	0.17	0.9	0.03
impact 0.25	0.2	0.00	3.7	0.10	0.7	0.02
impact 0.50	1.6	0.02	10.0	0.26	3.1	0.09
impact 0.75	6.6	0.09	16.2	0.42	5.8	0.16
impact 1.00	20.6	0.30	1.8	0.05	8.5	0.24
impact 1.25	32.1	0.46	0.1	0.00	9.5	0.27
impact 1.50	7.3	0.11	-	-	5.5	0.15
impact 1.75	0.7	0.01	-	-	1.8	0.05
impact 2.00	-	-	-	-	0.1	0.00
sum	69.5	1.00	38.3	1.00	35.9	1.00

Figure 2-8 (A) Post-war trajectory type per transect with witness (%), (B) Impact factor per transect (%), (C) Post-war trajectory type (without witness) per impact factor for the three transects together (%)

2.5 Discussion & conclusion

This study illustrated that knowledge of landscape changes can be applied in historic conflict landscapes to determine the possible preservation of military relics in the landscape today. This was accomplished by the use of a rich and powerful source: historical aerial photography. These photos represented valuable information about the landscape during and after the First World War. The generated maps based on the interpretation of the historic photos through time, delivered clear and precise information about the changing landscape in the past 100 years. Two problems arose while digitising the old WWI-aerial photos. First, not all the photos covered completely the studied areas (cf. 'no data'); this especially on the borders of the transects. However, the digitised area was still sufficient enough to make valuable landscape analyses since large transects were studied. Second, per studied year, the oldest photos were selected. If not enough photos were available, younger photos were used. In the case too 'young' photos were analysed, the time difference in one year was to large making some digitized areas incorrect (cf. consistency). Consequently, the study area around Nieuwpoort could not completely be taken into account. Approximately the half of the area was appointed not to be consistent. However, this information could only not be used to analyse the landscape dynamics in the area. The information could still be used for a general overview of the area Nieuwpoort.

Results of the exploratory analysis indicated that WWI had an enormous influence on the landscape, with the cumulative effect of four years of constructive works (trenches, bunkers, etc.) and destructive activities (artillery shelling, mining, etc.). The most striking examples of these impacts were observed on the 'Westrozebeke Ridge' and the Flemish Hills, which corresponds to the notes of Pearson et al. (2010) and Stichelbaut et al. (2016). Later in 1940, the landscape was completely restored and only little research has been performed so far regarding the reconstruction process of the pre-war landscape from a spatial nor historical aspect. Few studies focus on urban areas and settlement (Cornilly et al., 2009) but less attention was paid to the rural landscape. Dendooven (2009) states that this restoration was characterised by a traditional reflex, respecting most of the historical reality but some changes could nevertheless be observed (e.g. barbed wire instead of green parcel borders). Results of the exploratory analysis corresponded to this point of view. In general, one can conclude that the detailed exploratory analysis is in agreement with literature and provides new empirical data such as visuals and maps with a corresponding quantification of landscape changes. Moreover, the results are constructed on a landscape scale which makes it more accessible and understandable for planners and also supports a more sustainable heritage management (Fairclough, 2003).

Following the research objectives formulated in the introduction section, the WWI impact on the landscape was more closely analysed with both a trajectory and impact analysis. Both analyses are useful to identify areas with a degree of preservation of constructive and destructive WWI heritage today. Both have a complementary relationship as the trajectory analysis evaluated the degree of preservation of constructive WWI heritage, and the impact analysis estimated the degree of preservation of both constructive and destructive heritage by incorporating the visibility of military remains through time. Therefore, both need to be taken into account to predict the general degree of preservation of WWI military relics. This complementary relation could be statistically detected in the three transects as the correlation was rather low, illustrating that this methodology can be applied in various landscapes types.

This estimation model (cf. trajectory and impact analysis) is the launch of a general estimation model of the possible degree of preservation of WWI relics and demonstrates how landscape changes can be useful for future landscape planning and management of heritage landscapes as a predictive tool. However, this estimation can always be more refined by firstly taking into account the sequence of the character types in the model as each character type has its associated characteristics relative to

the preservation of WWI relics. For instance, if the character type in the end of the post-war trajectory (1940) would be 'woodland', then the preservation of WWI relics would be abundantly higher compared to other character types such as 'arable land' or 'industry'. Or if the character type in the middle of the post-war trajectory (1918) would be 'arable land', then the probability would be lower compared to other character types such as 'woodland' or 'pasture'. Secondly, the model can also be more refined by incorporating the WWI relic of interest since many forms exist. Each type of relic has own characteristics such as the material of construction (e.g. trenches in wood, bunkers in concrete) or the way they were built (e.g. trenches half in the ground, dug outs below ground). These characteristics have specific preservation relationships towards the character types and the related soil. For instance, the preservation of remnants of trenches in 'arable land' is less favourable than in 'woodland' as fertilizers affect the wood of the trenches (Kibblewhite et al., 2015). The preservation of dugouts is more favourable if houses and their foundations stayed above these constructions during the whole trajectory (e.g. Dug out Zonnebeke is located underneath the fundaments of the church of Zonnebeke). Last, the possible preservation can be validated by interdisciplinary techniques (e.g. archaeology, geo-soil sensing). I can conclude that this model has many options for refinements. Ideally, this refined model could be a construct of interdisciplinary research combining knowledge and expertise from different perspectives (e.g. excavations and remote-sensing from an archaeological point of view, geo-soil sensing techniques).

GIS played an important role in this research and provided a rich spatio-temporal dataset. Nevertheless, the holistic and manual process of digitizing is time consuming but necessary to acquire an extensive dataset on a detailed scale, which is not yet possible in an automatic manner. Hence, the detected landscape changes could be studied in a more detailed way. Observations of changes are namely linked to the change magnitude, which is next to the accuracy and comparability of the data, also connected with the degree of detail (Antrop, 2003).

The spatio-temporal database was set up with the predetermined aims of this dissertation in mind and was therefore based on three aspects. First, the classification of landscape information into historical characters was chosen to be addressed with the ideas and concepts of the HLC as this would provide the possibility for a wide range of archaeological, historical and cultural change analyses in the militarised landscape (Fairclough, 2003). Second, the main source for the characterisation was chosen to be historical aerial photographs. Other than maps, aerial photos provide a holistic perspective on the landscape (Troll, 1966) with information about land use, topography and context as well as their mutual relations (Cowley & Ferguson, 2009). Notably, the use of maps would not be appropriate as no topographical large scaled maps existed during World War One. Third, after analysing the historical aerial photos it was clear that land use/land cover and linear structures would be the landscape elements that determine the landscape characters.

Four time periods were used to analyse hundred years of land use/land cover and linear structures changes. Land use is the most dynamic characteristic because of the crop rotation and the changing land use each year (Antrop, 2003). Consequently, the hundred years' study in four time slices is not extensive. However, the objectives of this paper mainly focused on the landscape changes between the beginning, the end and after the war. Hence, choices of the analysed time phases had to be made as the process of digitizing was time consuming. One would be able to supplement the dataset between 1940-2012 by using other available aerial photographs.

Although this study analysed the landscape with the attributes land use/land cover and linear structures, which were defined by the perceivable information on the photographs, it is also important to analyse also other landscape components (e.g. topography, soils) as well as to define change, which would make the approach more holistic (Antrop, 2003). Therefore, this is an interesting thought for further research in order to identify the changes of WWI more in a comprehensive way. This can be accomplished by emphasizing transdisciplinary research because the driving forces of change are complex to understand (Käyhkö & Skånes, 2006).

Furthermore, this methodology, relying on the unique combination of the historic landscape characterisation (HLC) and Landscape Change Trajectory Analysis (LCTA), can also be used in other conflict landscapes with another military influence on the landscape, warfare and other landscape characteristics, for the indication of military relics in the current landscape. The suggested military landscape characterisation can be adapted and executed with the same (historic aerial photographs) or other available sources of the specific area (maps, remote sensing data, …) (Pearson, 2012).

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CHAPTER 3 – REVEALING THE PRESERVATION OF FIRST WORLD WAR SHELL HOLE LANDSCAPES BASED ON A LANDSCAPE CHANGE STUDY AND LIDAR

"A place with an evil name, pitted and pocked with shells, the trees torn to shreds, often reeking with poison gas"

(Nash, 1948, p. 187, when he walked in the landscape of the Ypres Salient in 1917)

Modified from:

Van den Berghe, H., Gheyle, W., Note, N., Stichelbaut, Van Meirvenne, M., Bourgeois, J., Van Eetvelde, V. (2018) Revealing the preservation of First World War shell hole landscapes based on a landscape change study and LiDAR, Danish Journal of Geography, 119(1), pp 38-51.

ABSTRACT The surface scars of the First World War (1914-1918) are rapidly disappearing due to modern and fast changing landscapes. Therefore, there is a need to monitor landscape relics that mark our past. This study examines depressions caused by shelling. These shell holes are still present today and are one of the last remains of the military destructions during the four years long stalemate on the Western Front. Shell hole landscapes are until now overlooked in landscape research and little attention is given to the causes behind the absence or presence of these shell holes in the present-day microtopography. This paper aims to identify these causes by using digital interdisciplinary techniques on a landscape scale: LiDAR giving insights into the preservation of the shell holes today, landscape maps indicating the evolution of land use/land cover in the past century, and a shell hole density map representing the situation of 1918. Results revealed that the WWI shell hole landscape is still abundantly present today, and where it has disappeared, a direct link was found to land use/land cover transformations and the intensity level of cultivated fields from past to present. To work towards a sustainable management of WWI-heritage, these findings are indispensable.

KEYWORDS landscape changes, historical aerial photography, shell hole density map, microtopography, military geography, Flanders

3.1 Introduction

A century after the end of the First World War (WWI) it is generally accepted that the war created a militarised environment (Pearson et al., 2010). However, the impact of the war on the landscape is still not fully understood. This ranges from the physical impact, which can be subdivided into above and underground impact (e.g. shelling, military infrastructure) (Note et al., 2018; Stichelbaut, 2011), to the influence on the memory and identity of places (e.g. political influences) (Miles, 2016; Smith, 2016; Trout, 2010; Woodward, 2005). This paper investigates the specific impact of continuous artillery shelling at the former WWI battlefields. Following Prentiss (1937), approximately 1.45 billion of shells were fired by the German, French and British armies on all the fronts, whereof 400 million along the Western front are still unexploded (Miles, 2016). The frontline in Flanders (Belgium) was one of the most shelled areas during the war (Pearson et al., 2010) which changed into a lunar like environment, peppered with craters and full with mud and military infrastructure. The shelling almost completely concealed the pre-war landscape and destroyed much fauna and flora (Miles, 2016; Wearn et al., 2017). Shortly after the war, the local population returned and rebuilt the cities, villages and surrounding landscapes (Claeys, 2017; Dendooven, 2009). The fields were cleaned by collecting war debris and the terrain was levelled by filling craters and trenches. By doing so, the landscape was restored (Dendooven, 2009). Today, a lot of war traces are not always visible anymore. Nevertheless, the war left its footprint in the landscape, forming the last witness of the war (Chielens, 2009; Pearson, 2012). In only few areas clearly visible scattered or clustered shell holes can still be identified since they are legally protected (Agentschap Onroerend Erfgoed, 2018) or are conserved in seldom cultivated fields (e.g. woodland and pasture) (Gheyle et al., 2018).

The shell holes left their footprints in the landscape as shallow depressions. Depending on the sort of artillery and the different calibres used, these depressions varied from 1 to 10 m diameter, and had corresponding depth ranges (Hupy & Schaetzl, 2006; Magnini et al., 2017). A distinction has to be made between two different types of shell footprints (Gheyle et al., 2018): on the one hand the below-ground preserved traces which are visible in the mixed soil (also the so-called 'pedoturbation') and often induced a changed local water table that also changed the vegetation populations or the conditions of growth (see studies of Hupy & Schaetzl, 2006; Note et al., 2018; Taborelli et al., 2017b; Van Meirvenne et al., 2008), and on the other hand the above-ground preserved traces that are noticeable in the microtopography (see studies of Magnini et al., 2017; Stal et al., 2010). This paper investigates the latter whereby relics of these impacts - to a certain extent modified by sedimentation, erosion or other processes - are considered as war heritage. In addition, less visible and subtle footprints of shell impacts can be observed in the microtopography of the area. Gheyle et al. (2018) identified on a landscape scale of research these shallow depressions by using a high-resolution airborne laser scanning (ALS or LiDAR) (Informatie Vlaanderen, 2017). This revealed that the conflict landscape is better preserved than previously thought. The authors hypothesised about the reasons of presence or absence and identified certain associations between the presence of the shell holes and the current land use (e.g. woodland, pasture) (Gheyle et al., 2018). This can be considered as the first step towards a more profound understanding of these fragile and forgotten relict landscapes.

An in-depth historical landscape analysis of the changing patterns of land use (e.g. agriculture, recreation) and land cover (e.g. woodland, urban infrastructure) (LULC), fills this gap in the research and provides new insights in the preservation of WWI shell holes in the terrain of Flanders today (Van den Berghe et al., 2018). The analysis of the topography in combination with LULC is not new considering that the land surface forms the basis of the landscape (Florinsky, 1998), carrying the elements of it (Antrop & Van Eetvelde, 2017). Geomorphometry – or geomorphology (cf. terrain analysis) – carefully quantifies aspects of the land surface and measures these on a landscape-scale (Mark, 1975; Pike et al., 2009; Shary et al., 2002; Walz et al., 2016). The treated subjects support many other disciplines such as geology and landscape studies (Florinsky, 1998, 2017; Pike et al.,

2009). The combination of the latter (cf. landscape studies) with land surface measurements was already commonly examined and tested in landscape ecology (Swanson et al., 1988; Turner, 1989; Walz et al., 2016). More specifically, this aggregation with the relief (or the 'third dimension') has its origin in the concerns of researchers about the simplified projection of a planimetric landscape (Hoechstetter et al., 2008; Jenness, 2004; Stupariu et al., 2010; Walz et al., 2016). Especially, this aspect is important when a landscape changes and evolves in time (or the 'fourth dimension') (Drăguţ et al.2010), as can be seen in landscape dynamic studies. This lack of relief information has widely been tackled with the incorporation of relief knowledge into landscape metrics (Dornert et al., 2002). In summary, additional data and knowledge of the topography of the landscape contribute to more realistic and comprehensive landscape studies. The information of landscape features from both vertical (y-axis) (e.g. relief) and horizontal (x-axis) (eg. LULC) perspective is sometimes lacking (Walz et al., 2016).

The availability of high-resolution digital data such as airborne laser scanning (ALS or airborne LiDAR) and many new applications of this enhances the growing field of three-dimensional information in landscape studies (Hoechstetter et al., 2008; Walz et al., 2016). Researchers already developed 3D-metrics that rely on LiDAR (Blaschke et al., 2004; Goetz et al., 2010; Listopad et al., 2015; Pekin et al., 2012). This trend is also noticeable in landscape studies that are not specifically related to the studies of patterns and processes (Dorner et al., 2002), since others used LiDAR for historical landscape archaeological purposes (e.g. historical route network and settlement studies) (Van Lanen, 2017; Verbrugghe et al., 2017; Werbrouck et al., 2011) or to monitor land use/land cover changes (Christensen & Brandt, 2016).

LiDAR has also recently been used to study WWI conflict landscapes as a way to explore the landscape without damaging it (or non-invasive) (Gheyle et al., 2018; Montgomery & McNeary, 2016; Stal et al., 2010). In France, Taborelli et al. (2017a) identified WWI traces on LiDAR in the region Champagne-Dardenne and showed that there is a heterogeneous preservation degree which is explained by several factors of influence (e.g. urban expansion, agricultural and forestry practices). In regions such as Verdun, Berry-au-Bac and Argonne, the microtopography was observed whereby clear imprints of shelling were visible in the landscape (Brenot et al., 2017; de Matos et al., 2016; Taborelli et al., 2017b). In Poland, a WWI prisonar camp was investigated (Zalewska & Kiarszys, 2017), while in Italy shell holes were located (Magnini et al., 2017). In Belgium, few studies used this technique for the analysis of the former WWI battlefield. Barracks, fire- and communication trenches, bunkers and other military objects were identified by use of LiDAR (Gheyle et al., 2018; Stal et al., 2010), while surface traces of the underground tunnelling war were located (Stichelbaut et al., 2017).

Hence, LiDAR is not the only non-invasive technique for the study of WWI shelled landscape (or other conflict landscapes). Geo-soil sensing explores material remains under the topsoil layer (Note et al., 2018; Ripka et al., 2007; Saey et al., 2013), while historical aerial photography and maps are used as a starting point for the location of shelled areas (Van Hollebeeke et al., 2014). Lastly, metal detectors can locate scattered metal objects (van der Schriek & van der Schriek, 2014) derived from shelling.

This research combines three types of non-invasive interdisciplinary information: surface information processed from LiDAR, a historical landscape change analysis and a historical shell hole density map. This paper (i) quantifies the present-day preservation of historical shell hole landscapes, and (ii) investigates the evolution and the landscape dynamics in the past century. The outcomes can be used to give advice to future heritage management.

3.2 Study area

The research focuses in this chapter only on two of the three areas which are both a section through the Western front region in Belgium, starting at the North Sea and deflecting in a south-west direction to the French border. The most southern area comprises the Messines-Wytschaete Ridge (stalemate 1915-1917) (Doyle et al., 2002). It includes Kemmel Hill (156 m) and extents over an area of 31.8 km^2 (Figure 3-1). Kemmel Hill is a part of the landscape region of the Flemish hills (De Vos et al., 2014) and was a strategic observation point during the war (Barton, 2008). The second study area, located north of the main study area (81.6 km^2), is used for validation (see methodology) and is similarly a section through the frontline, comprising both parts of the frontline and the hinterland.

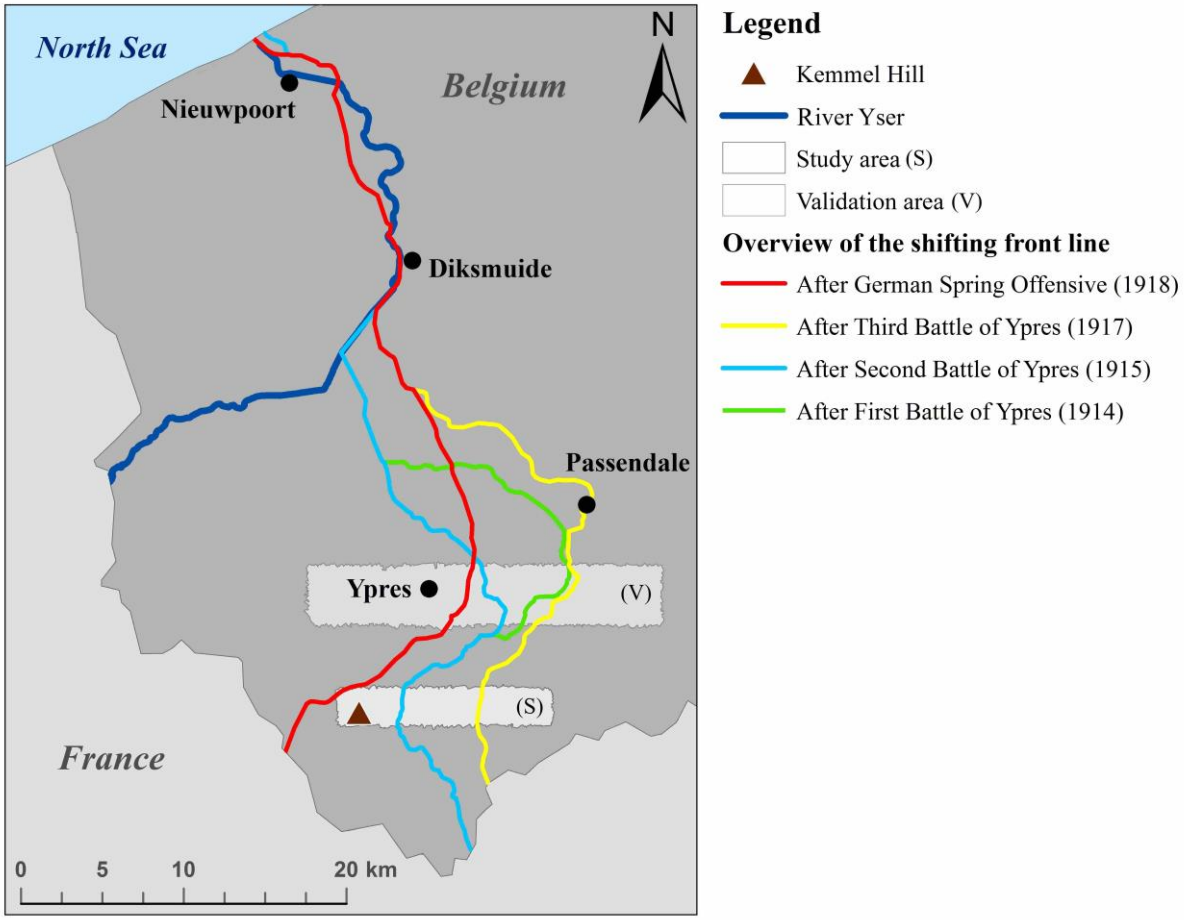

Figure 3-1: Study and validation area

3.3 Material and methodology

Figure 3-2 illustrates the methodology for comparing the war landscape of the past and today. First, the present-day situation was analysed by mapping visible traces of WWI shell holes by use of LiDAR visualisations (Informatie Vlaanderen, 2017). Second, these traces were confronted with the original wartime situation (1918) by generating a shell hole density map (Note et al., 2018), to compare the historical shell hole density and the visibility degree of these shell holes today. Thirdly, the association between the past and present was studied based on LULC changes (Van den Berghe et al., 2018), with a related intensification history linked to land use that occurred in the last century. As a way of validation, the main associations between the LULC, the intensification and the preservation of shell-holes were tested in another study area in order to confirm that this relationship is besides the study area also generally recognisable (or not) in the wider landscape.

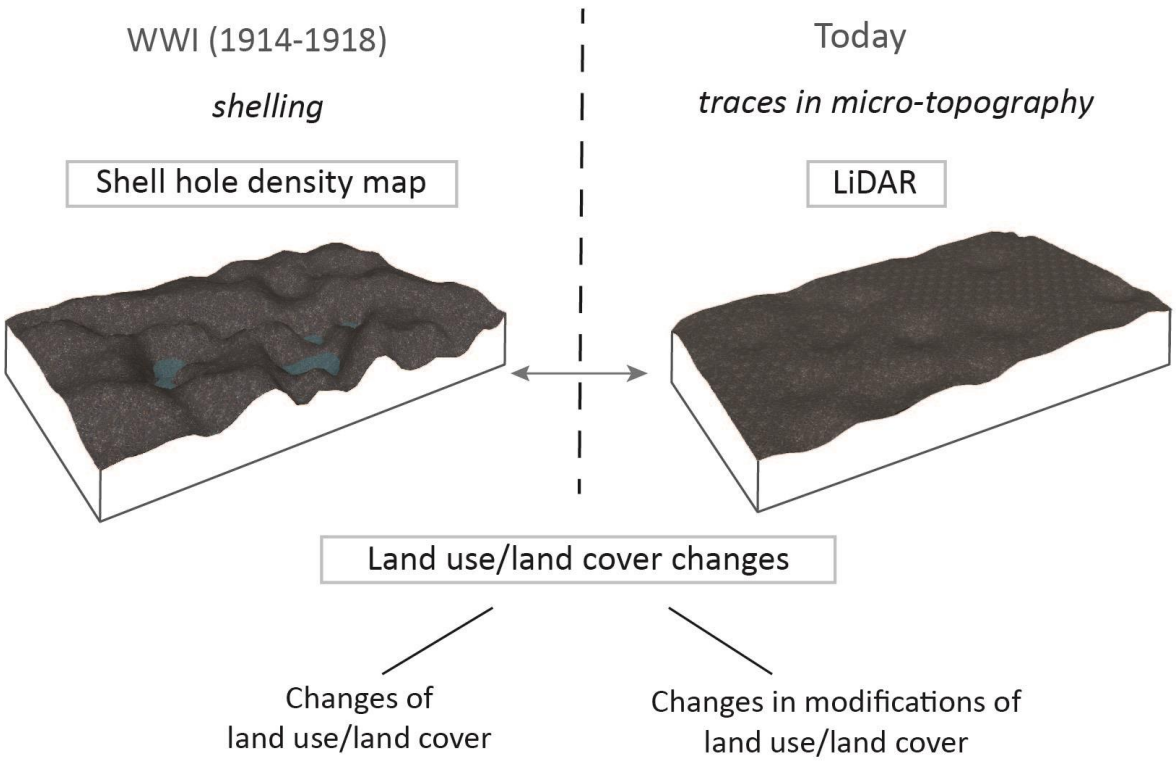

Figure 3-2: Comparison of the WWI landscape in the past and present by integrating several sources

3.3.1 Present-day landscape: Airborne LiDAR

The above ground preservation of WWI relics was studied by analysing LiDAR visualisations. This is a remote sensing technique in which the distance to objects is measured. From the air, the airborne laser system measures the physical relief by determining the distance between the aircraft and the earth's surface. The laser scanner works in the spectrum from visible light to near infrared and continuously emits short laser pulses of a specific wavelength that scans the earth's surface in lines. The time between the emission of the pulse and the reception of the reflected pulse can be used to calculate the distance to the scanned object (Vlaamse Overheid, 2018). The IMU (Inertial Measurement Unit) and the GPS (Global Positioning System) both help to measure the aircraft's position while taking measurements. The IMU determines the position of the aircraft in degrees in three dimensions by measuring the vertical and horizontal movements of the aircraft (roll, pitch and yaw) (Ellis et al., 2014). The GPS determines the aircraft's position in latitude, longitude and altitude (Vlaamse Overheid, 2018) (Figure 3-3).

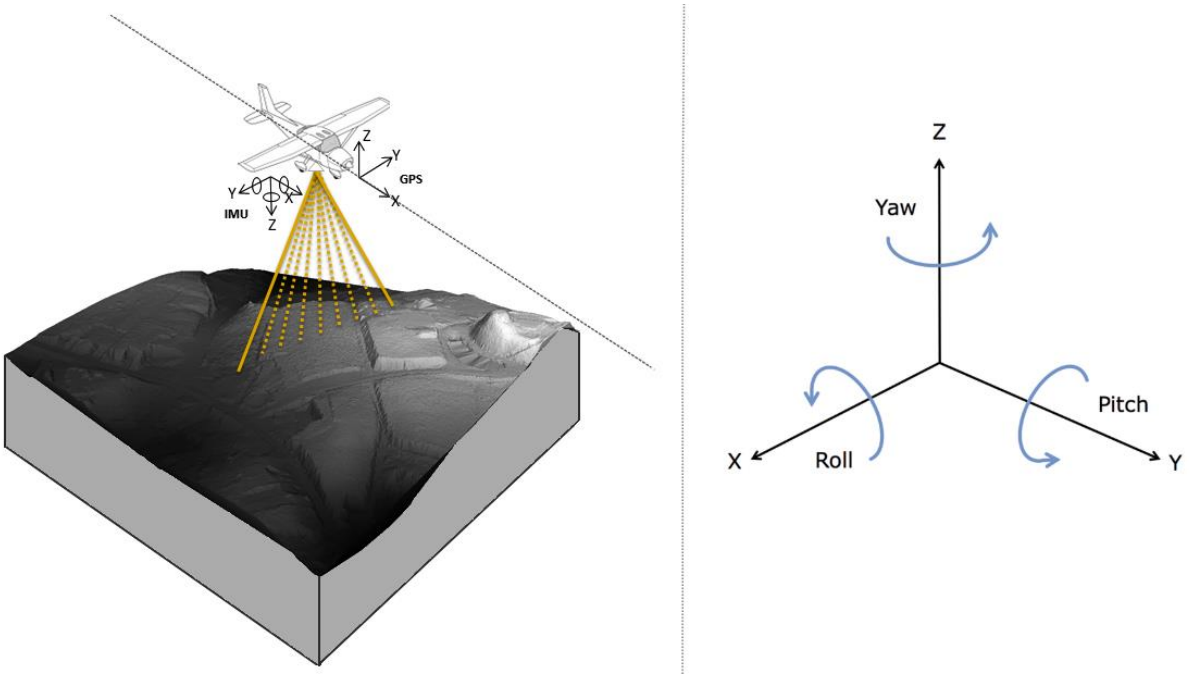

Figure 3-3 Left: Airborne LiDAR with IMU and GPS system to measure the aircraft its location (source: Vlaamse Overheid, 2018), Right: IMU measurements in roll, pitch and yaw (source: Ellis et al., 2014)

In Flanders, high precision airborne laser scanning data is available. The raw database which was created during 2013-2015 (16 points/m^2, XY accuracy 0.10 m, Z accuracy 0.05 m) (Informatie Vlaanderen, 2017), was transformed and observed in a historical landscape context by using the Relief Visualisation Toolbox (Kokalj et al., 2013). Two types of visualisations were prepared to detect the shell holes. Following the methodology of Gheyle et al. (2018), the sky-view factor (SVF) and multi-hillshade (MH) visualisations proved to be the best fit for the relief mapping (Kokalj et al., 2011; Zakšek et al., 2011). SVF (10 m search radius in 16 directions) revealed small topographic depressions (Hesse, 2014) and is created by illuminating the relief from the celestial hemisphere (Kokalj et al., 2011). The MH (35° sun elevation from 16 directions) exposed sharp edges in the topography and is created by lightening the earth's surface from several light sources which creates shadow on the relief (Kokalj et al., 2011). In the study region, no other similar structures are present which makes the shell holes easy to identify.

By using a determination key (see details in Gheyle et al., 2018), all fields with visible shell holes were identified and stored in a geospatial database[36]. Fields represent visible delineated properties on LiDAR such as agricultural fields. Shell holes were divided into three classes of visibility (attribute 'class'): clearly (class 1), moderately (class 2) and poorly (class 3) visible shell holes (Figure 3-4). To distinguish these classes, the shape of the shell holes and the profiles derived from the visualisations were analysed, determining clear separate circular-shaped depressions in class 1 (depths between -0.6 m and 0.4 m), to less clear separate circular depressions due to erosion and sedimentation processes in class 2 (a variation in depths between -0.6 m and -0.2 m) and class 3 (depths between -0.4 m and -0.2 m).

Additionally, the selected fields were also classified as 'presence' (attribute 1) of shell holes and unselected fields with no visible traces as 'absence' (attribute 0).

[36] In order to not to confuse the shell holes with visible drinking pools on LiDAR, an additional database was consulted (Stichelbaut, 2011). This database contains the location of the shell holes at the end of WWI (1918). If the spatial location of shell holes on LiDAR did not agree with the location of a shell hole observed in 1918, one could conclude that this was not a shell hole but rather a drinking pool for cattle or a fishery pond.

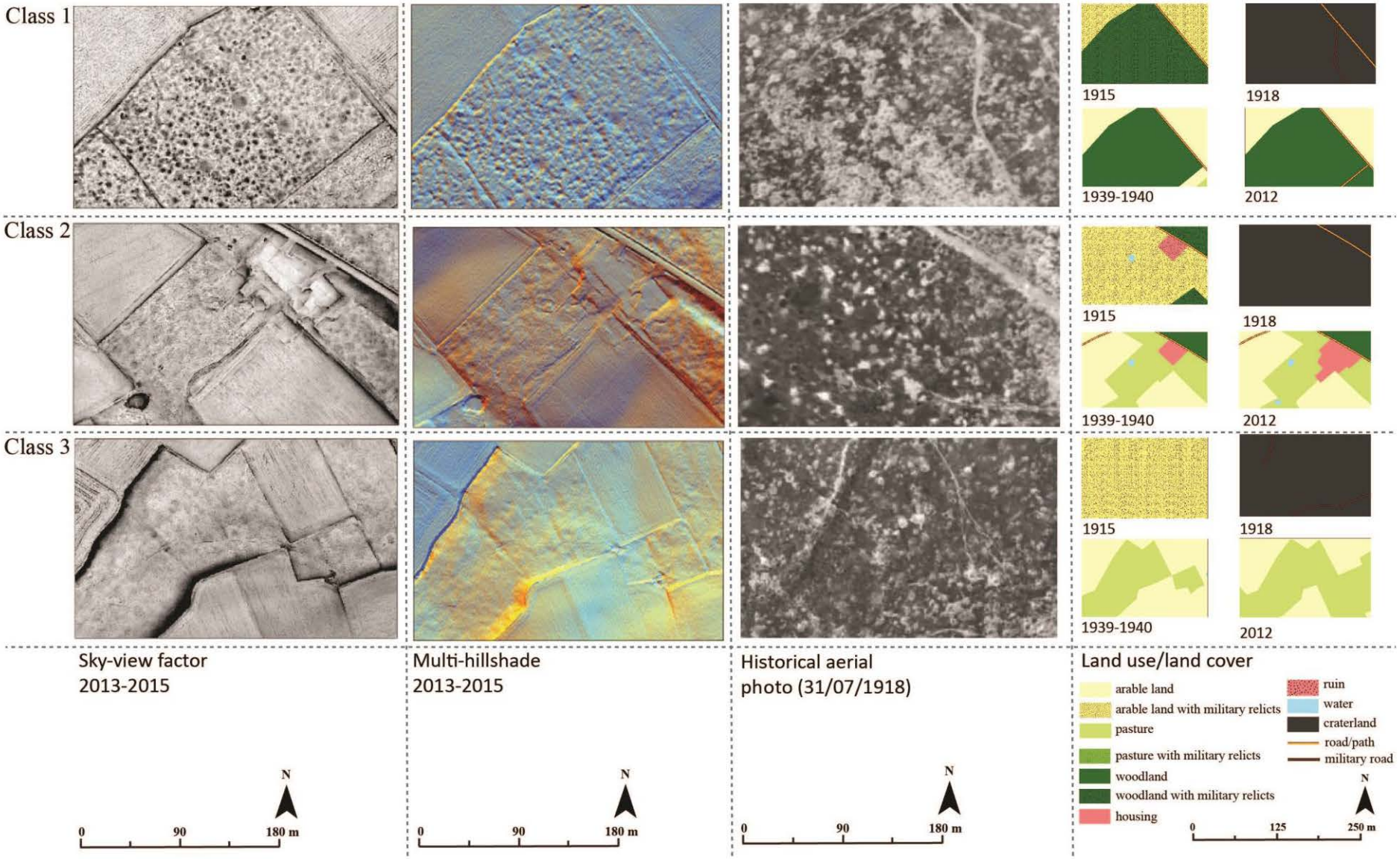

Figure 3-4: Classes of visibility of the shell holes determined with sky view factor and multi-hillshade visualisations of the Flemish DHMVII 1 m raster DEM with accompanying historical aerial photos from 1918 and land use/land cover maps of the present-day landscape (photos copyright In Flanders Fields Museum)

3.3.2 Situation WWI versus today: shell hole density map and LiDAR

Subsequently, the historical density of shell holes was compared with the visibility of these shell holes today (LiDAR). The density map, representing the original situation, was based on the number of shell holes identified on historical aerial photographs on which the heaviest battles occurred (1918). First, the shell holes were identified and manually digitized in selected samples. These samples were selected in a grid of 50 m by 50 m with an inclination angle of 45°. Second, the shell hole information in these samples was interpolated for the whole studied area. Third, the densities were subdivided into five density shelling classes: 0-20, 20-80, 80-200, 200-480, >480 shell holes/ha. The result was validated by randomly generating locations in the area and by counting the number of shell craters. Per sample this amount of shell holes was compared with the created shell hole density map. The classification had a success rate of 83%. Moreover, the created shell hole density map was also validated by measuring the metal shrapnel pollution with electromagnetic induction surveys. A relation was found between the increasing shapnel pollution and the increasing shell hole densities (see more details in Note et al., 2018) (Figure 3-5).

In this chapter, the association between the previous described density map and the information derived from LiDAR was statistically explored using a Spearman Rank Correlation[37] (Kutner et al., 2005) in two ways: to explore the relation between the historical shell hole density (shell holes/ha) with (1) the presence or absence of shell holes today and with (2) the different classes of visibility (good to poor) today.

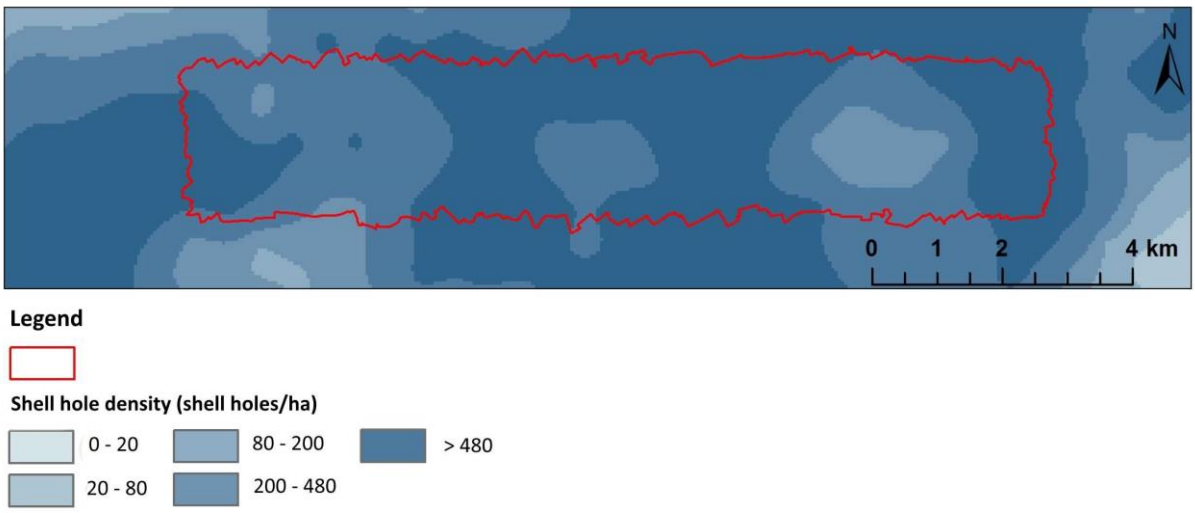

Figure 3-5 Shell hole density map (shell holes/ha) and the research area (Shell hole density according to Note et al., 2018)

[37] The Spearman correlation was used because the dataset consisted of categorical data (Kutner et al., 2005). The presence of shell holes was indicated by '1' and an absence with '0'. Furthermore, the classes of visibility were indicated with '1' (clearly visible), '2' (moderately visible) and '3' (poorly visible).

3.3.3 Situation WWI until today: LULC changes

It is generally known that LULC changes modify the topography of the landscape (Bakker et al., 2008). Therefore, to understand the reasons behind the absence or presence of the shell holes in the landscape today, a historical spatio-temporal database was consulted consisting of LULC information derived from aerial photos from 1915 (first available time series of historical aerial photographs), 1918 (last time series of photographs taken during the war), 1939-1940 (first time series of aerial photographs available after WWI) and 2012. The complete database allows for an in-depth landscape change analysis whereby the LULC is known for four time phases in history (see details of this geospatial database in chapter 2).

Two types of information can be extracted from this spatio-temporal database, each with another meaningful influence on the topography of the shell hole landscape in the past century (Figure 3-6): the historical changes of LULC and the modifications in the LULC of the past. LULC changes are clear and visible conversions in the landscape of one LULC type into another (Antrop & Van Eetvelde, 2008; Lambin, Rounsevell, & Geist, 2000), which directly enhance the disturbance of the surface and soils (Smith et al., 2016). Modifications of LULC are subtle and are amongst physical processes (e.g. erosion or sedimentation because of the slope of a field[38]) (Bakker etmili al., 2008), mainly caused by human management (e.g. ploughing) (Lambin et al., 2000). This study only focuses on the human management of fields with the intensification of fields as an objective (Vuorela & Toivonen, 2001) since on the one hand intensified areas result in a more disturbed topic layer of the soil which is expressed by erosion and sedimentation export (Bakker et al., 2008) and are therefore interesting in the study of the microtopography of WWI shell holes. On the other hand, historical intensification information can easily be derived from literature. Notably, the intensification of fields can be expressed in different ways (e.g. income/ha or yields/ha) (Turner & Doolittle, 1978). In this study, it is defined as a human input (e.g. deep-ploughing, pesticides, mowing gardens) in the land use to improve the output and returns (also called input intensification) (Lambin et al., 2000; Turner & Doolittle, 1978).

[38] A field is a piece of land used for a particular purpose (Oxford Dictionary, 2019). Hence, in this dissertation, a field is a polygon with a similar purpose which is not specifically bounded to one piece of land.

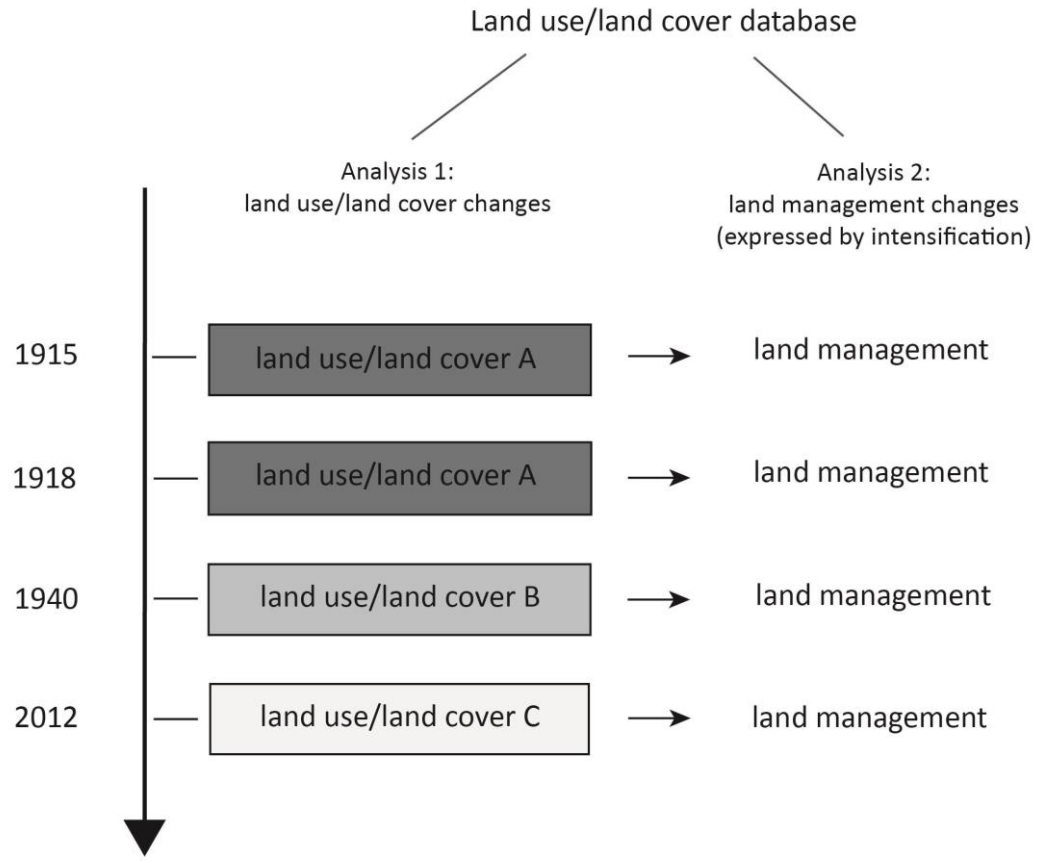

Figure 3-6 Land use/land cover database analyses: land use/land cover changes and the changes in land management

3.3.3.1 Analysis of LULC changes

The LULC changes for each field during the past century studied in four time periods (1915, 1918, 1939-1940 and 2012) were compared with both the shell hole density of 1918 (shell holes/ha) visible on the shell hole density map and the information of shell holes of today derived from LiDAR. The sequence of LULC changes over the different time periods formed a specific pathway of LULC (e.g. arable land (1915), pasture (1918), woodland (1939-1940), woodland (2012)). To extract the fields with the most interesting pathways out of the study area, the fields with the following criteria were analysed:

- The highest density class (shell holes/ha) in 1918 versus the absence or presence of shell holes today and the related visibility classes (1, 2 and 3)
- The lowest density class (shell holes/ha) in 1918 versus the absence or presence of shell holes today and the related visibility classes (1, 2 and 3)

3.3.3.2 Analysis of modifications expressed by intensification

Intensity values (I)[39] were linked to the land use specified in the LULC types. These LULC types were used as the first attribute to determine the historical landscape characters in Chapter 2 (Table 2-3). Intensity values were given to each time phase (cf. 1915, 1918, 1940 and 2012) (Vuorela & Toivonen, 2001). The intensification history of Flanders was consulted in literature and was compared with the past land use in the studied area in order to give appropriate intensity values (no unit) ranging from zero (no intensity) to eight (high intensity). (Table 3-1). These intensity values were ranked and with this prepared rank the gradations in intensity which are related to the degree of military influence could be included. This military influence includes both destructive and constructive military influence and was incorporated in the spatio-temporal database (see 'i' in Table 3-1). The higher the military influence was in a certain time phase, the lower the intensification (cf. few military traces compared to the destructed state). In addition, with this rank of intensity values the different gradations of intensity throughout the last century could also be taken into account (see time phases 1915, 1918, 1940 and 2012 in Table 3-1). This chapter will not give an extensive overview of all the given LULC intensity values, but will use the case of the hay land and crops (arable land) and pasture (grassland) as an example because these types are in the majority in the studied area (see chapter 2, Table 2-5). An overview of on the one hand the literature that was consulted for the other LULC types and on the other hand the summarised assumptions which were used to identify the intensity values (also briefly mentioned in the following paragraph), can be found in Appendix 3.

Despite the presence of scattered shell holes and trenches in the area at the beginning of the war (1915), the LULC was still recognizable on historical aerial photographs (Van den Berghe et al., 2018; Chapter 2). However, the fields were not fully being exploited because of a trade blockage in Flanders which was initiated by the Allies to restrain the German forces (De Schaepdrijver, 1997; Nath & Van Alstein, 2012). Since Flanders was – before the war and even from Germany (Van De Perre, 1919) - dependent from import on several products (e.g. fertilizer, seed) problems arose (Van Molle, 1990). In the occupied part of Belgium, the blockade, refugee flow and the regulation and demands for supplies and money for the German army disturbed the economy severely (De Schaepdrijver, 1997). This declining economy and poor living conditions - sometimes compared with a lemon being 'squeezed' by the German forces (De Schaepdrijver, 1997, p. 136) - were also noticeable in the unoccupied part of Belgium whereby for instance transport of supplies were hampered, labourers were called for military service for the Allies (Demasure, 2013) and pastures were occupied by many military camps (PAWVL, 1917). With the previous information coming from literature, low-intensity values to the LULC's were given to this time phase (1915). Each type of LULC got despite the different levels of military influence ('i' in Table 3-1), an equal intensity level in the understanding that every parcel was equally useful in wartime. At the end of the war (1918), domestic and economic activities were considered as closed down (intensity values zero) (Demasure, 2014; Van den Wijngaert et al., 2006). The landscape in the study area was fiercely disturbed and was

[39] Notably, these intensity values which were previously defined by the human input (section 3.3.3) include only the inputs given by the civilians and not the inputs given for military purposes. I chose this methodology because the spatio-temporal database does not make a difference between military constructions and destructions and are both marked as military influence ('i' in Table 3-1). Therefore, no exact human input - in this case the military input for intensification purposes - can be assigned to these military influences in the landscape.

mainly transformed into craterland (Van den Berghe et al., 2018), as the area was destroyed several times by the shifting frontline (Figure 3-1). After the war and the spectacular reconstruction of the landscape (first visible on time series of 1939-1940) (Dendooven, 2009; Van den Berghe et al., 2018), the LULC types were recovered between 1915-1940 during an intensive clean-up (De Vos et al., 2014). Therefore, this time phase obtained higher intensification values compared to the values given to the LULC types in the beginning of the war (1915) (Demasure, 2014; Jespen et al., 2015). Notably, pasture forms an exception because the livestock led to heavy losses during WWI which was not easily to be restored after the war. Therefore, the human input in pasture in this time period was not extensive as the cattle did not (yet) reach a higher number of animals than before the war. An equal amount of cattle, horses and pigs was only reached in 1931 (Demasure, 2013, 2014, 2019). Additionally, in contrast with the situation in 1915, a still visible military influence in 1940 does mean a decrease in intensity because remaining military remnants such as a bunker or crater prevent the optimal use of a field.

Between 1940 and 2012, the agricultural intensification changed in the landscape. The focus in this time-period is mainly driven by mechanisation and motorisation of LULC because this type of human intensification had the largest impact on the topography. After the Second World War, the volume of agricultural production was lower than before the conflict. It took until 1948 to reach the similar production level (Brassley et al., 2016). Later, because of the flat landscapes in Flanders amongst other things, mechanization was easily applicable (Bakker et al., 2008). Between 1960 and 1990, the double return of the arable lands was reached (FOD Economie, 2011; Lambin et al., 2000; Tilman, 1999), since draught animals were replaced with machines (Auderset & Moser, 2016). Between 2000 and 2010, a decrease of arable lands and pasture was noticeable. However, the output reached a maximum (FOD Economie, 2011). Consequently, the intensity values given to hay land and crops in 2012 are higher than in 1940. Also the amount of livestock increased compared to 1940, resulting in a higher intensity value for pasture in 2012 (Landbouw en visserij, 2017).

Table 3-1: Land use/land cover and the original state ('o') and military influenced state ('i') linked with the intensity values for the four time phases. No value ('-') means that no fields were observed in the considered land use/land cover category and the related year (land use/land cover categories according to chapter 2)

Land cover (land use)	'o'	'i'	Intensity value 1915	Intensity value 1918	Intensity value 1940	Intensity value 2012
arable land (hay land and crops)	1.1		4	0	6	8
		1.2	4	0	5	-
		1.3	4	-	-	-
Grassland (pasture)	2.1		3	0	3	4
		2.2	3	0	2	-
		2.3	3	-	-	-
Woodland (not known)	3.1		1	0	4	3
		3.2	1	0	3	-
		3.3	1	-	-	-
Build up land (housing)	4.1		1	0	2	2
	4.2		1	0	2	2
Unrecognisable build up land (*not known*)		5.1	0	-	-	-
		5.2	0	-	-	-
Grassland with trees and lakes (castle park)	6.1		1	0	1	1
		6.2	0	0	1	1
Cemetery or monument (mourning)	7.1		1	0	1	1
	7.2		1	0	1	1
	7.3		1	0	0	0
Golf course, water,... (recreation)	8.1		4	0	-	4
Warehouses and factories (industry)	9.1		4	0	0	8
Water (*not known*)	10.1		1	0	1	1
Disturbed and no recognisable land cover (military purposes)		11.1	0	-	-	-
		11.2	0	-	-	-
	11.3		0	-	-	-
	11.4		0	-	-	-

After assigning the intensity values (I) to each LULC, every field was attributed a general value calculated by the mean (IM) of all the intensity values in the past:

$$IM(Intensity\ Mean) = \sum_{i=1}^{4} \frac{I_i}{4} = \frac{I\,(1915) + I\,(1918) + I\,(1939 - 1940) + I(2012)}{4}$$

The IM for each field was compared with both the landscape information of shell holes for each field derived from LiDAR and the LULC changes, to understand their relationships. A Spearman Rank Correlation test[40] (Kutner et al., 2005) was performed for the following research questions:

- Q1: Is there a correlation between IM and the presence or absence of shell holes today?
  (HO: there is no correlation between IM and presence or absence of shell holes)
- Q2: Is there a correlation between IM and the classes of visibility of shell holes today?
  (HO: there is no correlation between IM and the classes of visibility)
- Q3: Is there a correlation between IM and the amount of LULC changes in the past?
  (HO: there is no correlation between IM and the amount of changes)

The test was performed three times for each question, taken into account the IM calculated for all the time phases (1915, 1918, 1939-1940 and 2012), three time phases (1915, 1939-1940 and 2012), and two time phases (1939-1940 and 2012). In this way, the years with a meaningful influence of intensification on the absence or presence of shell holes today could be determined.

3.3.4 Validation

To validate the calculated correlation (or no correlation) between IM and the visibility of shell holes today (see Q2 in section 3.3.3.2), another area was investigated nearby the city of Ypres (Figure 3-1). Firstly, depending on the results determined in the main study area, LULC pathways[41] were selected that proved to have a direct association between IM and the visibility of shell holes today. Subsequently, the fields with the same LULC pathways were selected in the validation area. Secondly, for those selected fields the visibility class of the shell holes was also analysed on the LiDAR visualisations. Lastly, a Spearman Rank Correlation[42] was performed (Kutner et al., 2005) between the determined visibility classes on these selected fields in the validation area and the visibility classes of shell holes that were determined in the main study area for these pathways. If the correlation between both is high, the methodology and correlation could be validated (more details in the results section).

[40] The Spearman Rank Correlation was performed because the studied datasets are categorical by nature (Kutner et al., 2005).

[41] This is the sequence of LULC types in the past century (e.g. arable land (1915) > arable land (1918) > pasture (1940) > woodland (2012))

[42] The Spearman Rank Correlation was performed because the studied datasets are categorical by nature (Kutner et al., 2005).

3.4 Results

3.4.1 Present-day landscape: LiDAR

In total 6.20 km^2 of the study area (31.81 km^2) contain traces of shell holes today (19.49 % of the study area). The majority of these have a moderate visibility (class 2). The area with no visible traces of shell holes covers 25.61 km^2 (80.51 % of the study area) (Table 3-2).

Table 3-2 Presence and absence of shell holes (km^2 and %) on LiDAR per visibility class (class 1, 2 and 3)

	Area (km^2)	Percentage of study area (%)
Presence shell holes	**6.20**	**19.49**
Class 1 (clearly visible)	1.70	5.35 (27.47 % of presence)
Class 2 (moderately visible)	2.50	7.87 (40.36 % of presence)
Class 3 (poorly visible)	1.99	6.27 (32.17 % of presence)
Absence shell holes	**25.61**	**80.51**
Total area	31.81	100

3.4.2 Situation WWI versus today: Shell hole density map and LiDAR

Fields with visible shell holes on LiDAR were compared with the historical shell hole density (1918). For example, fields were selected per density class. From these fields it was then determined whether they currently have certain craters on LiDAR (Table 3-3). Results indicate that fields with the most pronounced shell hole traces (class 1) today are logically linked with fields that had the highest shell hole density in 1918. 86.07 % of the total area of class 1 has a shell hole density category of >480 shell holes/ha. The proportion of fields in this shell hole density category then steadily decreases according to a decline in visibility (from class 2 to 3). Additionally, it is clear that the majority (47.86 %) of fields with no visible shell holes today are also linked with the highest density class of >480 shell holes/ha.

Table 3-3 Density of shell holes (shell holes/ha) of 1918 compared with the absence or presence of shell holes today per visibility class (1, 2 and 3). No value ('-') means that no fields were observed in the considered shell-density category of 1918 and associated absence or presence today

Shell hole density (1918) (shell holes/ha)	**Presence shell holes (today)**						**Absence shell holes (today)**	
	Class 1 (clearly)		Class 2 (moderately)		Class 3 (poorly)			
	Area (km^2)	*%*	*Area (km^2)*	*%*	*Area (km^2)*	*%*	*Area (km^2)*	*%*
0-20	-	-	-	-	-	-	0.33	1.28
20-80	-	-	-	-	-	-	-	-
80-200	-	-	0.17	6.82	0.07	3.51	1.66	6.48
200-480	0.24	13.93	0.85	33.91	0.90	45.36	11.36	44.38
>480	1.47	86.07	1.48	59.26	1.02	51.13	12.25	47.86
Total	**1.70**	**100**	**2.50**	**100**	**1.99**	**100**	**25.61**	**100**

The first correlation test indicates that there is a significant small positive association between the historic shell hole density (shell holes/ha) and the absence (attribute 0) or presence (attribute 1) of shell holes today ($r_s(7052) = .098$, $p<0.01$, two-tailed). This indicates that there is a higher appearance of shell holes today in the areas with a high shell-density class in 1918. The second correlation test suggests a small negative association between the shell hole density (shell holes/ha) and classes of visibility (class 1, 2 and 3) on LiDAR ($r_s(2734) = -.142$, $p<0.01$, two-tailed), pointing out that the higher the shell hole density is, the more effortless it is to identify shell holes today. Previous findings

indicate that the shell-hole density during the war is not a determining factor for the presence or absence of shell holes in the microtopography of today as the correlations are rather small. Therefore, other determining factors have to be investigated such as LULC.

3.4.3 Situation WWI until today: LULC changes

3.4.3.1 Analysis of LULC changes

Following the methodology, pathways in shell hole density class >450 shell holes/ha (the highest category) and 80-200 shell holes/ha (the first lowest category with sufficient cases[43]) of 1918 were studied. The three highest percentages of the most common pathways within these categories are selected for further analysis (Table 3-4)[44].

When comparing these pathways with the presence and absence of shell holes today, it seems that fields with no shell holes today are mostly linked with a development of arable land (hay land and crops). On the contrary, the presence of shell holes is notably associated with grassland (pasture) and woodland. When the pathways are compared with the classes of visibility of shell holes today, it is clear that class one (clearly visible), is not present in the category of 80-200 (shell holes/ha). On the contrary, this class is abundant in the category of >480 (shell holes/ha) and is mainly linked with woodland and grassland (pasture).

[43] I could not analyse the pathways in the lowest category since not enough fields were available with a shell hole density of 0-20 shell holes/ha (see Table 3-3). Therefore, I chose to analyse the first lowest category with sufficient cases which was the category of 80-200 shell holes/ha.

[44] This because a wide range of pathways are linked with both a high shell-hole density and low shell-hole density. The most interesting cases are the ones that appear the most; this indicated with the highest common percentage in the area.

Table 3-4 Three highest percentages of land cover(land use) changes (or pathways), linked with the presence and related visibility or absence of shell holes on LiDAR for shell-hole density class >480 (shell holes/ha) and 80-200 (shell holes/ha) in 1918

		Shell hole density (craters/ha)									
		>480 (shell holes/ha)					***80-200 (shell holes/ha)***				
		1915	1918	1940	2012	%	1915	1918	1940		%
Presence shell holes	1	Grassland (pasture) with relics	Craterland	Grassland (pasture)	Grassland (pasture)	15.58	Grassland (pasture)	Disturbed grassland (pasture)	Grassland (pasture) with relics	Grassland (pasture)	19.08
	2	Woodland with relics	Craterland	Woodland	Woodland	14.78	Grassland (pasture) with relics	Disturbed, unrecognisable militarised landscape	Grassland (pasture)	Grassland (pasture)	17.00
	3	Arable land (hay land and crops) with relics	Craterland	Arable land	Arable land (hay land and crops)	10.63	Arable land (hay land and crops) land with relics	Disturbed, unrecognisable militarised landscape	Grassland (pasture)	Grassland (pasture)	14.06
Class 1 (clearly)	1	Woodland with relics	Craterland	Woodland	Woodland	38.62	-	-	-	-	-
	2	Grassland (pasture) with relics	Craterland	Grassland (pasture)	Grassland (pasture)	13.17	-	-	-	-	-
	3	Arable land (hay land and crops) with relics	Craterland	Grassland (pasture)	Grassland (pasture)	7.57	-	-	-	-	-
Class 2 (moderately)	1	Arable land (hay land and crops) with relics	Craterland	Grassland (pasture)	Grassland (pasture)	18.06	Grassland (pasture)	Disturbed grassland (pasture)	Grassland (pasture) with relics	Grassland (pasture)	23.29
	2	Arable land (hay land and crops) with relics	Disturbed, unrecognisable militarised landscape	Grassland (pasture)	Grassland (pasture)	16.53	Arable land (hay land and crops) with relics	Disturbed, unrecognisable militarised landscape	Grassland (pasture)	Grassland (pasture)	19.28
	3	Arable land (hay land and crops) with relics	Craterland	Grassland (pasture)	Grassland (pasture)	9.44	Grassland (pasture) with relics	Disturbed grassland (pasture)	Grassland (pasture)	Grassland (pasture)	12.21
Class 3 (poorly)	1	Grassland (pasture) with relics	Craterland	Grassland (pasture)	Grassland (pasture)	17.67	Grassland (pasture) with relics	Disturbed, unrecognisable militarised landscape	Grassland (pasture)	Grassland (pasture)	47.57
	2	Arable land (hay land and crops) with relics	Craterland	Arable land (hay land and crops)	Grassland (pasture)	6.65	Grassland (pasture) with relics	Disturbed grassland (pasture)	Grassland (pasture)	Grassland (pasture)	10.15
	3	Arable land (hay land and crops) with relics	Disturbed, unrecognisable militarised landscape	Arable land (hay land and crops)	Arable land (hay land and crops)	6.19	Grassland (pasture)	Disturbed grassland (pasture)	Disturbed grassland (pasture)	Grassland (pasture)	8.79
Absence shell holes	1	Arable land (hay land and crops)	Craterland	Arable land (hay land and crops)	Arable land (hay land and crops)	40.64	Arable land (hay land and crops) with relics	Disturbed Arable land (hay land and crops)	Arable land (hay land and crops)	Arable land (hay land and crops)	23.40
	2	Arable land (hay land and crops)	Disturbed, unrecognisable militarised landscape	Arable land (hay land and crops)	Arable land (hay land and crops)	8.27	Arable land (hay land and crops) with relics	Disturbed, unrecognisable militarised landscape	Arable land (hay land and crops)	Arable land (hay land and crops)	20.95
	3	Arable land (hay land and crops)	Craterland	Arable land (hay land and crops)	Grassland (pasture)	6.80	Arable land (hay land and crops) land with relics	Disturbed, unrecognisable militarised landscape	Arable land (hay land and crops)	Arable land (hay land and crops)with relics	6.10

3.4.3.2 Analysis of modifications expressed by intensity

When comparing the presence of shell holes with the IM (with values going from 0.5 to 4.5), three peaks (IM 2.0, 2.5, and 3.5) are noticeable in the graph (Figure 3-7). Looking at the classes of visibility in these peaks (the bars in the graph), it is clear that in each pique a particular visibility class on LiDAR is dominating, with clearly visible traces (class 1) in the first pique marked by the lowest intensity mean (IM 2.0), moderately visible traces (class 2) in the second pique (IM 2.5) and the poorly visible shell holes (class 3) in the third pique (IM 3.5). When comparing the peaks with the pathways (Table 3-5), the first pique is mainly characterised by pathways with a history of woodland, the second pique with grassland (pasture) and the last pique with a mix of arable land (hay land and crops) and grassland (pasture).

The comparison between IM and the absence of shell holes on LiDAR (Figure 3-7) shows that the higher the IM, the fewer shell holes are visible today, apparent by a remarkable increase at the end of the graph. Additionally, one pique is noticeable on IM 3.5. When consulting the pathways, it is noticeable that the majority is related with a development of arable land (hay land and crops) until today for the pique on 4.5 IM and from arable land (hay land and crops) to grassland (pasture) in 2012 for the pique on 3.5 IM (Table 3-5).

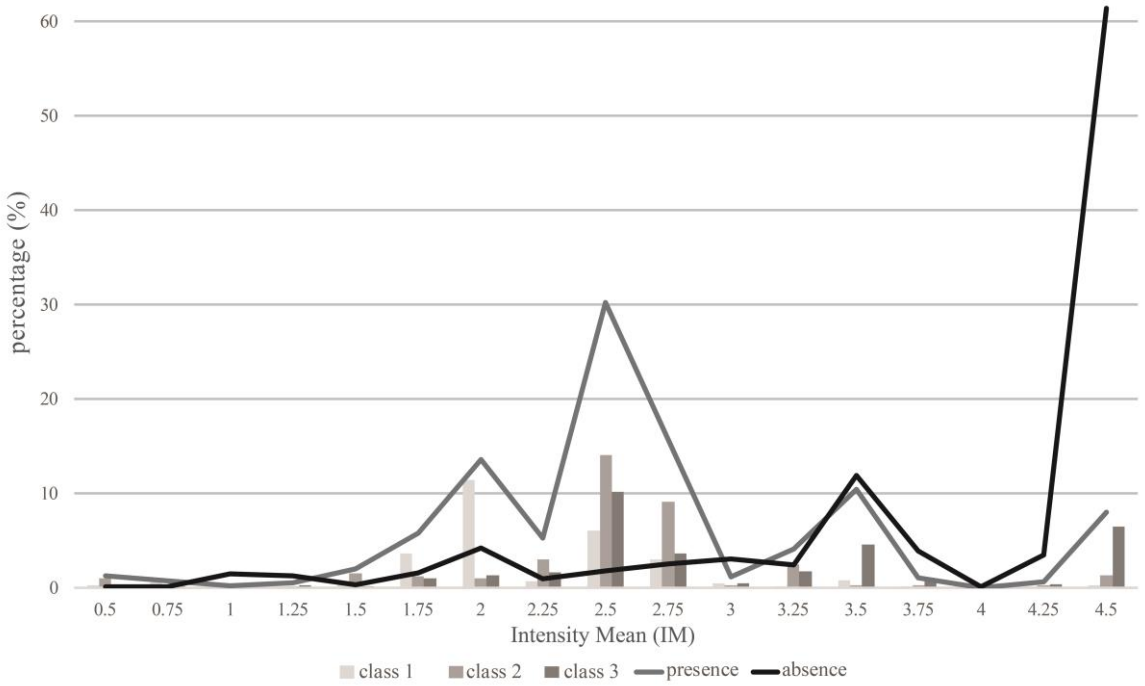

Figure 3-7 Absence and presence of shell holes on LiDAR and classes of shell holes per intensity value (1915-1918-1940-2012) (%)

Table 3-5 Three highest percentage of land cover(land use) changes (or pathways), linked with a particular mean of intensity (IM) and visibility of shell holes on LiDAR (class 1,2,3 and absence)

		1915	1918	1940	2012	%
IM = 2 & class = 1 (clearly)	1	Woodland with relics	Craterland	Woodland	Woodland	80.68
	2	Woodland with relics	Disturbed, unrecognisable militarised landscape	Woodland	Woodland	6.62
	3	Disturbed woodland	craterland	Woodland	Woodland	3.25
IM = 2.5 & class = 2 (moderately)	1	Grassland (pasture) with relics	Craterland	Grassland (pasture)	Grassland (pasture)	32.37
	2	Grassland (pasture) with relics	Disturbed, unrecognisable militarised landscape	Grassland (pasture)	Grassland (pasture)	23.91
	3	Grassland (pasture) with relics	Disturbed pasture	Grassland (pasture)	Grassland (pasture)	21.90
IM = 3.5 & class = 3 (poorly)	1	Arable land (hay land and crops) land with relics	Craterland	Arable land (hay land and crops)	Grassland (pasture)	39.57
	2	Arable land (hay land and crops) land with relics	Disturbed, unrecognisable militarised landscape	Arable land (hay land and crops)	Grassland (pasture)	16.96
	3	Grassland (pasture) with relics	Craterland	Grassland (pasture)	Arable land (hay land and crops)	10.28
IM = 3.5 & absence	1	Arable land with relics	Craterland	Arable land (hay land and crops	Grassland (pasture)	30.85
	2	Arable land with relics	Disturbed, unrecognisable militarised landscape	Arable land (hay land and crops)	Grassland (pasture)	17.56
	3	Arable land	Disturbed, unrecognisable militarised landscape	Arable land (hay land and crops)	Grassland (pasture)	9.12
IM = 4.5 & absence	1	Arable land with relics	Disturbed arable land (hay land and crops)	Arable land (hay land and crops)	Arable land (hay land and crops)	42.01
	2	Arable land with relics	Craterland	Arable land (hay land and crops)	Arable land (hay land and crops)	32.41
	3	Arable land with relics	Disturbed, unrecognisable militarised landscape	Arable land (hay land and crops)	Arable land (hay land and crops)	10.45

Results show a significant negative correlation (-.499) between the absence and presence of shell holes today on the one hand and the IM on the other hand. This indicates that the higher the IM, the fewer shell holes are present. The largest correlation is observed within the IM calculated for 1940 and 2012, indicating that the intensity values of the years 1915 and 1918 are not really a contribution to this correlation. Further, results show a significant positive correlation (.437) between classes of visibility of shell holes (1, 2 and 3) and the IM, suggesting that the higher the IM is, the less visible the shell holes are today. This correlation is - with a small difference - the highest when including all the time phases, suggesting that the more phases that are included with a particular degree of disturbance and a related intensity value, the higher the relation with the visibility of shell holes today. Finally, results do not show a meaningful association between the absence or presence of

shell holes today and the number of changes in LULC, showing that the analysis of landscape changes has no influence on the preservation of shell holes (Table 3-6).

Table 3-6 Spearman Rank Correlation values (rs, p<0.01, two-tailed), for three research questions tested on three IM values

	IM (1915-1918-1940-2012)	IM (1915-1940-2012)	IM (1940-2012)
Question 1	-.494	-.499	-.499
Question 2	.437	.327	.327
Question 3	-.047	-.009	.039

3.4.4 Validation

The fields with the three highest percentages of the most common LULC changes or pathways with a clear association between IM and the shell hole density (Table 3-5) in the main study area were analysed in the validation area (Figure 3-8). They encompass a total area of 14.50 km^2 (17.77 % of the total validation area). After assigning the visibility classes in these fields and comparing these with the visibility classes in the main study area, a highly significant positive correlation of .86 (two-sided, p>0,05) was found, indicating that the visibility classes on LiDAR associated with a specific pathway and IM are for 86 % the same in the validation area. This indicates that the relationship between IM, pathways and visible shell holes on LiDAR is also noticeable in other areas on the former front line of Flanders.

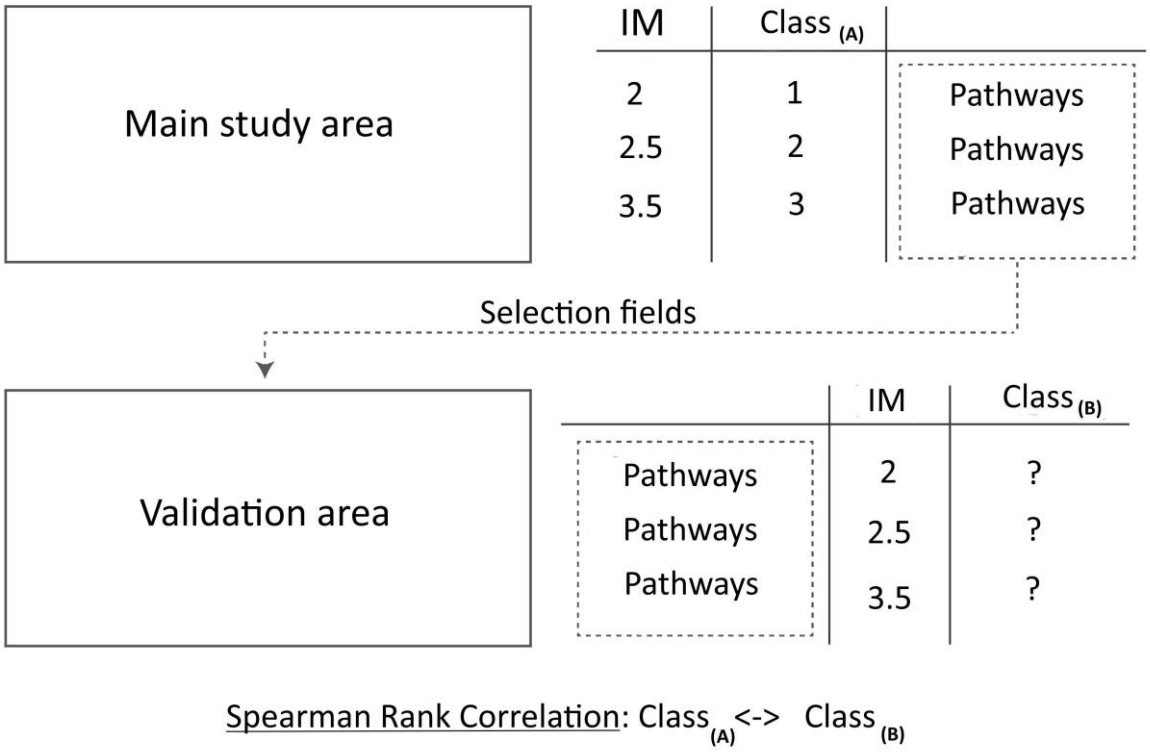

Figure 3-8 Validation by comparing the pathways that are linked with a specific IM (intensity mean) and visibility class derived from LiDAR in the main and validation area

3.5 Discussion and conclusion

LULC changes can quickly erase the last traces of WWI shell holes in the microtopography. In agreement with the findings of Gheyle et al., (2018), fields with a stable history of grassland (pasture) and woodland that are linked with severe shelling during the war, seemed to be the fields with the best preserved shell holes on LiDAR. However, some fields that had only a development of arable land (hay land and crops) had also visible traces, hence they are less clearly apparent. Additionally, results showed that the incorporation of the history of the intensification of agricultural practices, gave a more profound and nuanced explanation towards the absence or presence of shell holes today and the related visibility degree (poorly to clearly visible). One might assume that more changes of the LULC - with an associated intensification level - would have a negative effect on the preservation of shell holes. Hence, on the contrary, this research showed that this had no influence on the preservation. Only the order of LULC changes – indicated by the pathways - with a related intensity is important to consider and analyse the preservation. It is noteworthy that despite arable fields had an intense development, shell holes can still be found in the landscape. On the contrary, contemporary grassland is not always an indication for preserved shell holes.

New insights into the microtopography of Flanders were obtained by combining digital data, knowledge and ideas from interdisciplinary research on a landscape scale. This methodology allowed to interpret the former front zone in a more profound manner by empirically analysing a large study area (31.8 km^2), which represents the complete landscape of combat. Consequently, the large number of studied fields in several time periods provided strong statistical information (Kutner et al., 2005).

This paper only tackled one type of war heritage: the above-ground preserved shell holes. Above ground preserved constructive WWI relics and below-ground WWI relics in the soils are not included (Figure 3-9). Hence, each type of WWI remain has to be investigated with an appropriate methodology. Additionally, this paper investigated only one causing factor of change in the microtopography in the past (cf. LULC and related intensification history) (Bürgi et al., 2004). To gain a further understanding, other factors of influence (e.g. spatial and political aspects, geological and geomorphological parameters) need to be investigated.

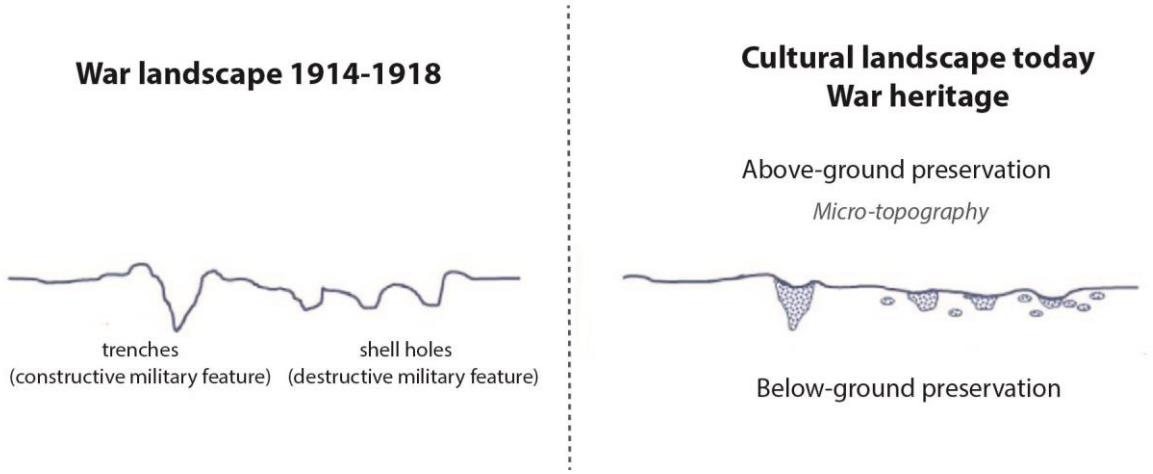

Figure 3-9 Left: war landscape 1914-1918 with both constructive and destructive military features; Right: cultural landscape of today with both above- and below-ground preservation of military features (after Gheyle et al., 2018)

Future heritage management and sustainable decisions in WWI heritage landscapes in Flanders are supported by this research, since the understanding of landscape changes form an important factor towards the conservation of archaeological sites and their associated landscapes (Parcak, 2009). With the significant results, an appropriate conservation strategy for invisible shell holes can be obtained. By doing so, an archaeological 'reserve' can be created which can be studied by later generations (Council of Europe, 1992, article 2).

War-landscapes can be approached in a four-dimensional way by the incorporation of LiDAR and time (Draguţ et al., 2010). Therefore, this study fits in the growing field of the combination of topographical information and landscape changes (Walz et al., 2016). Different aspects of conflicts fought in three dimensions - which are 3D-warscapes in the sense of air, underground and above ground boundaries (Derui et al., 2016; Weizman, 2007) - need convenient visualising methods in volumetric terms, like for instance LiDAR data.

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CHAPTER 4 – UNDERSTANDING THE LANDSCAPE DYNAMICS FROM A DEVASTATED TO REVIVED CULTURAL LANDSCAPE: THE CASE OF THE FIRST WORLD WAR IN FLANDERS THROUGH THE LENS OF LANDSCAPE PATTERNS

"The war did not just change the landscape; it became the landscape."
(Bishop & Bostridge, 1998, p. 252)

Modified from:

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ABSTRACT The First World War (1914-1918) wreaked an overwhelming damage in Flanders. Allied and German forces battled four years, transforming the pre-war landscape with scenic views into a destroyed landscape fully covered with craters. Afterwards, the landscape was entirely reconstructed by the help of local initiatives and by national and international policy. In this paper, changing landscape patterns are analysed with historical land use/land cover data to unravel the underlying landscape dynamics of the restored area until present. The composition and spatial configuration of the landscape are observed by focussing on the post-war reconstructed landscape. Furthermore, the relation between the degree of military influence during the war and the observed patterns in the reconstructed landscape is studied. Results show that the fragmentation and diversity increased in the past hundred years whereby changes were first seen in urban areas and afterwards in the countryside. Additionally, changes in size and the complexity of fields proved to have a significant relation with the military influence. This study observed the reconstruction period with landscape changes, to understand the post-war land use policy in an innovative manner.

KEYWORDS landscape metrics, war landscape, landscape changes, landscape patterns, LULC

4.1 Introduction

4.1.1 Context

Tragic events are one of the main cultural drivers behind landscape change (Antrop, 2005). The First World War (1914-1918) (WWI) in Flanders (Belgium) is such an example. The impact of this cultural calamity on the landscape was enormous and turned it into a military environment. Landscape elements (e.g. houses, hedges and roads) were inevitably destroyed in many areas. Complete cities, churches, schools, infrastructure (water, roads) and natural areas were demolished and overloaded with ammunition (Barton, 2008; Van den Berghe et al., 2018a; Wearn et al., 2017). After the Armistice, the rebuilding of the area took a lot of effort, as well as time and money. Literature described many aspects of this successful reconstruction that was realized by architects, engineers, companies, and a wide range of local, regional and international organizations (Claeys, 2017; Cornilly et al., 2009; Dendooven, 2009; Uyttenhove, 1990). The landscape gradually became habitable again and the economy flourished again. The post-war landscape was rebuilt in the wake of the conservative pre-war landscape (Clout, 1996). This means that the main structure of roads and houses of cities and villages was an imitation of the past (Dendooven, 2009). However, literature indicated that the pre-war example has not always been perfectly copied, whereby the locations of the houses and streets were often not located in the same place. Moreover, villages were sometimes completely moved to an adjacent and more suitable area (Dendooven, 2009; Van den Berghe et al., 2018a). Today, the area is a heritage landscape that comprises two dimensions: the traces of the reconstruction period and the associated memory of the First World War (WWI). However, the modern emerging needs of the 20th century suppress the characteristics of the rebuilt region (Cornilly et al., 2009).

In general, we hypothesize that the observed pre-war land use/land cover (LULC) patterns of for instance previous mentioned infrastructure (roads) and cities and villages (housing), differ from the observed post-war patterns due to continuous natural (e.g. recovery, biodiversity loss) and human processes (e.g. policy discourses, abandonment, reconstruction plans, social needs), which were triggered by the conflict (Antrop & Van Eetvelde, 2017; Chielens et al., 2006; Van den Berghe et al., 2018a).

The study of LULC patterns between pre- and post-conflict landscapes have already extensively been recorded with the aid of remote sensing techniques. The use of satellite images and (historical) aerial photos proved to be a helpful source to observe and analyse the impact of a cultural conflict on the fauna, flora, urban and rural development. Studies of changes between pre- and post-conflict landscape structures can be divided in two themes: the composition and the spatial configuration of LULC (Turner et al., 1989; Uuemaa et al., 2007). Publications were mainly focused on changes in the composition (or presence and amount) of LULC types such as on forestry, housing and agricultural lands (Baumann et al., 2015; Geri et al., 2010; Gorsevski et al., 2012; Van den Berghe et al., 2018a; Wilson, 2014; Witmer, 2008). Only few authors studied the impact of a conflict on the spatial configuration (or spatial character) of LULC types. In Lebanon, scholars analysed the altered spatial configuration of a landscape which was caused by the massive influx of 1.2 million refugees from the Syrian war; this by studying and mapping information that came from satellite images. For example, the openness of the landscape between the new established tents of the refugees was studied by analyzing land use changes (Trovato, 2018). The changing configuration caused by a conflict was also investigated by Gbanie et al. (2018). The changes in fragmentation in the landscape of Sierra Leone that were caused by refugees, were calculated on the basis of landscape data from the period before, during and after the conflict. Others described the by the civil conflict caused fragmentation in forests in Congo and Nicaragua also by help of landscape metrics (Nackoney et al., 2014; Stevens et al., 2011).

The use of landscape metrics is an important methodology to monitor the geometrical dynamics in the landscape (Turner, 1989; Uuemaa et al., 2013), which is useful for land use policy (Boongaling et al., 2018; Fry et al., 2004; Haines-young, 1999; Lauf et al., 2016; Liu et al., 2016; Van Eetvelde & Antrop, 2009). In addition to the first information layer of a landscape obtained by visual analysing the landscape (e.g. spatial plans, observations) or by thematic mapping the landscape (e.g. landscape characterisation), the landscape metrics provide a second information layer by describing (quantitatively) landscape patterns that are caused by imperceptible processes (Bartel, 2000). This paper applies both information layers by exploring the changing LULC between two time phases (first information layer) and by calculating landscape metrics (second information layer).

4.1.2 Aim

By using metrics, it is possible to make an evaluation of the impact of the policy on the changes in the landscape (Parris, 2004; Veerle Van Eetvelde & Antrop, 2009). It is not known whether the spatial configuration of the landscape before the First World War (WWI) differs quantitatively from the post-war reconstructed landscape. This is caused by processes in the twentieth century, such as the intensification of the rural landscape or the increasing need for housing after the war (Jespen et al., 2015). Furthermore, the military influence in the region varied from the frontline to the hinterland (Note et al., 2018; Van den Berghe et al., 2018b), whereby the consequences of this impact on post-war patterns are not known.

Therefore, the objective of this study is to analyse dynamic patterns in the landscape in an innovative manner by using historical remote sensing data from Flanders and by analyzing these data with landscape change maps and landscape metrics. The following research questions are discussed that further subdivides the main question formulated at the beginning of this dissertation into subquestions (Q4 in section 1.5.1):

- Q1: Are there particular trends noticeable in the changing landscape patterns of the last century?
- Q2: Are patterns in the post-war reconstructed landscape different?
- Q3: Is spatial variability in the landscape configuration of the post-war rebuilt landscape observable in relation to the spatial variability of military impact during the war?

4.1.3 Study areas

The research focuses on three areas that are located in the former WWI front region of Flanders, starting at the North Sea and deflecting in a south-west direction to France. The frontline frequently shifted, causing the landscape elements in the area to be repeatedly destroyed. The study areas have each a different characteristic landscape and a corresponding former warfare (Figure 4-1).

The first most northerly located study area (i; 23.7 km^2) is part of the coastal plain of Flanders[45] (Doyle, 2014), which is an artificially habitable drained area, also called the 'Polders' (Bertrand & Baeteman, 2005; Vandenbohede, 2016). This landscape is characterised by open views and abundant

[45] Only the area on the right bank of the river Yser is used for analysis because this area proved to be 'consistent'. I argued that only consistent areas can be used to compare different time phases (see section 2.3.3.1 for the explanation of 'consistency' and Figure 4-1 for the studied area in this chapter).

ditches and waterways that surround the fields. During the war, the area between the left bank of the river Yser and the railway from Diksmuide to Nieuwpoort was inundated by opening the locks to the North Sea, consequently holding back the German forces (Barton, 2008).

More to the south, the second study area is characterised by a pronounced relief. The 'Westrozebeke Ridge' starts in the north at the city of Diksmuide and continues in a southerly direction passing by the city of Passchendaele (Antrop, 1989) and has heights going to 50 m (Doyle, 2014). The rural landscape is marked by fields that were completely enclosed by hedges and tree rows, which resulted in the Flemish '*bocage*' landscape (or hedgerow landscape) (Antrop, 2006). The First (October-November 1914), Second (April-May 1915) and Third Battle (July-November 1917) of Ypres occurred in the area, completely destroying the landscape. In this study area, an extensive trench system was developed, especially on the ridge of the so-called 'Ypres Salient' (Doyle et al., 2001).

In the third study area (iii; 83.6 km2), the southernmost point of the 'Westrozebeke Ridge' is located (Antrop, 1989). In the west, the ridge flows into the Flemish Hills with the Kemmelberg as the most important observation hill (156 m) for the Allies when the German forces occupied the higher 'Westrozebeke ridge' (Barton, 2008; De Vos et al., 2014). Because of the pronounced elevations, this area was the scenery for the underground war whereby 24 mines were placed and whereof 19 exploded (Institution of Royal Engineers, 1922).

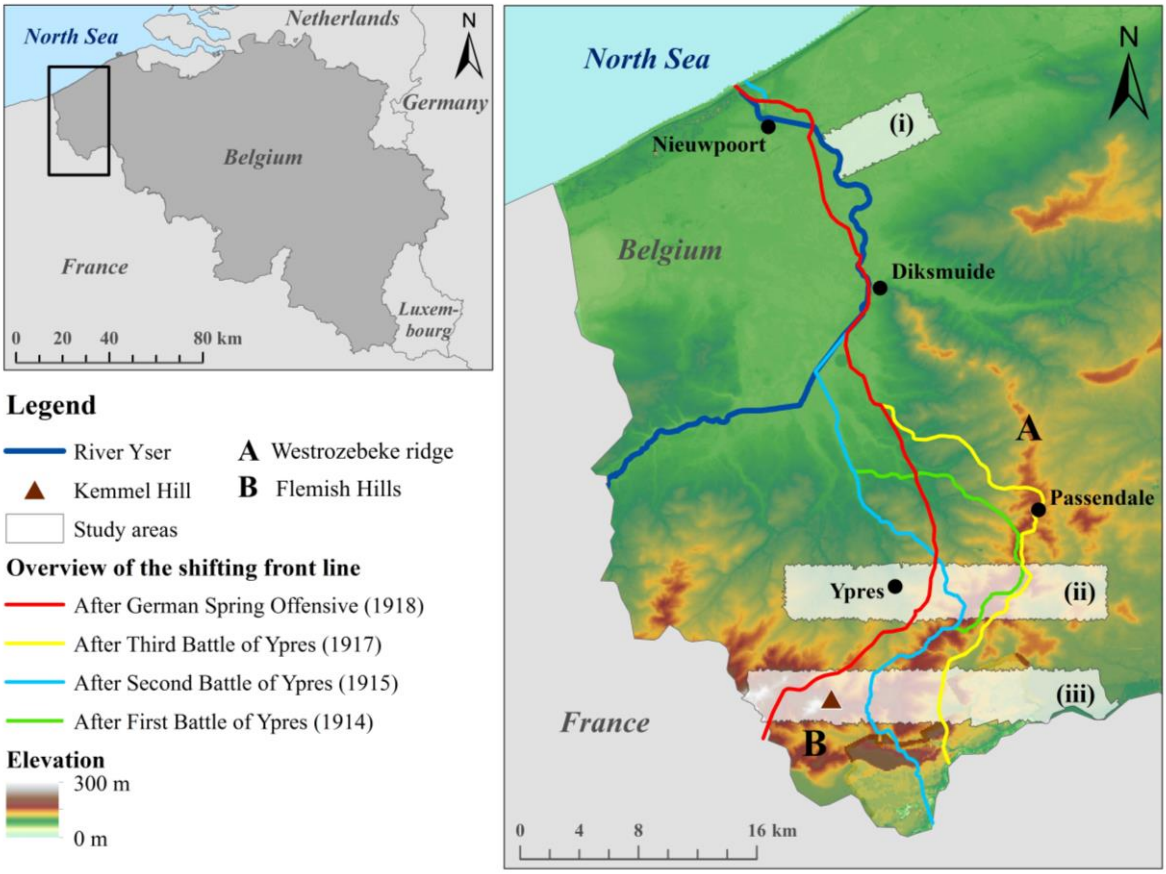


Figure 4-1 Location study areas (digital elevation model copyright National Geographic Institute)

4.2 Methods

A land use/land cover (LULC) database composed of polygons (vector data) was examined with binary change maps and landscape metrics. This database was generated based on the visual image interpretation of historical black and white and coloured photos. LULC types were specifically chosen

in light of the characteristic WWI landscape in Flanders (Table 4-1), making it a suitable database for this analysis (for more details of this database see Van den Berghe et al., 2018a). The database provides LULC information at four points in time: 1915 based on the first available time series of historical aerial photographs (various scales), 1918 as the last time series of photographs taken during the war (various scales), 1939-1940 as the first time series of aerial photographs available after WWI (1:5000) and lastly the post-war period in 2012 (1:1000). The situation of 1915 is considered to be the pre-war situation since the destruction due to war activities that destroyed the landscape had not yet erased the landscape, suggesting the LULC from before 1914. Due to a lack of available historical photos during the war, the database did not provide LULC information that completely covered the three study areas. Consequently, only the entire areas covered with LULC information for the four time phases will be applied for the subsequent twofold analysis: a LULC change analysis and a landscape metric analysis (Figure 4-2).

Table 4-1 Land use/land cover types in the study area (according to Van den Berghe et al., 2018a, see also chapter 2, Table 2-3)

Land cover (land use)	Spatial code
Arable land (hayland, crops)	1
Pasture (grassland)	2
Woodland (not known)	3
Build up land (housing)	4
Unrecognisable build up land (not known)	5
Grassland with trees and lakes (castle park)	6
Cemetery and monument (mourning)	7
Golf course, water (recreation)	8
Warehouses and factories (industry)	9
Water (not known)	10
Disturbed and no recognisable land cover (militarised purposes)	11

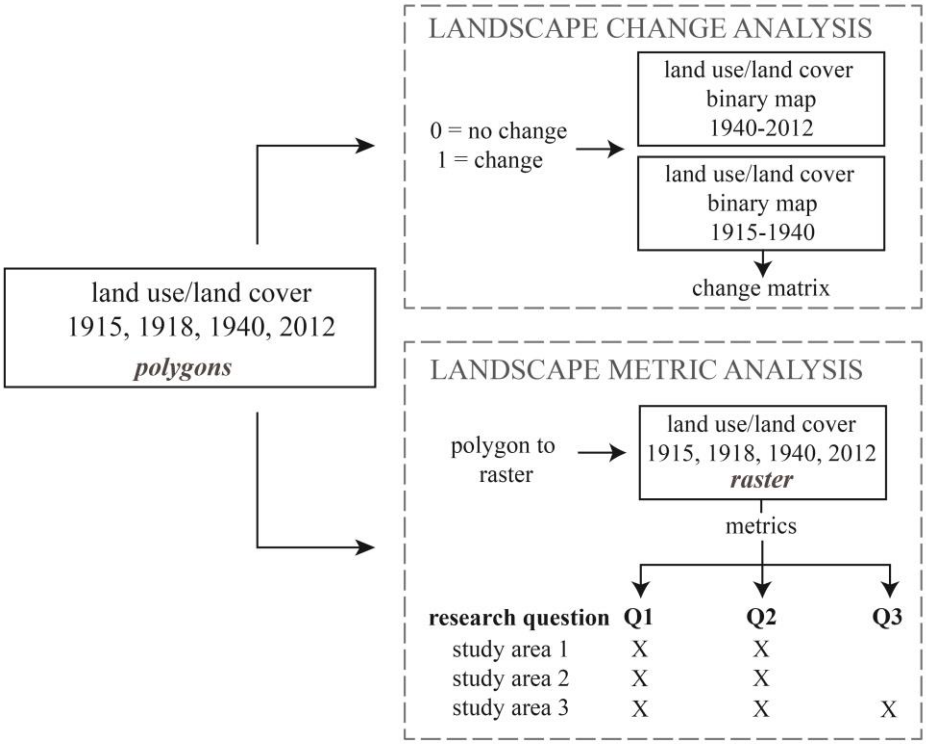


Figure 4-2 Land use/land cover database applied for the landscape change and landscape metric analysis

4.2.1 LULC change analysis

To explore the main changes in the LULC dataset, two change maps were created between the time phases 1915-1940 and 1940-2012. To do so, binary maps were prepared with category '1' (change in LULC) and '0' (no change in LULC) (Veerle Van Eetvelde & Käyhkö, 2009), with an accompanying LULC change matrix of all the LULC types (Pontius et al., 2004) (Table 4-1).

4.2.2 Landscape metric analysis

4.2.2.1 Set up data

Landscape metrics were computed in the software Fragstats (version 10.4) developed by McGarigal et al. (2012). The software provides a wide range of metrics for the analysis of the geometrical and spatial characteristics of the patches in the landscape (configuration) and the presence and amount of each patch type within the landscape (composition) on a categorical basis. Before analysing the LULC database in Fragstats, the vector data (cf. polygons) was transformed into raster data with cells of 10 m x 10 m [46](grain). This size represents the smallest polygon or the minimum mapping unit of the phenomenon (LULC) under study (McGarigal & Marks, 1995). It should be noted that the conversion of data can have an impact on the calculation of the metrics. For example, the choice of grain may determine the outcome. In this case, the conversion of a vector data into a raster data can cause information to be lost. However, these were avoided as much as possible by choosing an appropriate grain size in the context of this study and in line with the data (Gustafson, 1998; Uuemaa et al., 2005; Wu, 2004). Moreover, following Wu (2004) "there is no single correct or optimal scale".

To discuss research question one (Q1) and two (Q2) (see section 4.1.2), metrics were calculated in the three study areas (or extents) for each time phase. To solve research question three (Q3), the analysed extent had to be adjusted to create spatial variance from the former frontline (highest military impact) to the hinterland (lowest military impact). Therefore, the raster file of time phase 1940 (Figure 4-3, A) was divided into raster samples of 1 km^2 whereby each sample will serve as an extent for the calculation of landscape metrics (Figure 4-3, B). As the average patch size in 1940 is 0.08 km^2, this size represents in an integral manner the organizational level of human expressed by LULC. To generalize the impact factor per 1 km^2, the average of the impact factors represented in the 1 km^2 was calculated by including also the area (cf. weighted)[47] (Figure 4-3, D). These average weighted impact factors (IF/km^2) were determined from the impact factor map (Figure 4-3, C), which was created by calculating the military impact for each field in the last century starting from the beginning of the war. This impact factor was assigned to defined historical landscape characters in Chapter 2. The more a field was shelled or disturbed by military constructions during the past century which was visible on historical aerial photographs, the higher the impact factor for that particular field (or polygon) (see section 2.3.3.3 for more details op this impact map). Only the third study area will be used to answer Q3 because this study area provided the most 1 km^2 samples. Notably, due to the irregular boundaries of the study area, not all the 1 km^2 samples were completely

[46] The smallest polygon was found in within the LULC type 10 (water).

[47] This was done by dividing a certain impact factor of a polygon by its surface (km^2). Afterwards, the sum was made for all these calculations for all polygons in a certain raster sample of 1 km^2. This was done by the tool 'zonal statistics' in ArcGIS.

covered with LULC information (Figure 4-3, B). Consequently, only samples were selected for analysis with complete LULC coverage as patterns can only be compared between samples with the same extent (Leitao et al., 2008; Wu, 2004). Questionable results are namely reached when patterns between different extents are compared (Turner et al., 1989). In total, 48 samples were suitable and selected for the landscape metric analysis for Q3 (Figure 4-3, B). In the results section, the raster samples of 1 km^2 were firstly ordered according to an increasing average weighted impact factor (Figure 4-3, D). Afterwards, the landscape metrics values belonging to these samples were determined whether they have an increasing or decreasing trend when the weighted military impact rises (cf. ordered samples). This relation between the increasing average weighted military impact factor and accompanying landscape metrics values is firstly visualised in graphs with an associated trend line and afterwards statistically explored with a Pearson Correlation test[48] (Kutner et al., 2005).

[48] As I do use continue data to calculate the correlation I can use the Pearson Correlation test instead of the previous conducted Spearman Correlation test in the other chapters (Kutner et al., 2005).

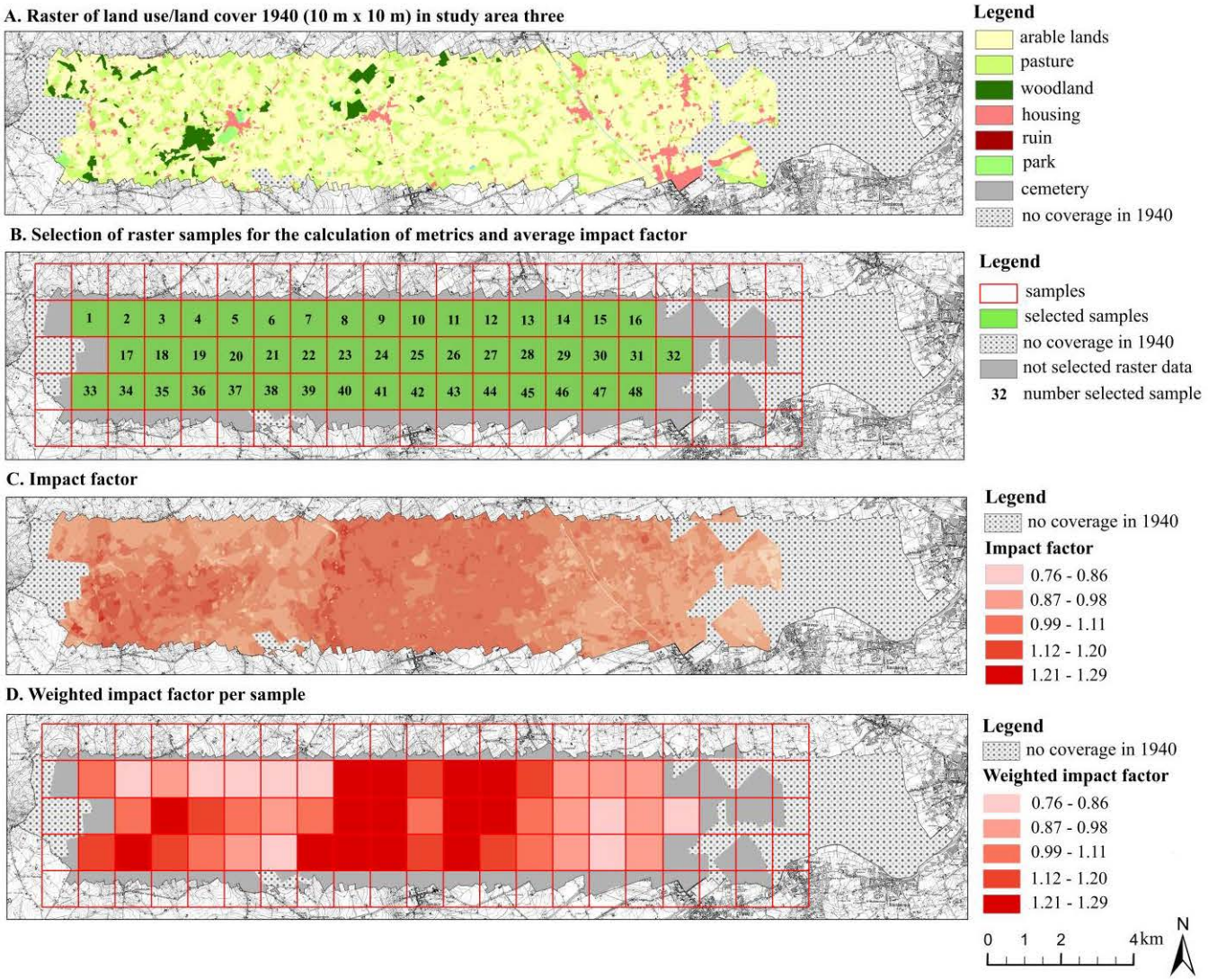


Figure 4-3 Procedure for the analysis of the military impact on the landscape (A) raster of land use/land cover 1940, (B) selection of samples, (C) impact factor map and (D) weighted impact factor per sample

4.2.2.2 Framework selection metrics

In landscape research, there is a wide range of metrics that are applied (Uuemaa et al., 2007). Therefore, an analytical framework is needed to select the most convenient metrics. This study follows four criteria for the selection of metrics. First, metrics were chosen addressing the formulated research questions (see introduction). Per metric, the information obtained is consulted whereby the utility of the metric is explored for this study. Secondly, the choice of metrics depends on the type of data that is used (Antrop & Van Eetvelde, 2000). The patches in the LULC database do not represent fields with visible delineated properties but are aggregated fields with the same LULC type. Consequently, only metrics were selected with the patch neighbor 8-cell rule option on class (information of patches belonging to the same class) and landscape level (information of the patterns in the landscape) and not at patch level. Third, the use of one metric is insufficient. Therefore, it was decided to select several metrics that provide a complete study of the spatial characteristics (Botequilha Leitão & Ahern, 2002; Dale & Beyeler, 2001; Gustafson, 1998b). Complementary metrics were selected whereby each of them provided information about at the one hand the configuration and at the other hand the composition of the landscape. For instance, the metrics CAP (class area proportion), PLAND (percentage of the class in the landscape) and AREA_MN (mean patch size) complement each other. Last, many metrics provide the same information and are redundant. Consequently, only suitable metrics were chosen with an added value for this research. For instance, the metrics PROX (proximity) and ENN (Euclidean nearest neighbour) both provide information about the isolation and proximity of patches. The choice between both relies on the formula. The metric PROX incorporates a radius wherein the distance to neighbouring patches is calculated. Since this radius has no added value to this research, the metric ENN was chosen.

This study tried to fulfil the previously mentioned criteria in the best possible manner. Table 4-2 lists the chosen metrics with the extracted landscape information. For the formulae, see McGarigal et al. (2002). For an extensive overview of how the selection of the metrics was carried out, see Appendix 4C.

Table 4-2 Selected landscape metrics divided in landscape composition and configuration per landscape or class level with the provided landscape information, after McGarigal et al. (2002)

Metric	Description	Units	Range	Landscape level	Class level	Indicator for	Type of metric
Landscape composition							
CA	Class area proportion	Hectares	0 < CA ≤ 1		X	How is the composition of the landscape? How diverse is the landscape?	Area/density/edge metric
PLAN	Percentage of the landscape	Percent	0 < PLAND ≤ 100		X	How is the composition of the landscape? How diverse is the landscape?	Area/density/edge metric
PR	Patch richness	Dimensionless	≥1. without limit	X		How diverse is the landscape in terms of representative patch types?	Diversity metric
PRD	Patch richness density	Number per 100 hectares	PRD > 0. without limit	X		How diverse is the landscape in terms of representative patch types per area unit?	Diversity metric
SHEI	Shannon's Evenness Index	Dimensionless	0 ≤ SHEI ≤ 1	X		How evenly distributed are the patch types in the landscape?	Diversity metric
SHDI	Shannon's diversity index	Dimensionless	SHDI ≥ 0. without limit	X		How diverse is the landscape in terms of representative patch types and the even distribution of these patches types in the area?	Diversity metric
Landscape configuration							
AREA_MN	Mean patch size	Hectares	without limit	X	X	How much is the landscape and is each class subdivided or fragmented?	Area/density/edge metric
AREA_SD	Standard deviation size	Hectares	without limit	X	X	Have the patches of each class the same size or is it diverse? Have the patches in the landscape the same size or is it diverse?	Area/density/edge metric
TA	Total area	Hectares	Without limit	X		What is the area of each extent?	Area/density/edge metric
NP	Number of patches	Dimensionless	≥1. up to the total number of patches	X	X	How much is the landscape fragmented?	Area/density/edge metric
PD	Patch density	Number of patches per 100 hectare	≥1. up to the total number of patches	X	X	How much is the landscape fragmented?	Area/density/edge metric
TE	Total edge	Meters	TE ≥ 0. without limit	X	X	What is the sum of all the edges in the landscape per class and in the landscape?	Area/density/edge metric
ED	Edge density	Meters per hectare	ED ≥ 0. without limit	X	X	What types of land cover/land use are aggregated? How aggregated is the landscape?	Area/density/edge metric
GYRATE_MN	Mean Radius of gyrate	Meters	≥ 0. without limit	X	X	Is there patch extensiveness? Is there ribbon development?	Area/density/edge metric
SHAPE_MN	Mean shape index	Dimensionless	≥1. without limit	X	X	How complex are the patches of each class and in the landscape? Are they compact and simple?	Shape metric

SHAPE_SD	Standard deviation shape	Dimensionless	≥1. without limit	X	X	Are the shapes very differently shaped in each class or in the landscape?	Shape metric
ENN_MN	Euclidean Nearest Neighbor Distance	Meters	> 0. without limit		X	Which types are accessible or in the contrary scattered in the landscape?	Isolation/ proximity metric
AI	Aggregation index	Percent	0 ≤ AI ≤ 100	X	X	What types of land cover/land use are aggregated (dispersion)? How is the landscape aggregated?	Contagion/ interspersion metric
IJI	Interspersion and Juxtaposition index	Percent	0 < IJI ≤ 100	X	X	How much are land cover types aggregated with other land cover types (interspersion)? How evenly distributed are the edges amongst the available classes in the landscape?	Contagion/interspersion metric

4.3 Results

4.3.1 LULC change analysis

In total, 25.0 % of the LULC changed in the three study areas between 1915 and 1940. Changes are particularly visible in the cities and villages whereof 9.43 km^2 was gained compared to a loss of 0.68 km^2. This gain is particularly derived from former ruins (3.29 km^2), arable lands (3.61 km^2) and pasture (2.18 km^2) that were replaced by other LULC types. Later, after the reconstruction of villages and cities, the landscape changed between 1940 and 2012 (31.9 %) whereby especially villages and cities in the countryside expanded and replaced rural fields into housing, marked by a bigger loss than gain for arable lands and pasture (see Figure 4-4, Figure 4-5 and Table 4-3).

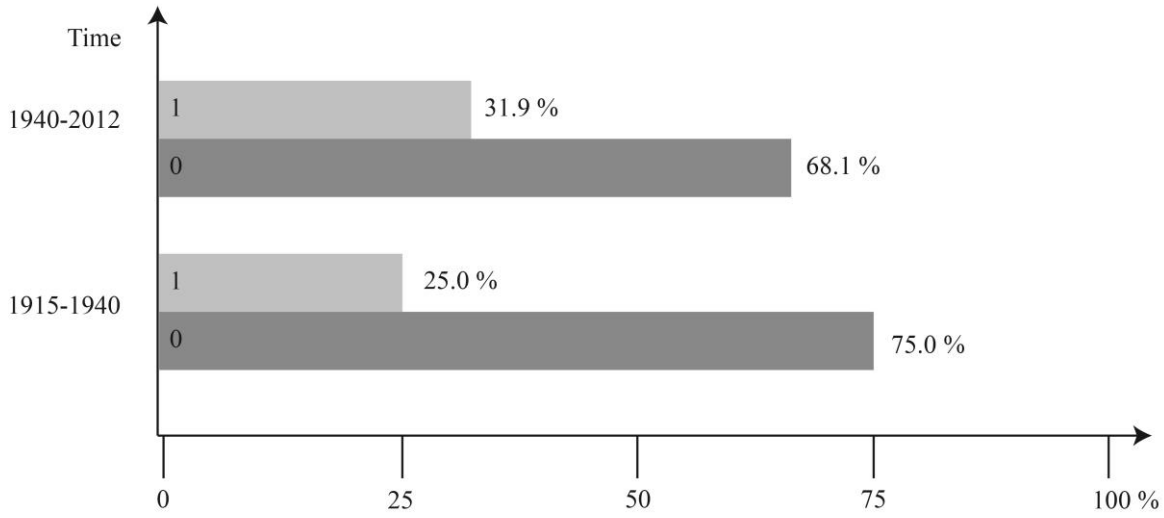


Figure 4-4 Horizontal plot representing the percentages of change (1) and no change (0) of land use/land cover patches generalised for the three study areas for time phases 1915-1940 and 1940-2012

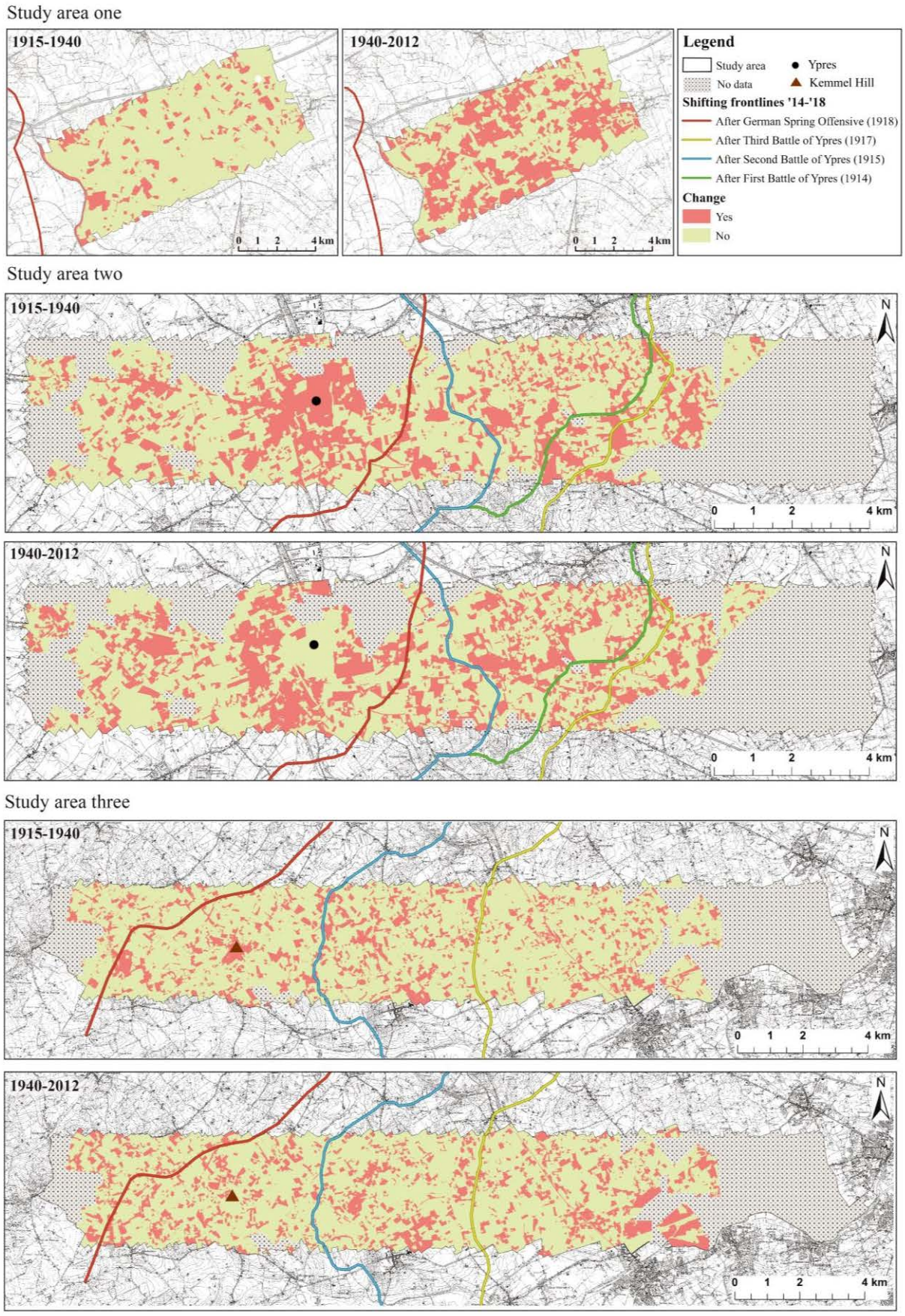


Figure 4-5 Change maps with change (1) and no change (0) of land use/land cover patches generalized for the three study areas for time phase 1915-1940 and 1940-2012

Table 4-3 Change matrix between 1915-1940 and 1940-2012 calculated for the tree study areas (in km²)

		1940												
1915	**LULC types**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**total 1915**	**loss**
	1	74.67	9.90	0.58	3.61	0.00	0.16	0.08	-	0.09	0.08	0.15	89.31	14.64
	2	8.36	26.58	0.36	2.18	-	0.00	0.04	-	0.06	0.10	0.07	37.76	11.18
	3	0.95	0.73	3.61	0.09	-	0.23	0.01	-	-	0.01	-	5.63	2.02
	4	0.30	0.31	0.02	1.60	-	-	0.00	-	0.04	0.00	-	2.28	0.68
	5	0.48	0.76	0.03	3.29	-	0.01	0.00	-	0.00	0.01	0.02	4.61	4.61
	6	0.14	0.08	-	0.02	-	0.63	-	-	-	0.01	-	0.88	0.25
	7	0.00	0.00	0.01	0.02	-	-	0.04	-	-	-	-	0.07	0.03
	8	0.00	0.00	0.01	0.00	-	-	-	-	-	-	-	0.02	0.02
	9	-	-	-	-	-	-	-	-	0.02	-	0.00	0.02	0.00
	10	0.09	0.60	0.02	0.01	-	0.02	0.00	-	0.00	0.59	-	1.33	0.74
	11	0.77	0.52	0.22	0.21	-	-	-	-	-	0.02	0.00	1.75	1.74
	total 1940	85.77	39.49	4.86	11.04	0.00	1.05	0.18	-	0.21	0.81	0.24	143.65	
	gain	11.10	12.91	1.25	9.43	0.00	0.42	0.14	-	0.19	0.22	0.24		
		2012												
1940	**LULC Types**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**total 1940**	**loss**
	1	65.66	11.01	0.82	6.44	0.02	0.15	0.13	0.31	1.11	0.14	-	85.77	20.11
	2	17.00	17.13	0.44	3.73	0.06	0.06	0.01	0.24	0.56	0.26	-	39.49	22.36
	3	0.28	0.66	3.63	0.19	-	0.06	0.01	0.01	0.00	0.03	-	4.86	1.24
	4	0.36	0.48	0.04	9.85	0.01	0.01	0.03	0.05	0.20	0.01	-	11.03	1.18
	5	-	-	-	-	-	-	-	-	-	-	-	0.00	0.00
	6	-	0.00	-	0.06	-	0.68	-	0.31	-	0.00	-	1.05	0.37
	7	0.00	0.00	-	0.01	-	-	0.16	0.00	-	0.00	-	0.18	0.02
	8	-	-	-	--	-	-	-	-	-	-	-	0.00	0.00
	9	-	0.01	0.01	0.03	-	-	-	-	0.16	-	-	0.21	0.05
	10	0.10	0.02	0.02	0.01	-	0.00	0.00	0.01	0.01	0.63	-	0.81	0.18
	11	0.03	0.07	0.00	0.03	-	-	-	-	0.11	0.00	-	0.24	0.24
	total 2012	83.43	29.37	4.95	20.35	0.09	0.96	0.33	0.95	2.14	1.07	-	143.65	
	gain	17.74	12.25	1.32	10.50	0.09	0.28	0.18	0.95	1.98	0.44	-		

4.3.2 Landscape metric analysis

4.3.2.1 Research question one: spatial trends over time per study area

To analyse the spatial trends in the past century, results of the landscape metrics of 1915 are specifically compared with 2012. In the 'Polders' or the first study area (TA; 2371.5 ha), arable lands (hay land and crops) and grassland (pasture) are dominant in the four time phases (PLAND; aggregated percentage of 93.1 % of the landscape in 1915, 85.8 % in 1918, 96.6 % in 1940 and 93.0 % in 2012), indicating a landscape with no even distribution of the LULC types. Over time, the amount of grassland declines (PLAND; 45.3 % to 14.4 %) and became increasingly fragmented in many small spatial units (PD; 2.4 patches/100 ha to 3.9 patches/100 ha), marked by a decrease in the mean area (AREA_MN; 18.5 ha to 3.7 ha) and more equal sized patches (AREA_SD; 54.5 ha to 7.4 ha). Arable lands show less fragmentation over time (PD; 2.4 patches/100 ha to 1.6 patches/100 ha), characterized by less equal sized patches (AREA_SD; 112.8 ha to 295.3 ha), less complex patches (SHAPE_MN; 1.6 to 1.4) and an increase in the mean area of patches (AREA_MN; 18.6 ha to 49.1 ha). Arable lands become less aggregated over time (ED; 63.4 m/ha to 54.9 m/ha) than pasture (ED; 72.5 m/ha to 48.2 m/ha), while patches are more interspersed with other patch types (IJI arable lands; 40.2 % to 53.3 %; IJI pasture; 45.9 % to 41.9 %). Build up land (housing) is the most fragmented LULC type (PD; 3.2 patches/100 ha to 5.2 patches/100 ha) with an increase in the amount of patches (NP; 77 to 123 patches) and the mean size (AREA_MN; 0.6 to 1.2 ha). Notably, patches become more irregular sized (AREA_SD; 0.9 ha to 1.2 ha) whereby ribbon development developed (GYRATE_MN; 28.8 m to 38.6 m) with more complex shaped patches (SHAPE_MN; 1.3 to 1.5). Water bodies become more fragmented over time (NP; 77 to 123 patches) but are the most compact patches (SHAPE_MN; 1.2 and 1.2). When studying the complete landscape, it can be concluded that the landscape is the least diverse in 2012 (SHDI; 1.0 to 0.7), expressed by a decrease in the equal distribution of patches (SHEI; 0.5 to 0.4) and an equal amount of LULC types (PR; 6 types in 1915 and 6 types in 2012) (Appendices 4A and 4B).

In the second study area or the area of the Ypres Salient (TA; 5385.2 ha), arable lands are dominant in the four time phases (PLAND; 24.5 % in 1915, 16.5 % in 1918, 55.9 % in 1940, 43.0 % in 2012), resulting in a non-even distribution of LULC types in the landscape. The sizes of the patches are variable but became notably more equal sized (AREA_SD; 251.2 ha to 78.8 ha) and compact (GYRATE_MN; 164.0 m to 132.7 m) with a decline in the mean size (AREA_MN; 53.5 ha to 20.3 ha). Patches became also more fragmented with time (PD; 1.1 to 2.1 patches/100 ha). Grassland, the second dominant LULC type (PLAND; 24.4 % of the landscape to 23.0 %), shows a small decrease in fragmentation (PD; 4.5 to 4.1 patches/100 ha) marked by no changes in the mean area (AREA_MN; 5.5 ha to 5.6 ha) and the equality of the size of patches (AREA_SD; 12.5 ha to 11.7 ha in 2012). Build up land (housing) increases over time (PLAND; 0.3 % to 21.9 % of the landscape) and becomes more fragmented (PD; 1.0 to 8.0 patches/100 ha) with no equal sized patches (AREA_SD; 0.8 ha to 25.1 ha). Notably, ribbon development is an increasing phenomenon (GYRATE_MN; 18.5 m to 42.0 m). All LULC types become more aggregated and equally adjacent (IJI; increased for all types and ED; increased for all types except for arable lands). In the complete area, the diversity of the landscape increases (SHDI; 1.2 to 1.5), whereby also an increase is noticeable in the even distribution (SHEI; 0.5 to 0.7) of patches and a decline in patch richness (PR; 9 types to 11 types) (Appendices 4A and 4B).

In the area of Kemmel Hill or the third study area (TA; 6612.9 ha), arable land is also dominant (PLAND; 70.2 % to 63.0 %) with sharply decreasing patch sizes (AREA_MN; 103.2 ha to 38.2 ha), which become more equal sized and compact (GYRATE_MN; 167.5 m to 100.4 m and AREA_SD; 531.5 ha to 309.9 ha). Hence, the patches are more fragmented over time (PD; 0.7 to 1.6 patches/100 ha in 2012, PN; 45 to 109 patches). Grassland becomes less fragmented over time (PD; 5.1 to 4.7 patches/100 ha in 2012, PN; 336 to 311 patches), with a small decline in the mean size

(AREA_MN; 4.4 ha to 4.1 ha) and more variation in the patch sizes (AREA_SD; 7.2 ha to 9.2 ha). Build up land (housing) increases over time (PLAND; 2.4 % to 10.8 % of the landscape) and is more fragmented (PD; 8.0 to 9.8 patches/100 ha) with more ribbon development and less equal sized patches (GYRATE_MN; 17.9 to 33.2 m and SHAPE_MN; 1.3 to 1.4). In the landscape, the diversity increases (SHDI; 0.9 to 1.1), caused by an increase in the even distribution of patch types (SHEI; 0.4 to 0.5) (Appendices 4A and 4B).

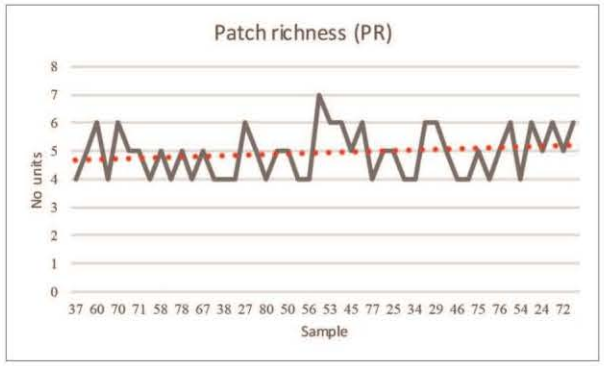
Generally, the studied area the 'Polders' shows opposite trends compared with the most southern located study areas around Kemmel Hill and Ypres. In the 'Polders', the diversity and aggregation of the total landscape declines and arable lands become less fragmented. The opposite happened in the other two study areas whereby the diversity and aggregation increased and arable lands became more fragmented. Furthermore, the fragmentation of grassland declines in the 'Polders' while this decreases in the other areas. Following from the knowledge obtained in the precious chapters, I argue that the opposite trends between the Polders on the one hand and the Ypres and Kemmel region on the other hand, are the result of another type of warfare (see section 1.3) which caused another degree of military influence. The study area in Nieuwpoort was less destructed compared to the regions Ypres and Kemmel. Afterwards, I argue that this influence induced another reconstruction history which was translated in other observed landscape patterns in this chapter (see results in section 2.4).

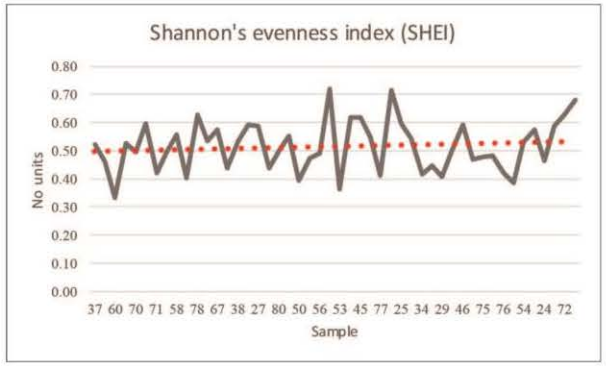
4.3.2.2 Research question two: trends post-war landscape in 1940

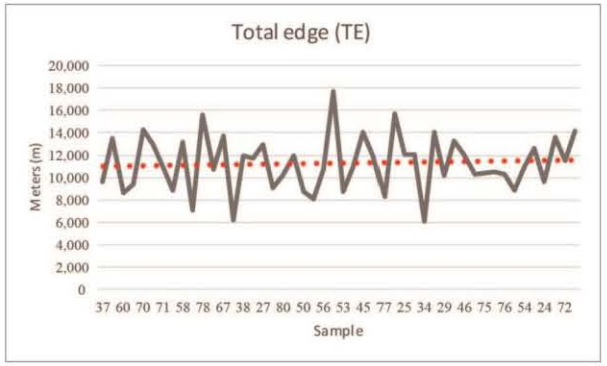
To unravel the spatial trends in 1940, results of the landscape metrics of 1940 are specifically compared with the other time phases. In the first study area, the landscape is the most aggregated (ED; 88.7 m/ha) and interspersed (IJI; 44.7) in 1940. This higher aggregation degree is caused by a higher aggregation in arable lands, pasture and housing (ED arable lands; 66.9 m/ha and ED pasture; 79.3 m/ha; ED housing; 20.8 m/ha). The diversity in the landscape is the lowest in 1940 (PR; 4 types and PRD; 0.2 types/100 ha). In the second study area, the landscape is the most fragmented (PD; 24.6 patches/100 ha) and aggregated (ED; 127.0 m/ha) in 1940. Especially arable lands and pasture are the most aggregated in that year (ED pasture 83.4 m/ha; ED arable lands 87.6 m/ha). The third study area marks the lowest diversity in 1940 (PR; 8 types and PRD; 0.1 types/ha). Generally, the reconstruction of the landscape after 1914-1918 was different than the pre-war landscape in a few aspects by which the landscape is less diverse, more fragmented and more aggregated (Appendices 4A and 4B).

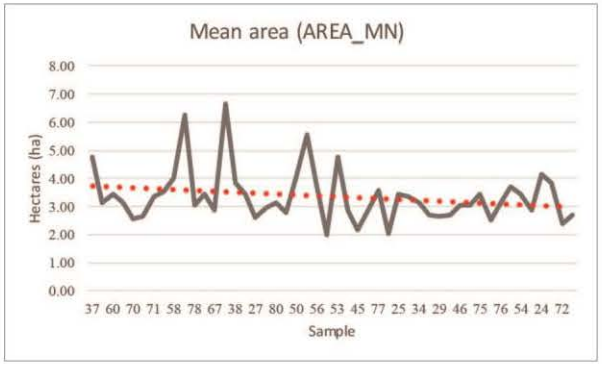
4.3.2.3 Research question three: military impact and correlated trends

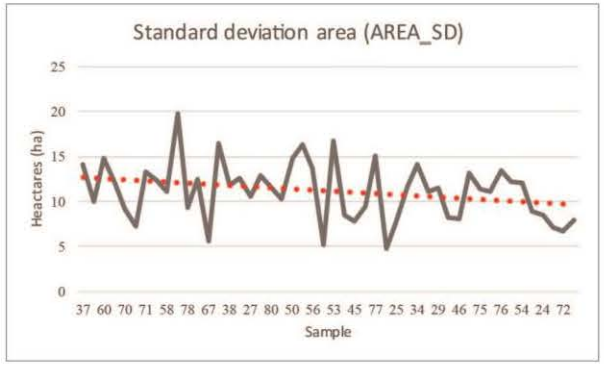
The variable military impact in the southern study area had an influence on landscape patterns in the post-war period (1940). Polygons in the raster samples with a higher military impact showed different metric outcomes compared with polygons that underwent a lower military impact. The higher the military impact in 1914-1918, the higher the diversity (SHEI, SHDI and PR) indicating that more LULC types are present and that polygons are more evenly distributed. The shape of these polygons is less extensive and complex (SHAPE_MN and GYRATE) with smaller and more equal sized patches (NP, AREA_MN and AREA_SD). Polygons of the same type were located closer (ENN_MN). No less or more aggregation is present in heavier impacted samples (IJI, ED, TE) (Figure 4-6).

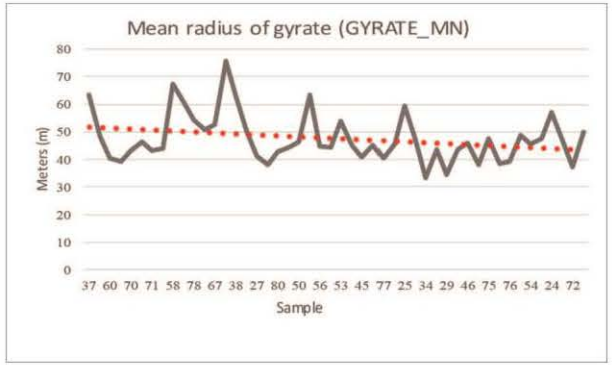

Patch richness (PR)
No units
Sample


Shannon's evenness index (SHEI)
No units
Sample


Total edge (TE)
Meters (m)
Sample


Mean area (AREA_MN)
Hectares (ha)
Sample


Standard deviation area (AREA_SD)
Heactares (ha)
Sample


Mean radius of gyrate (GYRATE_MN)
Meters (m)
Sample

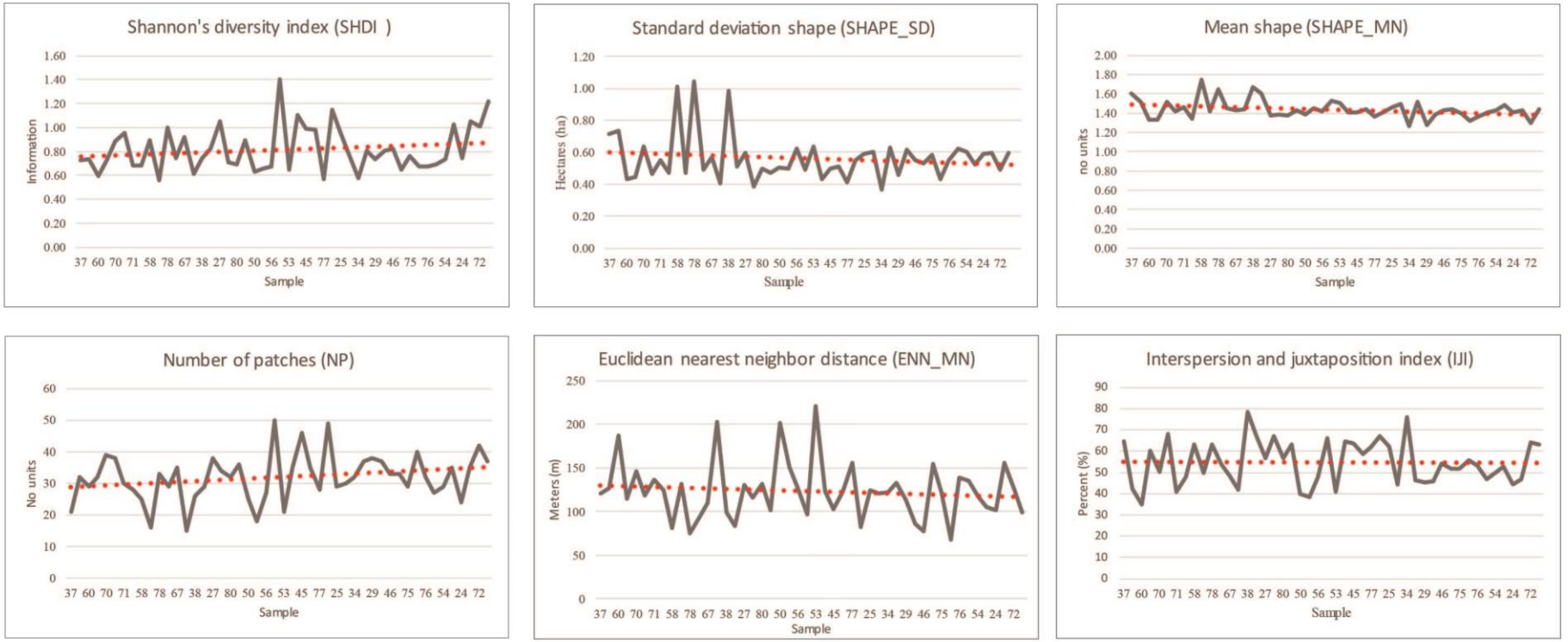


Figure 4-6 Graphs representing results of metrics (X-axis) in the raster samples relative to the ordered raster samples according to an increasing military impact (Y-axis)

The Pearson Correlation test indicated a significant correlation between six metrics and the military impact factor: NP ($r(46)= .287$, $p<0.05$, one-tailed), PD ($r(46)= .287$, $p<0.05$, one-tailed), AREA_MN ($r(46)= -.266$, $p<0.05$, one-tailed), AREA_SD ($r(46)= -.279$, $p<0.05$, one-tailed) and GYRATE_MN ($r(46)= -.323$, $p<0.05$, one-tailed) and SHAPE_MN ($r(46)= -.376$, $p<0.05$, one-tailed) (Table 4-4). In summary, the reconstructed landscape has significant smaller and more equal sized patches and less extensive and complex patches when the military impact is higher.

Table 4-4 Pearson Correlation test between landscape metrics and impact factor (p<0.05, one-tailed)

Metric	Pearson Correlation	Sig. (one-tailed)
NP	0.287	0.024
PD	0.287	0.024
TE	0.068	0.324
ED	0.066	0.327
AREA_MN	-0.263	0.035
AREA_SD	-0.279	0.028
GYRATE_MN	-0.323	0.013
SHAPE_MN	-0.376	0.004
SHAPE_SD	-0.191	0.097
ENN_MN	-0.081	0.292
IJI	-0.047	0.375
PR	0.204	0.082
PRD	0.204	0.082
SHDI	0.180	0.110
SHEI	0.097	0.256

4.4 Discussion

The reconstruction of the post-war landscape was evaluated with landscape metrics (Parris, 2004; Veerle Van Eetvelde & Antrop, 2009). Knowledge of the landscape structure or the 'second information layer' was obtained (Bartel, 2000). This layer helps to understand the relation between historical changing spatial patterns and related processes in Flanders on the former front zone. WWI-processes created a devastated militarised landscape with associated patterns and were the start of consecutive reconstruction processes embedded in land use policy and others initiatives. These were the 'answer' on the by then devasted state of the landscape. The relation between changing patterns and WWI-related processes afterwards continued, as WWI-remnants and memories became one with the landscape (Cornilly et al., 2009). Hence, these were and are still threatened by modern developments which fragments the landscape.

A relation between WWI processes and observed landscape patterns in the post-war landscape was shown. The degree of WWI impact proved to have a significant relation with the development of landscape patterns in the post-war landscape. Moreover, the study of patterns in different areas on the former front zone - which experienced each a different warfare - showed that post-war reconstruction patterns did not develop equally in these areas. These findings indicate that war influences on changing landscape patterns cannot be generalized for the complete front zone.

To analyse the dynamic landscape patterns, the 'flow' of history had to be stopped (Somers, 1994). Therefore, four time points were studied, representing the changing landscape patterns in the past century. Most landscape pattern analyses date back only 30 years (Uuemaa et al., 2013). Therefore, the studied time period of 100 years makes this study unique.

A wide range of studies revealed practical guidelines and technical limitations for the use of landscape metrics such as the selected grain, extent, landscape classification, metrics and the applied software. This study selected optimal values for the grain and extent, which were associated with the phenomenon under study. Hence, no perfect sizes for the measurement of spatial patterns exist (Wu, 2004). Notably, calculations within the boundaries of a studied extent can have an effect on the metric results if the extent is not large enough. The larger the landscape is compared with the average patch size, fewer metrics will be influenced by the boundary effects (McGarigal & Marks, 1995). This study surpasses this rule as only large areas were selected. Besides the grain and extent, the applied landscape classification has also an impact on the results (Mas et al., 2010). The use of the land use/land cover database proved to be appropriate in this study as this database was especially designed for the military and post-WWI modern landscape in Flanders (Van den Berghe et al., 2018a). The selection of metrics was performed critically (Dramstad, 2009), because one has to examine the ease of interpretation, scientific foundation and relevance for the subject (Dale & Beyeler, 2001; Dramstad, 2009; Stevenson & Lee, 2001). In this study, metrics were chosen in the light of the research questions. Arguably, no general agreement exists on the choice of metrics (Antrop & Van Eetvelde, 2000; Leitao et al., 2008). Lastly, the use of the software Fragstats was fundamental in this research. However, other methods for the calculation of landscape metrics also exist (Kupfer, 2012). Hence, Fragstats proved to be the best fit for this study since this free software provided relevant metrics, was easy applicable and is scientifically seen the most appropriate software for the calculation of landscape metrics.

The relevance of this research is that by analyzing the patterns first, one is more aware of the effective changes that have taken place. It would be interesting to combine these changes with the policy in that time (which is performed in Chapter 5). By doing first the landscape pattern analysis, it helps to select the relevant policy or events related to WWI that happened in that time. While vice versa if one is not aware of what has changed, one would start from scratch and would probably not be able to enter the specific context on which one is focusing; in this case the First World War. Therefore, the following research question is addressed for future research: How can one understand the relation between the in this paper observed landscape patterns and the agendas of the involved human actors and what can one learn from it for sustainable future heritage policy?

4.5 Conclusion

This research was designed to monitor changes in the landscape configuration that are specifically related to the devastating effect of WWI and its reconstruction afterwards. Changing landscape patterns over time were analysed using landscape metrics and landscape change analyses, based on a historical land use/land cover database. This database relied on unique historical remote sensing data including aerial photographs going 100 years back in time.

Three predetermined research questions were answered that compared the pre-war landscape with the post-WWI landscape until today. In the context of these questions (Section 4.1.2), significant results were obtained and proved that the war had an impact on landscape patterns. Changes between the pre- and post-WWI landscape were particularly noticeable in the cities and villages. Later, going from the reconstructed landscape to present, changes were visible in the countryside. When comparing the pre-war landscape with the present-day landscape, the diversity, fragmentation and aggregation of land use/land cover are higher in two of the three study areas while in the other area the opposite was observed. The reconstructed landscape is the least diverse and most fragmented and aggregated in the past century. The higher the military impact, the more the reconstructed landscape in 1940 has significant smaller and equal sized patches which are less extensive and complex. Generally, this study observed the reconstruction period in the former front area of Flanders in an innovative manner by revealing dynamical landscape patterns.

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CHAPTER 5 – THE FIRST WORLD WAR LANDSCAPE OF FLANDERS: A GEOGRAPHICAL INTERPRETATION OF HUMAN ACTORS

"The powerful fact that life must be lived amidst that which was made before"
(Meinig, 1979, p. 44)

Modified from:

Van den Berghe, H., Van den Berghe, K., Gheyle, W., Stichelbaut, B., Van Meirvenne, M., Bourgeois, J., Van Eetvelde, V. (2019). The First World War landscape of Flanders: A geographical interpretation of human actors, Applied Geography, submitted, May 2019.

ABSTRACT The First World War (1914-1918) (WWI) in Flanders profoundly changed the landscape. The pre-war landscape was transformed from a scenic landscape into a landscape full of craters and military constructions, completely demolishing buildings, fauna and flora. This devastated landscape near the front surpasses without any doubt human living conditions. It was decided that this 'tabula rasa' had inevitably to be rebuilt. The cooperation of many (inter)national stakeholders realized a significant reconstruction. However, an abundance of WWI-heritage, ranging from established commemoration monuments and military burial sites to less-visible military constructions and traces of destruction, is still present in the landscape. It makes the region today a particular remembrance and heritage landscape, with multiple aspects referring to the past conflict. The exact location and accompanying preservation condition of these remains is already investigated. However, it is still unclear why some remains are still preserved, disappeared or were demolished in the past century. This chapter examines the human decisive forces that explain the resulting militarised landscape of today. By applying a relational approach, we first analyse the political, economic and social-cultural geography of actors within four predefined time periods. Second, by using heritage policy as framework, we are able to understand the key forces that have enabled, modified or blocked war landscape preservation.

KEYWORDS actor analysis, heritage policy, landscape biography, spatial trends, reconstruction

5.1 Introduction

Landscapes ‘consume’ the human actions and reciprocally have the ability to shape themselves effecting human life (Council of Europe, 2000; Kolen et al., 2015). In this paper, we focus on the ‘creation’ of the remnants of the First World War (WWI) landscape (1914-1918). Hereby, we will not explain what battles have produced, but how stakeholders have made that this landscape still persists today hundred years later. A well-known example is the Belgian city of Ypres which was the scene of many devastating battles. British stakeholders decided that the city should not be rebuilt, to keep the remembrance alive; and also to ‘glorify’ the British victory. However, foremost the Belgians objected and Ypres eventually was rebuilt in its pre-war condition (Ingelbrecht, 2017). Ypres is rather an ‘extreme’ example, but in many other smaller cases, similar discussions were held during the last century.

Ypres is situated along the WWI Western Front in Flanders (Belgium), running from the North Sea to the French border in a north-south direction. This region was one of the most heavily shelled and destroyed areas during WWI (Figure 5-1) (Pearson et al., 2010). Already in the first months of the war, the war changed from a dynamic war to a stalemate in the trenches. Consequently, the same area was constantly shelled and substantially transformed towards a crater landscape, completely demolishing pre-war fauna, flora, houses and (valuable) historical constructions (Wearn et al., 2017). The reconstruction that was realized with divers stakeholders, changed the landscape again into a habitable area. However, scattered witnesses of this war – both military constructions and traces of destruction - are still found today (Van den Berghe et al., 2018b). The WWI landscape therefore is a landscape defined by a (path-dependent) network of actors, their actions and mutual interactions related to the specific cultural (global) conflict and translated within a region, hence creating a so-called ‘warscape’ (see section 1.2.1.3 for more information of the ‘warscape’) (Korf et al., 2010; Nordstrom, 1997).

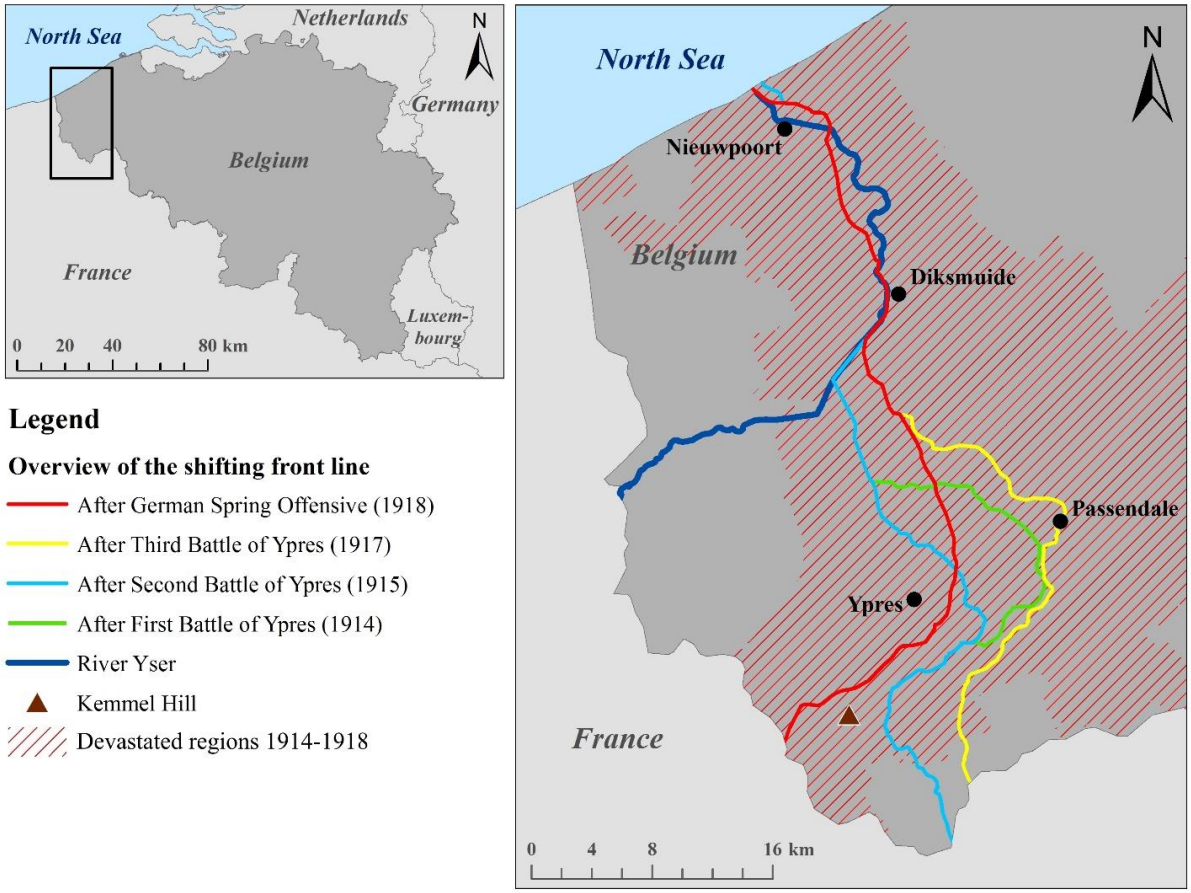

Figure 5-1 Study area (Devastated regions according to Ministerie van Binnenlandse Zaken, 1919)

The assumption of this chapter is therefore that remnants of the WWI militarised landscape in Flanders today are the result of actors that have enabled, modified or blocked this preservation. It is important to understand the evolving 'warscape' during the last century; this to understand why some remains sustained, disappeared or were demolished in the past. From this follows our research question in this chapter: What were the human decisive actors - or the 'warscape' - that lead to the preservation of the resulting militarised landscape of today?

The remains of this chapter are as follows. In the second section we introduce the concept of 'landscape biography'. In the third section, we operationalize this and present our conceptual framework. Our results are presented in the fourth section. This chapter closes with discussion and conclusion.

5.2 Landscape biography

The role of humans in the landscape and the herewith corresponding shaping of the latter forms regularly the main subject of research (Samuels, 1979; Zhang & Liu, 2018; Zhou et al., 2018). The performing of a landscape biography - the metaphor for studying the biography of a cultural landscape (Samuels, 1979) - is often used to study landscape changes. In this approach, the landscape is seen as the '*Lebenswelt*' ('life worlds') of humans, which is 'not ready-made' and is consequently adapted by human (Husserl, 1954; Kolen et al., 2015). Here, humans are considered as the 'authors' of the landscape (Samuels, 1979) writing a 'text', whereby actions of ordinary practitioners (Certeau, 1984), planners and administrators play the main role (Certeau, 1984; Kolen et al., 2015; Samuels, 1979).

A biography is built up along a certain time period with specific characteristics. Similar for a landscape biography, the context of the studied time period during which actions from the 'authors' formed the landscape is important to take into consideration (Samuels, 1979; Sayer, 2000); this interdisciplinary seen (e.g. geomorphology, hydrology and social system or events). However, examining such context in order to produce the landscape biography is subjective in at least two ways. First, every reader of the landscape has its own interpretation or disciplinary interests (Kolen et al., 2015). Some events or outcomes in the landscape history or genesis are withheld – or simply cannot be taken into consideration as they are already forgotten and disappeared into history - others are seen essential (Miles, 2016). Second, a landscape biography is per definition almost endless (Kolen et al., 2015). The first cultural landscape already appeared when human were hunters-gatherers (Mathewson, 2011; Sauer, 1963). As a landscape is always in the making, both looking back and looking forward, a landscape biography can be used – as we will show - in order to start, modify or block ongoing human actions in the making of (un)desirable landscapes (Van der Laarse, 2015). Hence, choices are (sometimes implicitly) made in what analytical time period is relevant (Sayer, 2000). In this paper, our 'start' is the beginning of WWI. This does not imply that before, no human actions altered the existing landscape, quite the contrary. However, as WWI in many aspects was the first global war (cf. technological, cultural, social, economic and political) and the impact on our study area was considerable - both during and after the war - arguably selecting this time period is relevant.

Following how we dealt with the second subjective aspect of landscape biography, our chosen limitation in time and geography, it is possible to consider the first subjective aspect of landscape biography, namely the selection of historical and relevant information of the landscape. We aim to focus specifically on the human actions in the landscape. Therefore, we need to know what actors and actions in the changing landscape should be selected (Latour, 1996). Also here, per definition these are numerous (Van den Berghe et al., 2018b). However, each landscape has its more relevant unique forces (Antrop & Van Eetvelde, 2017) and agents of a region (Thrift, 1990), specified by networks, relations and connections (Grabher, 2006). By initially studying the latter, one is able to 'dive into' the biography. In other words, the research is an itinerary of positive and negative feedback loops, of actions and reactions. The landscape biography of the human role unfolds itself thus by doing the research. However, it is important to stress that both the landscape and the related human actions hold a reciprocal relation. In the words of Paasi (2010) "a regions condition and are conditioned by politics, culture, economics, governance and power relations" (p. 2297). By iteration moving between action and landscape, one examines "multiple actors, multiple perspectives, incommensurable and/or conflicting interests, and important intangibles" (Rosenhead & Mingers, 2001, p. 15), eventually thus producing the landscape biography.

5.3 Conceptual framework

This chapter analyses actors and their actions from a wide range of historical and recent books, documents, maps and academic papers. To be able to use these to explain the existing WWI militarised landscape, they will be related to predetermined landscape changes and trends of the past century. To do this, we present our conceptual framework: a cross functional flowchart linking actors and their actions to predetermined landscape changes, eventually making it able to produce the 'warscape' biography (Figure 5-2).

The columns represent the taxonomy of actors, the rows the spatial trends. We apply this conceptual framework to four chosen time periods (Somers, 1994): 1914-1918 (WWI), 1918-1940 (Interbellum), 1940-1945 (Second World War, WWII) and 1945-today (post-WWII). These phases represent a historical main event or period important for the WWI militarised landscape in Flanders.

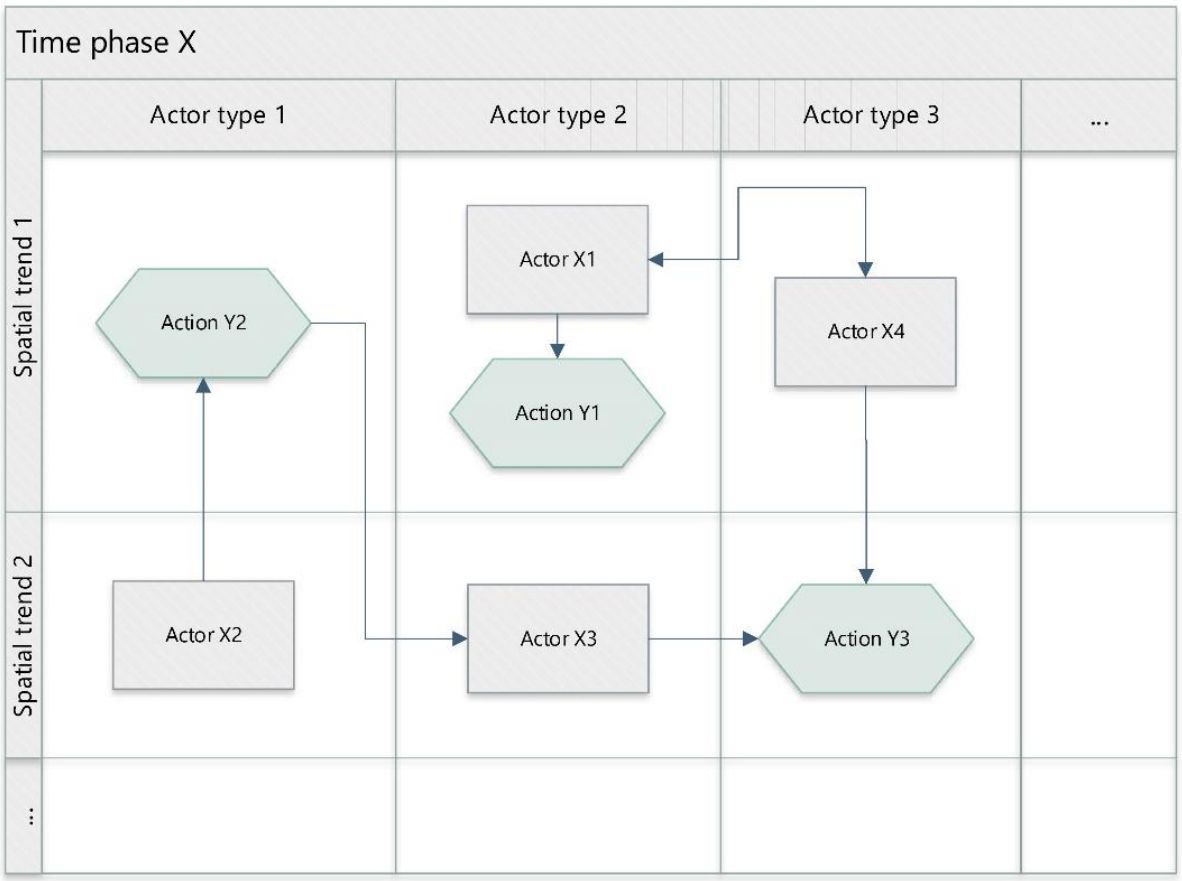

Figure 5-2 Conceptual framework linking actors and actions, this linked to a specific spatial trend within a certain time phase

Actors can be subdivided into types with common goals such as the subdivision into 'individual agency' for own purposes, 'proxy agency' for someone else, or 'collective agency' for the common (Mills et al., 2009). Actors can also be subdivided according to their function or position in society, for example the *homo economicus* (economical actor)*, homo politicus* (political actor), *homo laborens* (working actor*)* and *homo ludens* (playing actor) (Samuels, 1979, p. 52). Others divide actors into demographic, economic, (geo)politic and technology actors (Antrop & Van Eetvelde, 2017).

Within some WWI studies, the subdivision of actors is based on their common goals, such as the reconstruction of the post-WWI landscape (e.g. architects, municipal administrations) (Het Gekwetste Gewest, 2019). Others divide the actors into groups according to their position in the society, such as scholars, relatives of fallen soldiers, locals and travel agencies. Specifically to the 'warscape', latter division is interesting as it also reveals their interests in the landscape (e.g. a place to live in, to visit or to research) (Saunders, 2006).

Hence, divers divisions of human actors in the landscape exist. In relation to our subject, the 'warscape' of WWI in Flanders, we chose to subdivide relevant actors, within the specific time phase, according to their position in the society: policy, economic and socio-cultural actors. As we will show, this division by societal position is sufficient to link actions to their interests.

We defined four time phases and have an actor typology. What rests is our choice of relevant morphological landscape changes, patterns and trends. We work further on results of recent research, describing and analysing the land use/land cover (e.g. woodland, housing) and linear structures (e.g. roads, waterways) visible on historical and contemporary aerial photos (Gheyle et al., 2018; Van den Berghe et al., 2018a; Van den Berghe et al., 2018b or these can be find in the

chapters 2, 3 and 4). We use these results to describe briefly our selection of the main spatial trends for each studied time phase in the following paragraph.

Between 1914-1918, scattered military constructions (e.g. bunkers, military roads) and destructions (shell holes and mine craters) 'saturated' the area. Subsequently, rebuilding processes occurred which already started during the war. Between 1918-1940, most of the devastated landscape – with some exception after this period - recovered and villages, cities and the countryside were reconstructed, this with the addition of new landscape elements (e.g. monuments, large military cemeteries). During WWII (1940-1945), scattered WWII military destructions and constructions are noticeable in the landscape. Lastly (1945-today), another restart of the society occurred. This rebuilt society soon turned into a modern one, whereby one incorporated the existing relics (from both world wars), within the newly created fragmented, monotone and less divers Flemish landscape; highly mixing different industrial, agricultural, urban and rural functions.

This chapter will give an overview of the historical actors and actions which have a relation with the militarised landscape of Flanders[49]. These are discussed for each time phase (before WWI, WWI, Interbellum, WWII and post-WWII) and are divided in the three main themes as defined in chapter 5 (cf. policy, economy and socio-cultural). This overview discusses the main actors and related actors that are responsible for the changes in the militarised landscape. These were selected based on the spatial patterns and trends and are displayed in the cross-functional flowcharts in appendices 5B, 5C, 5D and 5E[50]. Additionally, also the actors and related actions prior to WWI are briefly discussed in order to understand the actors and actions during WWI more profoundly. Hence, these are not displayed in a cross-functional flowchart because this dissertation did not study the spatial patterns and changes prior to WWI.

5.4 Actor analysis

This section will give a brief[51] overview of the historical actors and actions in relation with the militarised landscape of Flanders. These are discussed for each time phase (before WWI, WWI, Interbellum, WWII and post-WWII) and are divided in the three main themes as defined (policy, economy and socio-cultural actors) in the conceptual framework (section 5.3). This overview discusses the main actors and related actors resposible for changes in the militarised landscape. These were selected based on the main changing spatial patterns and trends and are displayed in the cross-functional flowcharts in appendix 5A, 5B, 5C and 5D. Notably, also the actors prior to WWI are briefly discussed to understand the actors and actions during WWI. Hence, these are not displayed in a cross-fucntional flowchart because this dissertation did not study the spatio-temporal data for this period. A short version of the results of the actor analysis can be found in the discussion (section 5.5.1).

[49] This is not a complete overview.

[50] The four cross-functional flowcharts can also be viewed at:
https://www.dropbox.com/sh/mxnxfj795m83bpz/AABuAlt9zPypqHP_F22ggoaya?dl=0.

[51] This is not a complete overview of the actors in relation with the WWI-militarised landscape. Hence, the most important events, actors and actions are selected and discussed.

5.4.1 Before WWI: Beginning 20th century-1914

5.4.1.1 Policy

5.4.1.1.1 International politics

Several international political actions took place before WWI. These were induced by ruling politicians, powerful historical individuals and (secretly conspiratorial) collaborators. Ongoing tensions between political leaders resulted into (un)agreements of great impact which are (mostly)[52] recorded in a bottomless "ocean of sources" (Clark, 2013, p. 11). The latter gives us the possibility to study the part of the history that led to the start of WWI. The combination of all their actions prior to WWI proved how 'powerful' the policy is in its decisions makings.

In general, the whole balance between European countries before WWI was mainly disturbed by imperialism and nationalism. Many conflicts and tensions evoked a wide range of successive alliances in the competition for the strongest (de Vos, 2003). Hence, scholars agree that the main catalyst of WWI was the murder on crown prince Franz Ferdinand of Austria (28 June 1914) and his wife. They were murdered while they were visiting together Sarajevo, Bosnia-Herzegovina. This murder was not an impulsive action and was induced by a wide range of circumstances prior to 1914 which go back to 1300 A.D. (Clark, 2013; Daly et al., 2018; Hoover, 1951). A small resume will be given to understand the politics after the murder.

One of the most important events prior to the murder of Franz Ferdinand was the murder of the entire royal family Obrenovic in 1913. This family ruled Serbia from the moment this country gained kingdom from the Ottoman Empire (in the 19th century). The murder of the entire royal family was carried out by approximately one hundred conspirators with Colonel Dragutin Dimitrijević as the leader. The family was murdered in order to bring another family to power, namely the liberal Karadjordjevic family. The conspirators wanted another ruling family as the Obrenovic family was not popular because of their autocratic actions. The plan of the conspirators worked and after murdering the Obrenovic family the Karadjordjevic family ruled and made Serbia a parliamentary state. The northern neighbour Austria-Hungary which consisted of a double monarchy, was a good trading partner of Serbia during the reign of the Obrenovic family. Moreover, they also provided loans as Serbia was a poor country. This important trade for Serbia was endangered from the moment that the Karadjordjevic family was in power as this new ruling family wanted to make Serbia more independent. As a result, many trade disputes followed and Austria-Hungary stopped lending money to Serbia. Following on this action, Serbia was forced to find another 'financing' country. France was willing to give money in exchange for Serbian weapons. In the meantime, the group of conspirators who murdered the Obrenovic family wanted to make their 'Great Siberian' dream come true. This dream involved the reunification of all Serbian lands of the former Serbian Empire that were taken by the Ottoman Empire in 1300. This former Serbian empire included the grounds of Bosnia-Herzegovina, Albany, Serbia, Macedonia and North-Greece. To accomplish this dream, they secretly recruited followers in these former Serbian countries. However, Austria-Hungary annexed Bosnia-Herzegovina in 1908 and endangered the dream of the Serbian conspirators. Despite this setback,

[52] Sometimes politicians or important rulers destroyed precious documents to prevent them from being read by third parties (Clark, 2013).

the nationalistically oriented secret group of Serbia recruited 150,000 members who rebelled against Austria-Hungary; also in Bosnia-Herzegovina. However, the rebellion came into the background because the First and Second Balkan War (1912-1913) occurred in that time. Meanwhile, the conspiracy for the extreme nationalist 'Great Serbia' continued in secret (Clark, 2013).

This conspiracy reached another level when the young extreme Serbian-nationalists Gavrilo Princip and his friends joined the secret group of conspirators and planned the murder on Franz-Ferdinand from Austria-Hungary. Following them, Austria-Hungary formed an enormous threat for 'Great-Serbia'. The Serbian extremists saw the possibility of killing Franz-Ferdinand when he visited Sarajevo in the annexed Bosnia-Herzegovina. This murder in Sarajevo was carefully prepared by the help of the secret movement. These friends were trained by the movement and had to travel to Sarajevo in secret by help of the leader Dragutin Dimitrijević (Clark, 2013; Van Hengel, 2014). The Serbian nationalists proved successful in their plan and murdered Franz Ferdinand (28 June 1914). The murder induced the Third Balkan War which started on 28 July 1914 (de Vos, 2003). Austria-Hungary saw this war as an opportunity to control and dominate Serbia permanently (Van de Meerssche, 2006).

Hence, this war evoked not only the Third Balkan War but also the well-known First World War (1914-1918) as alliances between European countries were made prior to 1914 (Van de Meerssche, 2006). Austria-Hungary, Italy and Germany formed in that period together the 'Triple Alliance'. In the decades before WWI, Germany became very strong whereby France and Great-Britain often felt threatened. Therefore, both countries decided to become allies with Russia and to form the 'Triple Entente' to control Germany since France was already defeated once by Germany in 1870 and lost the Elzas and a piece of the Lotharingen on the border between France and Germany (de Vos, 2003). When the Third Balkan War started and Serbia was attacked by Austria-Hungary, Russia was also an ally of Serbia and mobilised its army to help Serbia. Because of the previous formed alliance, Germany decided to help Austria-Hungary and France helped Russia. Germany saw this war as an opportunity to occupy and defeat France as fast as possible (cf. Shlieffenplan), this by choosing the shortest path through the territories of neutral Belgium. Hence, Belgium did not want this and consequently Great-Britain and Belgium declared war to Germany. Together with all the colonies of the superpowers, the whole world was in war (Clark, 2013). All the nations "slithered over the brink into the boiling cauldron of war without any trace of apprehension or dismay" (Lloyd-George, 1933, p. 52). In total, 65,000,000 men were mobilised during WWI (Clark, 2013) and several front zones were formed such as the Western Front which went from the English Channel to the border of Switzerland, the East Front that went from Germany and Austria-Hungary and Russia and the Italian front; this in addition to the wars on the European colonies (de Vos, 2003).

5.4.1.1.2 National politics

Before WWI, the national policy in Belgium was dominated by conflicts between on the one hand the dominant Catholic Party (right leaning party) that had a strong position on the countryside, and on the other hand the Socialist Party and the Liberal Party (left leaning parties) that specifically ruled in the cities (De Wever, 2007). In this period, the Catholic Party was dominant because of the popularity of the Catholic faith in Belgium (Witte et al., 2009). Disputes between the different parties were particularly made about two affairs: the voting and school disputes (Van den Wijngaert et al., 2006).

Besides the school and voting issue, another dispute arose. Belgium was particularly dominated by French-speaking elite in a country whereof the population particularly spoke Dutch in the Northern provinces (or Flanders[53]). This issue gave birth to the Flemish national movement that demanded more Dutch rights. This was the start of the 'fracture' between Belgium and Flanders. The *Guldensporenslag* (Battle of the Golden Spurs) that took place during the Medieval times (1302) was seen as the example for Flemish activists. This battle was fought between peasants of the Count of Flanders and the French kingdom. In that period, Robert Van Béthune was the Count of Flanders and became the icon of the battle. He was nicknamed as the 'Lion of Flanders' because the Flemish peasants won and received afterwards Flemish independence. This story of this battle supported the Flemish ideology before WWI. This ideology was even more operative when the song *De Vlaamse Leeuw* (The Flemish Lion) was written in 1847 by Hippoliet Van Peene. This song was meant to be a nationalistic battle song with no underlying anti-Belgian purposes, but became later the 'battle' song of the *Flamigants* (Flemish activists) in 1900 (Shelby, 2014). The Flemish movement gained in importance amongst Dutch-speaking Catholic intellectuals and caused political changes during and after the war (see further) (De Wever, 2007; Deprez & Vos, 1998).

5.4.1.2 Economy

The decennia before the war – also called the '*Belle Époque*' (the beautiful era) – was marked by many advances in technology and science. Faster production processes and communications tools were evolving at a fast pace. Also art and entertainment was more accessible during this stable economic and political period (Figure 5-3) (Dick & Vandendriessche, 2018).

[53] Flanders is the overarching term for a separate geographic, cultural and political area in Belgium (Shelby, 2014).

Figure 5-3 Belle Époque: Summer leisure at the Belgian coast Agricultural

Before WWI, the agricultural economy in Belgium was internationally controlled because the United States of America, Argentina, Romania and Russia imported cheap grain and other products by means of steam ships and the train (Van den Wijngaert et al., 2006). Consequently, this internationally oriented market provoked a decline of grain prices in Belgium (Segers & Van Molle, 2004). Notably, also Germany imported in Belgium and delivered many products such as fruit, horses and flowers (Van De Perre, 1919). In response to the increasing amount of imported products from abroad, farmers decided to invest more in livestock and their products and horticulture (e.g. milk, bacon, meat and vegetables). Other investments were also made in the scientific development of the agricultural industry by educating students and by developing fertilisers (Segers & Van Molle, 2004).

5.4.1.2.1 Other industries

In addition to the changes in agriculture, the production of iron and steel has increased intensively. Belgian entrepreneurs also embedded international grounds. They have built blast furnaces, metal factories and tram lines in Russia. Also railroads were built by Belgium in China, Latin-America and Congo. These international investments made Belgium a respected industrial power in before WWI (Van den Wijngaert et al., 2006).

5.4.1.3 Socio-cultural

5.4.1.3.1 Belgian patrimony

Before WWI, Belgium owned a rich patrimony of monuments and buildings which had a typical architectural style dating from several periods (e.g. Belfry Ypres was built in 13th century). Since 1835, the *Koninklijke Commissie voor Monumenten* (Royal commission for Monuments) was established in Belgium as an advice commission for the Ministry of Belgium. They had to give advice to the Ministry in case repairs were planned of preserved public monuments (e.g. church towers, town halls and belfries). One can also interpret this new established commission as a manner to legitimate the right to exist of the Belgian Nation by preserving its typical heritage, which became national patrimony (Duvosquel et al., 1985; Stynen, 1985; Stynen & Draye, 1989). in 1872, the commission made a list of

the Belgian patrimony that had to be conserved for the future (e.g. castles, belfries). In 1912, also cultural landscapes obtained more attention and were sometimes advised by the Commission to be conserved. Consequently, the Commission expanded its name to the *Koninklijke Commissie voor Monumenten en Landschappen* (KCML) (Royal Commission for Monuments and Landscapes) (Stynen, 1985).

5.4.1.3.2 Castle domains as a part of the Flemish landscape

Many castle domains that were based on the English landscape style (cf. romantic style) were established in the pre-WWI period of Flanders. Distant vision axes, tree groups, bending walk paths are some of the main characteristics of these domains. It is known that some castles domains already originated from the 11th or 12th century and were developed from a in that period typical castle construction, which is called a *castrale motte* (castral motte)[54]. Moreover, some already had a precursor during the Carolingian period (8th to 10th century) such as the castle in Zonnebeke (South of Ypres) (Heyde et al., 2015).

Economically seen, the domains were used for wood production, fishery, hunt and for the growth of vegetables and fruits. Additionally, the ponds sometimes provided water for a neighbouring village or city such as the *Bellewaerdevijver* (8 ha) in the Hooghe castle domain supplied water for the city of Ypres. From a cultural point of view, the castle domains were owned by people with a high status such as nobles and the high bourgeoisie. They had a direct influence on the landscape developments around the castle domain since the lord owned a lot of land and rented it out to the local population. Land properties of the castle domains variated in size. For instance, the castle domain Kemmel consisted of 28 ha, Veldhoek in Geluveld of 19.5 ha, Elzenwalle in Voormezele of 75 ha, Couthof in Proven of 82 ha and Hooghe in Zillebeke of 165 ha. Before WWI, 45 castle domains were established in Poperinge, Zonnebeke, Ieper, Heuvelland and their districts, dominating the complete landscape and its development (Figure 5-4) (Heyde et al., 2015).

[54] A *castrale motte* consisted of two parts: upper court and lower court. The upper court was built on an artificial hill which was surrounded by a ditch. On top of the hill a *donjon* was built in the shape of a tower. The lower court consisted of buildings that were established for living and working functions (Agentschap Onroerend Erfgoed, 2019h).

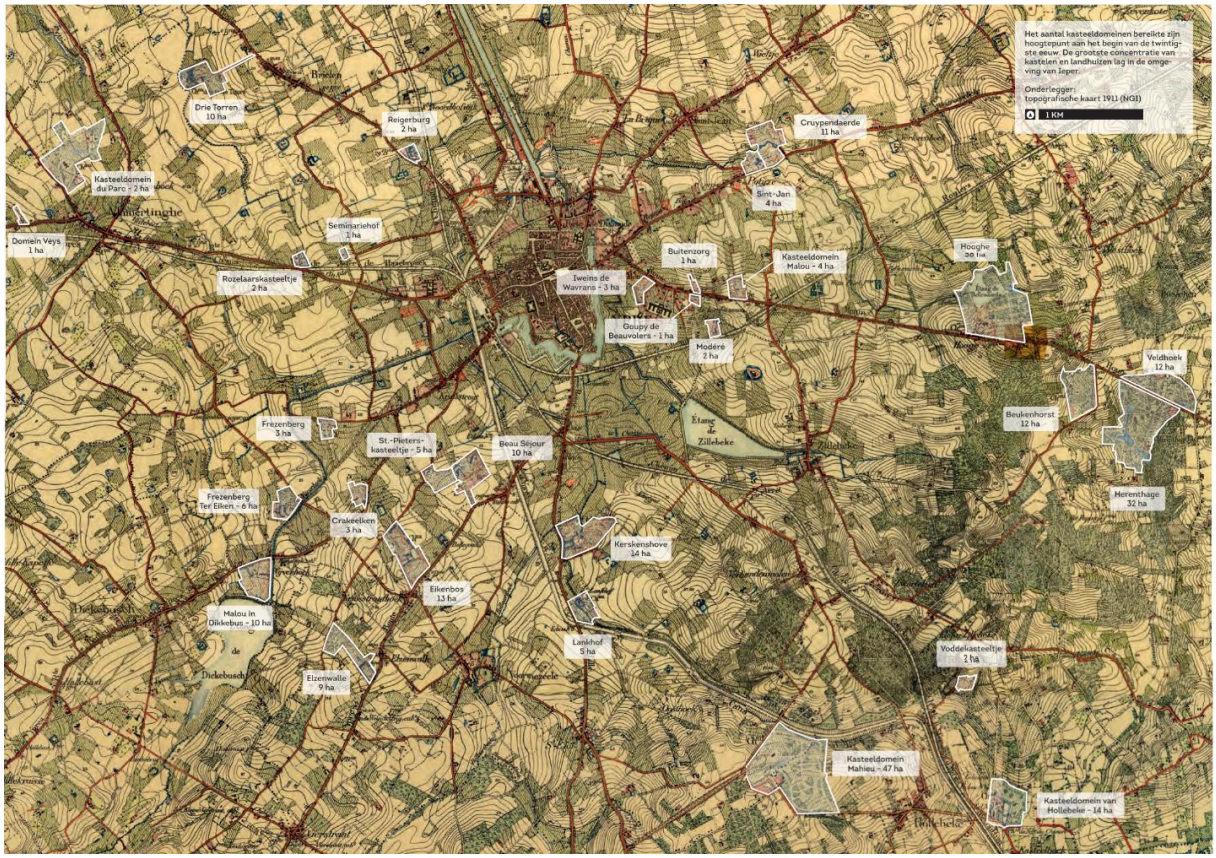

Figure 5-4 Castle parks at the end of the 19th century, region Ypres (Heyde et al., 2015)

5.4.2 WWI: 1914-1918

5.4.2.1 Policy

5.4.2.1.1 Food and housing was needed in Belgium

During the war, the provision of food was needed in the by the German forces occupied area which was economically blocked by the Allies. Allied international and national political bodies set up a food providing network. The Belgian '*Nationaal Hulp- en Voedingscomité'* (NHVC) (National Aid and Food Committee) and the American 'Commission for Relief in Belgian' (CRB) with Herbert Hoover as the chairman - president in the post-WWI period (1929-1933) of the United States of America - provided supplies and food for the Belgian people. Also the Netherlands and Spain offered to help (Van den Wijngaert et al., 2006). The international CRB had an agreement with Germany to ship safely supplies to the harbour of Rotterdam (Figure 5-5). Afterwards, these were distributed by boat by help of the national NHVC through the canals from Rotterdam to the Belgian cities (Hoover, 1951).

Figure 5-5 Belgian Relief ship for the transport of American goods to Belgium (Dick & Vandendriessche, 2018

The NHVC was established by cooperation of Belgian national, provincial and local bodies from different political parties (Catholic, Socialist and the Liberal Party); this leaded by Emile Francqui. As the war provoked patriotism, the political orientated bodies worked closely together in this difficult period. They unanimously supported King Albert I – Belgian King since 1909 - which stayed the whole war period on the last non-occupied national ground in De Panne (Van den Wijngaert et al., 2006). The Belgian government worked from October 1914 onwards in Le Havre (France) (Duvosquel et al., 1985). To preserve the collaboration between the parties and to create a balance in the pre-war established political landscape of Belgium, two Liberals (Paul Heymans and Eugène Goblet) and one Socialist (Emile Vandervelde) were promoted to become Ministers during the war. All these political parties and their members supported and helped to organise the food supplying network of the NHVC. Therefore, the NHVC could be seen as a "shadow government" of Belgium which had promising prospects for the post-WWI Belgian political landscape (Van den Wijngaert et al., 2006, p. 72). Hence, the plans and executed actions of both the CRB and the NHVC were sometimes difficult to by carried out because of two reasons. Firstly, Germany did not keep their promise to the CRB and attacked occasionally the CRB ships coming from the United States of America (Hoover, 1951). Later, when the VS declared war to Germany (1917), they attacked even more CRB ships (Martin, 1981). Secondly, the important role and mission of the NHVC was not always carried out perfectly. This organisation consisted of national, provincial and local contributors, whereof some committed illegal trade or stole supplies. Because of these illegal practices on the one hand, and the bad work and living conditions due to the occupier on the other hand, the occupied part of Belgium starved (Demasure, 2014).

Besides the provision of food, the NHVC executed also two other functions. Firstly, they represented the '*Landbouwsectie*' (Section of Agriculture). In this body, many commissions housed that supported the agricultural practices such as the '*Boerenbond'* (Union of farmers). One special task of this Union was to lend money to the farmers during the war (started already in 1915) to encourage the rebuilding of war-damaged farmsteads (Van Molle, 1990). Secondly, they subsidised *'De Vereniging van Belgische Steden en Gemeenten'* (The Association of Belgian Cities and Municipalities) (Duvosquel et al., 1985).

5.4.2.1.2 Preparations to recover the desolated landscape after the Armistice by the Belgian government in hostile

During the war, photos and narratives from the tabula rasa reached Belgian civilians and the Belgian government abroad. This tabula rasa was seen as an opportunity to incorporate modern ideas in the rebuilding plans for the cities. The International Garden Cities and Town Planning Association adopted this task and planned together with experts from around the world the rebuilding of Belgium. They educated and started to advise the Belgian architects in the United Kingdom. Additionally, the association organised the Town Planning Conference in London (11 to 16 February 1915) especially in the light of the reconstruction of Belgium. The Belgian Minister of Agricultural and Public Works Joris Helleputte - which stayed at that time in Le Havre - was the chairman of this conference. In total, 300 international specialists (e.g. United Kingdom, France, Canada) attended the conference. At the end of the conference, the Minister decided which plans he would adopt in the Belgian reconstruction plans such as the idea of establishing a reconstruction plan before the start of any rebuilding projects (top down planning going from national, provincial to municipal level), the creation of garden cities (only on local level and not on national level), and the establishing of a rebuilding plan for the most desolated areas (cf. Westfront); this all with the future growth of Belgian cities in mind (Duvosquel et al., 1985).

In the wake of this conference, the Belgium Town Planning Committee was established by help of the Belgian government. This committee entailed amongst others mainly Belgian architects, engineers, lawyers, city councilors and surveyors. This group studied and planned the reconstruction of the tabula rasa. New building materials and methods (e.g. steel and concrete), ideas and laws were introduced. For instance, the engineers in this Committee learned to construct paved roads which was needed for the growing amount of faster driving cars and trucks in the future. In addtion, this would improve the accessibility for economic and touristic activities (Duvosquel et al., 1985).

Besides the Town Planning Committee, many Decision Laws[55] were formulated that expedited the rebuilding of Belgium such as the Decision Law of the Reconstruction (25 August 1915). This law entailed ideas of the Town Planning Conference. Notably, to achieve the predetermined purposes of this law, the '*Koninkelijke Commissie voor Monumenten en Landschappen*' (see previously mentioned) was especially asked to help to realise this law (Duvosquel et al., 1985).

Later, the minister of Home Affairs established the '*Koning Albertfonds (KAF)'* (King Albert Fund) as a result of the '*Besluitwet voorlopige woningen – Koning Albertsfonds'* (Decision Law of temporary houses – King Albert Fund, 23 September 1916). The main focus of this fund was to provide housing for civilians (Carnoy, 1919; Duvosquel et al., 1985; Hortensius, 1989). However, this fund did not go

[55] A Law ('*Wet'*) is produced at federal level (cf. Belgium) by the Federal Parliament which is ratified and proclaimed by the King. A Flemish Decree ('*Decree*t') is produced at regional level (cf. Flanders) and ratified and proclaimed by the Flemish Parliament. A Decision Law ('*Besluitwet*') is a law produced by the King during 1914-1918 and 1940-1944, as the King was the only section of the legal system that stayed operational during wartime. A Royal Decision ('*Koninklijk Besluit'*) is produced by the King to carry out a Law, Decree or Decision Law. A Ministerial Decision ('*Ministerieel Besluit')* is made by one member of the parliament and is also established to execute a Law, Decree or Decision Law. Notably, this is the legal system of Belgium today. During 1914-1918, Flanders was not yet a separate region, so the Decrees did not exist yet.

into practice before the end of the war because the promised 1,000,000 BEF (25,000 euro) of the Belgian Government for this fund was lacking (Agentschap Onroerend Erfgoed, 2017a; Duvosquel et al., 1985).

Each Belgian Minister in Le Havre - such as previous mentioned Minister of Home Affairs and the Minister of Agricultural and Public Work - worked separately in thematic commissions to prepare the rebuilding (e.g. the Legislative Commission or the Commission of Research for Provisional Housing). However, there was need for an overview of the multiple ideas and plans to successfully carry out the reconstruction plans. As a solution, the '*Interministeriële Commissie Voor de Wederopbouw*' (Inter-Ministerial Commission for the Reconstruction) was established in February 1917 and contained three sections: the section for the reconstruction of the soil and agricultural, the section for the reconstruction of houses and cities and the section for the repatriation of refugees.

Later, the '*Besluitwet Dienst voor oorlogsschade – Oprichting'* (Decision Law Service for War Damage – Establishment, 15 August 1917) saw the light. This Service was on the one hand responsible for the preparation of documents that handled the war damage and on the other hand for the legislation in relation with the reconstruction processes (Duvosquel et al., 1985).

One year later, in 1918, the '*Prijs des Konings bestemd als beloning voor de Belg die het beste praktische ontwerp opmaakt voor het weer in staat van bebouwing brengen van de Belgische gronden door de oorlog verwoest'* (Prize of the King intended as a reward for the Belgian who makes the best practical design for restoring the Belgian land destroyed by the war, 21 October 1918) was established. This contest rewarded a prize to the best idea that handled the recovery of arable lands and other grounds (Belgisch Staatsblad, 1918b). Also in that year, the '*Koninklijk Besluit bijzondere Dienst voor het heropbouwen der door den oorlog verwoeste streken in West-Vlaanderen – Oprichting'* (Royal Decision in the light of the establishment of the 'Service for the Reconstruction of Devastated Regions' in the province West-Flanders, 22 October 1918) saw the light. The established Service had to prepare the reconstruction of arable lands, houses and roads in the devastated regions in the Province West-Flanders; this in cooperation with the governments of the other provinces and municipalities (Belgisch Staatsblad, 1918a).

One day later, the collaboration between the Ministers (cf. Inter-ministerial commission for the reconstruction) established the Decision Law for determining and estimating the war damage[56] (23 October 1918). This law represented the basis for the juridical procedure that granted compensations to war victims by help of the Court of War Damage. The law entails decisions about the working of the Court of War Damage and the corresponding war compensations for (im)movable goods and persons (Duvosquel et al., 1985). The law emphasised that money to restore the properties could only be given to persons with a Belgian nationality. The compensations for these restorations were determined by the established Court of War Damage (Belgisch Staatsblad, 1918d). Later, this law was further elaborated following the law of 10 May 1919.

[56] Or '*Wetbesluit betreffende het vaststellen en het ramen van de schade uit de oorlog voortspruitend'* (Belgisch Staatsblad, 1918d).

5.4.2.1.3 Flemish national movement meets German empire: 'Flamenpolitik'

In meanwhile, the before the war founded Flemish national movement developed gradually. Flemish and German interactions influenced the 'path' of Flemish nationalism (Shelby, 2014). The German occupier considered the Flemish disputes between the Dutch and French speaking Belgians as an opportunity to destabilise the country and to reinforce the Flemish movement. Therefore, they conducted '*Flamenpolitik*' (Flemish policy) in the cities Brussels, Ghent and Bruges. This entailed German (Dutch) propaganda, the sponsoring of Flemish newspapers, the removal of French street signs and the conversion of the French University of Ghent into a Flemish University (1916). Moreover, Germany refused to correspond in French and officers had to follow Flemish (or Dutch) lessons (Vrints, 2002; Wils, 1974).

However, the Government in Le Havre tried to supress the measures taken by Germany in the occupied side of Belgium by creating the '*Besluitwet waarbij het uitwerksel van de maatregelen getroffen door de bezettende macht en van de beschikking door de Regeering genomen'* (Decision law by which the executing of the measures taken by the occupying power are legally processed by the Governments civil procedural law, 8 April 1917). Following this law, these German measures were forbidden to support (Belgisch Staatsblad, 1917).

On the Belgian frontline going from the coastal city Nieuwpoort to Bikschote (Shelby, 2014), Dutch speaking soldiers were often humiliated by French speaking officers. These events made the Flemish movement grow even more. Flemish speaking Belgian soldiers that did not understand French (which had a share of 55 % of the Belgian army), were trained and ordered by French speaking elite and officers. This led to irreversible miscommunications and unnecessary deaths of Flemish soldiers (De Wever, 1994; Dendooven & Chielens, 2008). As a reaction, the Flemish soldiers formed together the '*De Front Beweging'* (Front Movement) in 1915 with as a main aim: "A free Flanders in a free Belgium" (Van den Wijngaert et al., 2006, p. 75). They also used the previous mentioned myth of the Battle of the Golden Spurs and its exact date (11 July 1302) as an incentive to celebrate the Flemish National Day on July 11th. The symbol of the 'Flemish lion' which refers to the Count of Flanders Robert Van Béthune (as previous mentioned) was already used during the mid-19th century as the symbol of Flanders (Figure 5-6) (Shelby, 2014). The Flemish movement, which recruited members during the war, could be regarded as the driving force behind post-WWI Flemish-nationalism (De Wever, 1994).

Figure 5-6 The myth of the Battle of the Golden Spurs (1302) was used to celebrate the Flemish National Day by nine Flemish soldiers (July 11th 1917) (Shelby, 2014)

5.4.2.1.4 Top down policy linked with the military destructions and constructions in the landscape

During the war, new Allies were from importance as geopolitical relations with other countries could decide the 'path' of the war. So became the United States of America an ally in 1917. They declared war to Germany. This was the result of Germany insulting them on the one hand by attacking their CRB ships with submarines and on the other hand by promising that grounds of the United States of America would go to Mexico in exchange for being an ally of Germany. The United States' American Expeditionary Force arrived in June 1917 on the Western Front. This Ally reinforced the exhausted soldiers and delivered material and food as well. This Force was also experienced in the making of military aircrafts as they made prior to WWI the first existing military aircraft (1909). Therefore, the help of the American Air Service contributed to warfare and aided to the offensive against the German forces. In total these American aircrafts dropped 140 ton bombs destructing entirely the Flemish landscape (Gould, 2014).

During the war, the battle for the strongest continued for four years whereby each strategy and step was carefully thought through in cooperation with the political leaders and commanders. King Albert I for instance was in the final year of the war the commander of the 'Armies of Flanders' which entailed two Allied American infantry divisions and the Belgian army. He guided these in the Battle of the Scheldt during the final offensive in 1918 (Agentschap Onroerend Erfgoed, n.d.).

5.4.2.2 Economy

5.4.2.2.1 Belgium and the economic recession during wartime

The recession of the economy began already before the invasion of Germany. In the months before WWI, civilians completely withdrew their savings entirely in cash from the banks. Therefore, the Belgian government imposed since the official ultimatum of the Germans (2th august 1914), a maximum withdrawal amount to avoid a financial downfall. However, the money accommodated in national banks was not safe for the German invasion and was to the German their displeasure transported to London. This action generated a shortcoming of money in the Belgian economy by which salaries could not be paid anymore to civilians. As a solution, laborious negotiations between Belgian financial institutions and the occupier resulted in a few remaining operative national banks (Van den Wijngaert et al., 2006).

In the beginning of the war, the '*Wet betreffende de spoedeischende maatregelen door de oorlogsverwikkelingen noodig gemaakt'* (the Law concerning emergency measures made necessary by the war, 4 August 1914) which became into practice on the 5th of August, prohibited the export of products and goods. This law entailed also the authorization of the government to regulate the food prizes. The regulation would ensure an equal food distribution to civilians and would consequently avoid famine (Belgisch Staatsblad, 1914).

Despite this law, the war led to economic exhaustion. The Allies blocked the economy in the by the German occupied areas. This was a problem because Belgian citizens were dependent on the sale of industrial material abroad (Van den Wijngaert et al., 2006). The economic blockage of supplies resulted in a shutdown of many commercial activities and evoked a famine (Demasure, 2014) and massive unemployment. The latter gave rise to the idea of restarting the export and import of goods in order to save Belgian industry. However, this idea was never executed because Germany also wanted to benefit from these exports and imports. The situation became even worse at the end of 1916 when Germany demanded all useful raw materials for German war activities, and also deported 120,000 Belgian workers to Germany. In 1917, also Belgian industrial machines (e.g. blast furnaces, motors) were dismantled and transported to Germany. Other rather old machines were dismantled and transformed into weapons (Van den Wijngaert et al., 2006).

Also on the countryside, the agricultural economy knew a drastic recess. In the occupied area, arable lands were unprocessed because they were abandoned by farmers that fled for the advancing German forces. After the stagnation of the frontline in the Province West-Flanders in 1914, few farmers returned to their properties and tried to restore their agricultural lands. However, all the livestock was taken by German soldiers and the restarted agricultural activities were now controlled by German ambassadors (Demasure, 2014). Germany demanded that Belgian farmers would provide an overview of the available crops, products, livestock and land ownerships with the accompanying activities on these lands (e.g. sawing, fertilizing or harvesting (Bertrand, 1919). In the countryside in the unoccupied area of Belgium, most farmers were also fled. Few remaining farmers did cultivate their properties for local purposes (e.g. locals, refugees) or they helped to supply the Allied forces (Demasure, 2014). Hence, food prizes were high because supply and demand were not in balance since the demand kept rising and the supply not. This unbalance was the result of uncultivated grounds as many farmers were obligated to fight or of pastures that were occupied by camps of Allied soldiers (PAWVL, 1917). The latter resulted in less grazing grounds for livestock. Additionally, the import of seeds and fertilisers from France in the wrong seasons due to a poorly functioning transport network also led to a decrease in production (Demasure, 2014). As a solution, the Belgian government started a sowing plan to enhance the production (PAWVL, 1917). Hence, the Belgian army tried to be self-sufficient by starting up vegetable gardens. This was performed by the '*Service des Plantations et de Jardins Potagers*' (Service of Plantations and Vegetable Gardens) whereby they cultivated crops on abandoned properties (Vandeweyer, 2007).

On the seacoast in 'free Belgium', fishery practices were stopped as fisherman immigrated to other countries such as France, the United Kingdom and The Netherlands (Demasure, 2014). Most of the fisherman fled to Zeeuws-Vlaanderen (NL), Rotterdam (NL) and Amsterdam (NL) (Schot, 1988).

5.4.2.2.2 Belgium's economic initiatives from Le Havre

From Le Havre (FR), the Belgian government established arrangements and supplies for warfare. The 550,000 Belgian refugees that fled to the United Kingdom (160,000), France (325,000) and The Netherlands (100,000), were considered by the Ministries of Industry and Labour as useful workers for the industrial warfare. Therefore, they established in 1914 in Le Havre a committee for to guide these unemployed Belgians, namely the '*Officieel Belgisch comité voor Vluchtelingen'* (Official

Committee for Refugees). Later, they established the '*Office National Belge du Travail'* (Official National office for working Belgians). Both initiatives had a positive effect as Belgian companies were now established in several cities abroad (such as London, Den Haag, Paris). Later, in the years 1916 and 1917, the unemployed rate of the Belgians abroad was stabilised (Duvosquel et al., 1985).

5.4.2.2.3 Germany's reconstruction initiatives in occupied Belgium

Before the war, the peace conference in Den Haag (NL) was held on October the 18th in 1907. This conference was the second conference held to stimulate peace between countries during conflicts. Because there was need for a permanent place to discuss this subject, the reconstruction of the '*Vredespaleis*' (Peace palace) started in Den Haag (Figure 5-7). Participants of this peace conference - whereof also Belgium and Germany - formulated guidelines for future occupiers during wartime. One of those guidelines was the prohibition of destruction of art and the prohibition to disturb the ongoing daily life in the occupied country (Den Haag Convention, 1907).

A few years later, during WWI, the German Empire broke the rules of this conference. While they were taking in Belgium, they could not avoid the destructions of valuable cultural goods and buildings. Consequently, Belgian patrimony was destroyed (e.g. historic city centre of Leuven). Although this may be true, the German forces distributed pamphlets with quotes and stories that denied the guilt of Germany. They blamed Belgium for not letting them cross the area to France. Despite the insults against Belgium, they felt guilty. Therefore, Germany wanted to avoid more destructed Belgian patrimony and therefore established a '*Kunstschutz*' (Art Protection) plan. This plan was carried out by a representative of Germany. He had to inventory all the culture heritage on the Western front and with this list he knew exactly the place of Belgian heritage. Afterwards, he had to communicate the place of this heritage towards the German forces in battle. However, the representative had only an advisory status and could not always prevent more destruction of heritage. To cover up these 'mistakes', war photos which were taken on the frontline had to be adapted before they were sent to the German press; this to avoid displeased German civilians (Cortjaens, 2011).

Figure 5-7 Vredespaleis Den Haag, Holland (source: Author, 21 April 2019)

Besides the protection of Belgian patrimony, Germany started to plan the rebuilding of occupied Belgium (Volkmann, 1917, p. 28). Following German architectures, this tabula rasa in '*das Land der Kathedralen'* (land of cathedrals), opened up new opportunities (Cortjaens, 2011). In the '*Kriegstagung für Denkmalpflege*' (War Conference for Historic Preservation) which was held in Brussels in 1915, the German general von Bissing saw each rebuilding project as German propaganda by means that each building could be considered as a symbol of German victory (Ernst, 1915). Moreover, they saw also the reconstructions as a chance to apply their knowledge to a country that is following them lagging behind in spatial planning. For instance, they argued that the Belgian Commission for Monuments and Landscapes was weak and not progressive at all (Cortjaens, 2011). Besides the (re)construction of buildings, also the economy had to be maintained whereby unemployment had to be avoided as this induced social unrest amongst Belgian civilians (Ernst, 1915). Due to a laborious cooperation with the Belgian civilians, Germany introduced in Brussels a German reconstruction unit that entailed engineers, architects and urban planners from Germany under lead of Carl Rehorst. The latter was also responsible for the conservation of monuments (Schüller, 1918). Immediately thereafter, several committees were established in the light of the reconstruction unit. For instance, estimation committees for war damage were created and also a study committee that had to create for instance the cadastre plans (Schüller, 1918). To finance the by the German started Belgium reconstruction, extra German funding was needed (Ernst, 1915). However, not a lot was made available by the country. Consequently, each project had to rely on private capital and donations from Belgians. In 1916, this budget contained only 2,000,000 BEF (converted 49,578.71 Euro) (Volkmann, 1917). From 1917 onwards, the German reconstruction knew gradually progress because of better weather conditions and more cooperative Belgians. In the context of the latter, the civilians became cooperative because on the one hand they became less anxious that the reconstructed houses would be destroyed again in case the German had to retreat. On the other hand, the largest part of the executed German reconstructions was performed for poor Belgian farmers which embraced German help as housing was needed to continue their profession (Schüller, 1918). Hence, the previous described rebuilding program is not commonly known in literature as German reconstructions were in the first place used as propaganda and therefore were ignored after WWI in Germany and Belgium as well (Cortjaens, 2011).

5.4.2.2.4 Technological evolutions in wartime

The war was not only unfavourable for the economy but evoked also promising new technologies that made the war economy flourish. The battle for the strongest and smartest army was the biggest motive. These technical and constructive evolutions can be subdivided into developments of above- and underground techniques (de Vos, 2003). We focus on these because these technological evolutions played a part in the destruction of the landscape of Flanders (Van den Berghe et al., 2018a).

5.4.2.2.4.1 Above ground evolutions

Besides the evolution of medicines (e.g. blood transfusion), sea weapons (e.g. submarines, ships) and radio goniometry (e.g. telegrams, radio waves), the evolution of arms techniques evolved. Arms trade and technologies knew a very rapid development during wartime. The armies had standard rifles, revolvers or pistols, hand grenades and mortars, artillery, gas, flame throwers and tanks amongst other. Hand gradates and mortars were especially used to harm the soldiers in trenches (de Vos, 2003). The artillery was the deadliest weapon in the war. This machine could not hit perfectly a target and destroyed also the area next to the focus point. Consequently, this machine was amongst other weapons responsible for the destruction of the landscape from grasslands and arable lands into a fully destroyed area. In that way, the Ypres Salient changed into an area full of mud and craters (Bostyn et al., 2014). During the war, two aspects of the artillery evolved: the machine and the used

shells (de Vos, 2003). Figure 5-8 shows different types of used shells. Each type was marked by a typical colour that indicated what the content was inside the explosive. For instance, the content of a shell could be explosive material that evoked the spreading of plumbed granules or the spreading of chemical gas (DOVO, 2017). Tanks appeared for the first time in the war in 1916. In 1917, these 'landships' were used for the first time in Belgium during the Battle of Messines (7-14 June 1917). One would think that tanks realised the biggest destructions in the battlefields, hence the contrary is true. The first tanks were very heavy and needed a firm underground, which was not the case in the muddy destroyed fields in Flanders. Additionally, they only reached a speed of 5 km/hour. However, they easily destructed barbed wire and trenches. These tanks evolved during the war into lighter and smaller tanks which could reach a speed of 20 km/hour (Bostyn et al., 2014) (Stichelbaut et al., 2018).

Figure 5-8 Different types of shells (source: Author, personal visit Poelkapelle DOVO, 10 November 2017)

The war also experienced a technical evolution in the air for both detection and offensive purposes. For the detection of the landscape, aerial photography developed in a very fast pace and became the "new eyes of the army" for espionage (Stichelbaut, 2009, p. 14). Because aerial photographs provided a wide range of information, WWI can be seen as "the first information/intelligence war of modern history" (Finnegan, 2009, p. 56). The main purposes of aerial photography were threefold[57]: overlooking the enemy its strategy, monitoring the progress of the field work of their own troops and the assembling of visible information into maps. Three types of aerial photographs existed: vertical (optical axis perpendicular to the surface), oblique (optical axis inclined in relation to the surface) and panoramic (optical axis more or less parallel to the horizon) (Défense Nationale, 1925; Stichelbaut, 2009). Many combating nations used this technology and today many archives exist which own these

[57] Another purpose of the aircraft was to take pictures of a crashed airplane to confirm the defeat of the enemy's or the Allied aircraft (Stichelbaut, 2009)

historical photos of Flanders[58]: Germany, Belgium, United States of America, Russia, France, Australia and the United Kingdom (see also chapter 2) (Stichelbaut, 2009).

Aircrafts were also used for offensive purposes[59]. At the start of the war, France had the best equipped air army of all Allies. However, they had to fight against the strong developed German aircrafts. Therefore, France invested even more into the development of better machines where after a wide range of technical evolutions followed (Cowin, 2000). In October 1914, France installed for the first time machine guns on board of an airplane. Later, steel protections were installed on the propellers and consequently machine guns were installed in front of the airplane. Later, machine guns were installed on the wing or on top of the nose of the airplane (de Vos, 2003). However, the French aerial dominance did not last long as Germany became better in the development of aircrafts. This continuous duelling between Allies and Germany lasted for four years (Cowin, 2000). As the result, offensive aircrafts had a destructive effect upon the landscape as these aircrafts co-operated with the infantry on the ground by carrying the infantry along with them when they moved forwards, herewith suppressing the enemy's infantry and other defensive structures. To do so, the pilots had an accurate knowledge of the landscape and its military infrastructure. During the battles, the aircrafts flew low and opened the machine guns, used hand-grenades and threw shells. Aircrafts were also deployed to cut off the main roads of the enemy by shelling it massively (Gray & Thetford, 1962).

Also the communication techniques knew an evolution during the war. In the trenches were thousands of phones installed (de Vos, 2003). Therefore, communication cables were buried under the ground to connect them. The traces of buried cables are visible on WWI aerial photographs (Stichelbaut, 2009). However, these cables were not mapped in the spatio-temporal database and are not going to be discussed. All the military constructions such as these cables, roads, military railroads, walls, bridges, narrow gauges and other military constructions were protected on the Allied side against destruction by civilians by establishing the '*Besluitwet met betrekking tot de vernietiging of beschadiging van door het leger opgetrokken verdedigingswerken*' (Decision law regarding the destruction or damage of defence constructions installed by the army, 20 August 1915) (Belgisch Staatsblad, 1915).

5.4.2.2.4.2 Underground evolutions

For the underground military constructions, the understanding of the topography and the nature of the terrain was essential. Many surveys were made and geological, hydrological and ground sustainability maps were produced during wartime by a group of experienced geologists amongst other disciplines on both the Allied and German side. Trenches, tunnels and dugouts were typically implemented in the landscape. These were seen as modern combat infrastructure to provide shelter and safe accommodation for the troops against direct shellfire. Trenches were carried out by labour battalions and fatigue parties, which had to dig the constructions sometimes very rapidly (Doyle, 2014). Successful trench constructions were depended on the position of the construction relative to

[58] This list is not complete but gives an idea of the dispersion of aerial photos in the world today (Stichelbaut, 2009, p. 24).

[59] For an extensive technical evolution of the airplanes during the war for both Allied and German aircrafts, see Cowin (2000) and Gray & Thetford (1962).

the slope (e.g. maximize observation), the geological underground (e.g. avoiding slumping in clay grounds) and the position of the water table (e.g. drainage) (Brooks, 1920).

Another type of underground military constructions was performed by military mining which aimed to make tunnels and dug outs. Tunnels were made for offensive and defensive purposes. The offensive tunnels for instance led to galleries underneath the enemy. In these galleries, munition was placed and was exploded to destroy strategic places of the enemy. On June 7th 1917, 19 deep mines were exploded along the frontline underneath the German frontline going from Hill 60 (Zillebeke) to Ploegsteert (Comines-Warneton) (Institution of Royal Engineers, 1922). These explosions created enormous surface scars. The defensive tunnels offered shelter while troops moved undetected from one point to another. These were often seen as secret 'subways'. Tunnels were also made to listen and to and intercept the underground troops of the enemy (Doyle et al., 2002). Once horizontal galleries were quarried, it was important to carry out the operation in the most silent manner in order to not expose themselves to the enemy. The difference in hardness of the geological formations provoked a far or not far reaching sound of the use of a pick in the tunnels and galleries (Brooks, 1920). Most defensive tunnels were constructed in the coastal dunes near Nieuwpoort and underneath the city itself (Doyle et al., 2002). Both defensive and offensive underground constructions relied naturally on the geological conditions, but also on the close position relative to the enemy (Brooks, 1920).

Dugouts are shelters against rifle or shell fires partly or completely constructed underground. These constructions required much time and materials. The position of the water table controlled the possible construction depth of the dugout (Brooks, 1920). Four forms existed depending on the depth a dug out reached: shallow recess dugout, cut and cover dugout, deep dugout with limited cover and deep dugout with a lot of cover (Figure 5-9). Shallow recess and cut and cover dugouts gave limited protection and depended on the same construction conditions as the trenches. Deep dugouts delivered the best protection against direct shellfire since they were covered by a soil layer. Two metres of ground as a roof was needed for the protection against light shelling and sixteen metres was needed for heavy shelling. On the British front, the ideal locations of these were investigated by the Royal Engineers (Doyle, 2014). Sometimes they were connected with underground tunnels (Doyle et al., 2002). One very well preserved deep dug out - which was temporarily opened for public (31 July – 11 November 2017) - was the Zonnebeke Church Dugout, built in 1917 by British soldiers underneath the foundations of the church. The construction is positioned five metres below ground level and entails a main gallery of approximately 30 metres long which stands in connection with several side corridors and chambers (Figure 5-10).

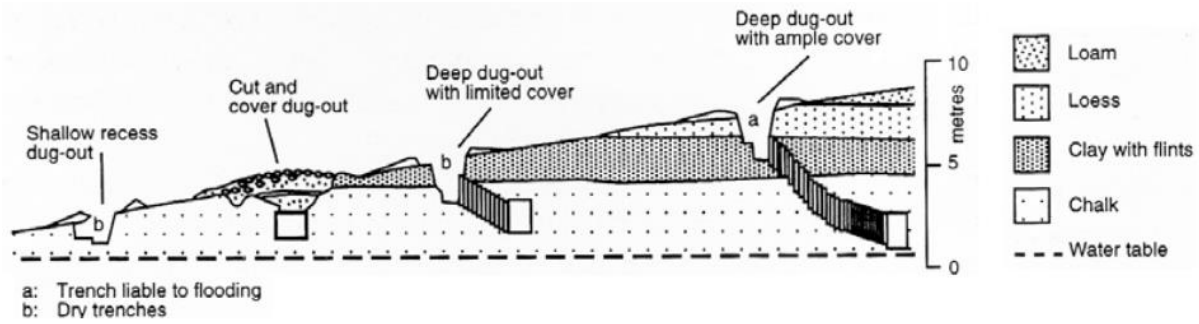

Figure 5-9 Types of dugouts in the Ypres area (adapted from Brooks, 1919 & Doyle, 2014)

Figure 5-10 Zonnebeke Dug Out (Source: Author, 10 November 2017)

5.4.2.3 Socio-cultural

5.4.2.3.1 WWI Tourism

Battlefield tourism started already before the Armistice (Vanneste & Foote, 2013). 'Tourists lines' behind the frontline in Ploegsteert Wood (South of Ypres) were set up for visitors (e.g. family, journalists, politicians) (Spagnoly & Smith, 2003). Additionally, the first of many Michelin guides handling the Battlefields of WWI was published in 1917. This guidebook discussed the Battle of the Marne and indicated touristic stops and several accommodations in the area (Michelin and Co, 1917).

5.4.2.3.2 WWI cemeteries

Military cemeteries are part of the commemorative heritage of WWI (Miles, 2016b). These were established by both national and international involvements. The Commonwealth War Graves Commission (CWGC) took the responsibility for the taking care of Commonwealth cemeteries. This

commission had its origin in the British Red Cross Unit which was operative from 1914 onwards in France with Fabian Ware as the leader of the Unit. The organisations of the war graves all started with the suggestion of Lieutenant-Colonel Stewart who encouraged the Unit to make more long-lasting inscriptions on the graves. Therefore, the Red Cross started to mark and inventory the graves. Later, families of fallen soldiers asked the help of the Cross to find the graves of their beloved ones. In meanwhile, the Cross became the only authorised group that marked and registered graves, which was called the 'Graves Registration Commission'. In 1915, the Commission already registered 31,300 graves. When the war changed in a static front line, cemeteries of the fallen were closely located and became soon fully occupied which meant that there was a lack of space. After many discussions between Fabian Ware and the French authorities, France was prepared to select French grounds in collaboration with the United Kingdom to establish new cemeteries for the Commonwealth graves. However, many criteria were imposed to locate these on the ideal place. These grounds had to be selected as far as possible from a road and could not occupy high quality agricultural lands. Later, This Commission - which was called the 'Directorate of Graves Registration and Enquiries' from February 1916 onwards – started also to negotiate with the Belgian government to obtain land for Commonwealth graves. However, this was not an easy task as the Belgian Government operated from Le Havre. Nonetheless, in September 1917 Belgium authorised land for perpetuity for the Commonwealth cemeteries. By April 2017, 150,000 graves were located and inventoried in both France and Belgium. Because of this extensive amount, Fabian Ware was in favour of the establishment of a specific body that had the duty to take care of these graves. In May 1917, this body was established and was called the 'Commonwealth War Graves Commission' which was and still is fully ruled by the Crown (Longworth, 2003).

In the case of the graves of the Belgian fallen, a difference was made between Belgian and Flemish graves. This because the previous discussed Flemish movement wanted to distinguish the graves of Flemish soldiers from the French speaking soldiers. The '*Comittee voor Heldenhuldezerkjes*' (Committee for Flemish Heroes Tombstones) designed a typical '*Heldenhuldezerk*' (Flemish Heroes Tombstone). The committee could realise the making of these tombstones by collecting donations from families of fallen Flemish soldiers, from Flemish soldiers on the front, or from close friends of the fallen. The Belgian Government did not provide any finances for this initiative. The design of the '*Heldehuldezerk*' was marked by a cross on top of the tombstone which referred to the Celtic High Cross. Also a bird and the inscriptions AVVVK that stands for '*Alles Voor Vlaanderen, Vlaanderen Voor Kristus*' (Everything for Flanders, and Flanders for Christ) were incorporated in the design. Flemish soldiers with this tombstone were buried in the graveyard of the church of their hometowns. By the end of the war, approximately 1,000 tombstones were produced (Shelby, 2014).

The first German fallen soldiers on the occupied side of Belgium were already buried in the village Vladslo in the year 1914, this during the Battle of the Yser (18 October – 31 October 2014). Only after the Armistice (1919), these were maintained and organised by the '*Volksbund Deutsche Kriegsgräberfürsorge'* (German War Graves Commission) (Volksbund Deutsche Kriegsgräberfürsorge, 2019).

5.4.2.3.3 Belgian patrimony

In the beginning of the war, *de 'Koninklijke Commissie voor Monumenten en Landschappen (KCML)'* (Royal Commission for Monuments and Landscapes) listed for the first time in Belgian history the valuable monuments and landscapes. This list entailed 436 religious, 368 public and 946 private buildings and also 21 landscapes that had to be protected and conserved during the war (Duvosquel et al., 1985). For instance, the list of the city of Ypres entailed in total 22 monuments and 1 landscape (Braeken, 2011). The complete list was made public by the KCML in September 1914. Hence, this announcement was made too late as the German army occupied quickly Belgium. The only thing the

Belgian Government could do from this moment on, was the planning of the reconstruction of the listed heritage. Plans included not only the reconstruction of monuments, but comprehended also the restorations of the immediate surroundings of the monument in order to create an coherent space (Duvosquel et al., 1985). During the occupation, German experts argued that the conservation measurements for Belgian monuments and landscapes by the KCML was falling behind compared to other countries. Villages and landscapes were not taken care of by the Belgian KCML. They argued that the interference of German expertise would improve the whole protection system (Ernst, 1915). However, the collaboration between the German experts and the KCML failed (Duvosquel et al., 1985).

5.4.2.3.4 Devastated castle domains

During the war, several castle domains were used for strategic military aims. For instance, castle towers served as strategic observation posts. From the moment these posts were discovered by the enemy, the towers and the castles were often completely destroyed (e.g. De Hutte in Ploegsteert on October 1914) (Heyde et al., 2015). The castle parks were also often the location of the battle such as the castle domain Geluveld which formed the battlefield during the First Battle of Ypres (October-November 1914) when German forces were approaching the city of Ypres from the city of Kortrijk. The German forces won the terrain and occupied the domain. However, the Allies reoccupied the park again (cf. 'Gheluvelt Day'). Hence, it was impossible to permanently protect this site where after the Allies already retreated on the same day. The back and forward occupation of the castle domains happened many times in this area. Sometimes, the frontlines were positioned in the middle of a castle park (e.g. Castle domain *Veldhoek* and Herenthage in the winter of 1914 to spring 1915). In general, these battles completely destroyed castle domains (e.g. *Hooghe* castle domain, Figure 5-11) while other castle parks behind the frontline served as the perfect location for headquarters or hospitals (Heyde et al., 2015).

Figure 5-11 Castle domain Hooghe (East of Ypres) was completely devastated (Australian War Memorial, 2019)

5.4.3 Interbellum period: 11 November 1918-1940

5.4.3.1 Policy

5.4.3.1.1 The desolated landscape as a reconstruction project for many stakeholders

5.4.3.1.1.1 First international help

Immediately after the Armistice, the Allies put to work the German prisoners of war to recover the main roads, railways and rural region under supervision of Allied forces. Also the Chinese Labour Corps Division helped with the restoration of the infrastructure and the landscape (Dendooven et al., 1999).

5.4.3.1.1.2 Buildings

The desolated country after WWI was the most important building programme in history of the Belgian authorities (Duvosquel et al., 1985). A series of laws and adaptations built further upon the already established Decision Laws during wartime in order to guide the reconstruction in a good

manner[60]. Already the day after the Armistice, the law provided advance payments on the final amount of war compensations to victims with urgent repairs (12 November 1918)[61]. These payments were juridical approved by the Court of War Damage by comparing the pre-war and post-WWI condition of the damaged goods. The money could only be used for the requested repairs such as repairs for immovable goods (houses, machines, public buildings) or movable goods (ships, clothes, drapery, raw materials for companies) (Belgisch Staatsblad, 1918c). Later, a new law was established that allowed the provision of advance payments on the final amount of the war compensations without any interference of the Court of War Damage (24 February 1919)[62]. This measure was taken to provide in a faster manner money for urgent repairs. For these cases a maximum of 2,000 BEF (50 Euro) was given. Later, this sum was deducted from the complete sum of war compensations (Belgisch Staatsblad, 1919f).

In April 1919, a new system was established (Law of 8 April 1919)[63], whereby destroyed municipalities with financial and organisational difficulties could let them adopt by the government. These municipalities were completely devastated and were positioned on the former front zone in the province West-Flanders whereof also Nieuwpoort, Ypres and Kemmel were part of. These municipalities were divided into three regions: the coast, northern and southern region (Figure 5-12). Each region was led by a Royal Commissioner. After one year, the adoption could be terminated. For these adopted municipalities the 'Decree Law of the Reconstruction of Devastated Belgian Municipalities' (25 August 1915) was not applied. The adoption of municipalities was organised by the '*Dienst der verwoeste gewesten (DVG)'* (Service of Devastated Regions) which saw the light one day after the previous discussed law (9 April 1919)[64] (Belgisch Staatsblad, 1919a). The DVG was part of the Ministries of Home Affairs, Economic Affairs and Agriculture (Hortensius, 1989) and helped to finance the rebuilding of public properties in order to realise housing in villages and cities by setting up building plans and roads, and by providing goods for refugees. As a result, the reconstruction in cities and villages became more organised (Cornilly, 2008). Hence, before houses could be reconstructed, the debris had to be cleaned up. Concrete military constructions (e.g. bunkers, shelters) were often impossible to dismantle without the interference of the Belgian Army which used explosions to destroy these. The DVG tried to recuperate as much as possible building materials for the houses (e.g. schistose, bricks and golf plates). Therefore, they hired people from other provinces of Belgium to help them. However, not all the debris could be recuperated. To provide new building materials, the DVG set up municipal department stores from 1919 onwards that sold different kinds of building materials to the municipalities. The construction of these stores was built with money coming from the previous established King Albert Fund (KAF). Municipalities could

[60] This dissertation will not give the complete list but will discuss the most relevant ones in the context of this thesis. For the complete list, see Federale Overheidsdienst Justitie (2019).

[61] Or '*Wetbesluit betreffende de steun te verlenen bij voorbaat inzake schade aan goederen (8 April 1919)'* (Decision Law to provide aid in advance in respect of damage to goods) (Belgisch Staatsblad, 1918c).

[62] Or '*Wet betreffende de voorschotten te verlenen door de Staat voor de door de oorlogsfeiten berokkende schade aan goederen (24 February 1919)'* (Law on advances to be granted by the State for damage to property caused by the acts of war) (Belgisch Staatsblad, 1919f).

[63] Or '*Wet nopens de nationale aanneming der gemeenten en het herstel der verwoeste gewesten (8 April 1919)'* (Law on the national adoption of the communes and the rehabilitation of the devastated regions) (Belgisch Staatsblad, 1919g).

[64] Or '*Besluit Dienst der verwoeste gewesten – Instelling (9 April 1919)'* (Decision of the Service of Devastated Regions – Institution) (Belgisch Staatsblad, 1919a).

request building materials to the DVG in exchange for payments, which after the DVG bought these in Flanders and transported the materials to the department stores. Besides new building materials (e.g. chalk, paint, roof tiles and bricks), these warehouses also sold recuperated second-hand building materials from debris (e.g. beams, wood and bricks). The transport of these materials to the warehouses was realised by the construction of a new transportation network of railways and roads. In total the DVG possessed 726 km railways, 2,391 wagons and 156 locomotives. The system of warehouses would be operative until 1925. Afterwards, the DVG sold much material to the Belgian Army (Hortensius, 1989).

Additionally, the DVG was also responsible for the cleaning up of unexploded munition. In four years (1919-1923), they collected in total 36,698 ton of unexploded projectiles with an average of 400 kilograms per hectare. Moreover, this service could also provide advance payments on war compensations with a maximum amount of 10,000 BEF (or 250 Euro) (Belgisch Staatsblad, 1919a). Figure 5-12 shows the adopted municipalities in this paper researched transects.

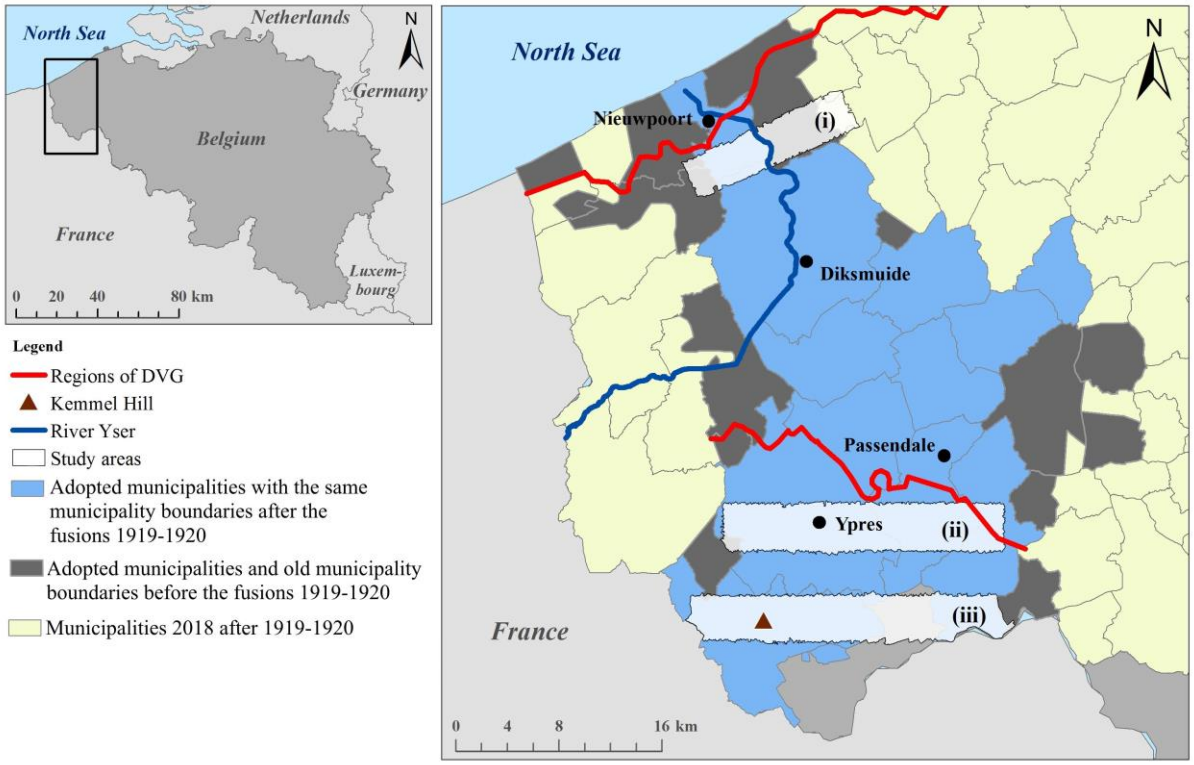

Figure 5-12 Adopted municipalities in 1919 (bleu and dark grey) by the 'Dienst der Verwoeste Gewesten' (Service of Devastated Regions) illustrated with the municipality boundaries of 2018 (yellow). The municipalities in that time were more divided in smaller municipalities (before fusions in 1919-1920). Therefore, the dark grey municipalities represent a municipality in that time which is only a part of a municipality today (yellow) (adapted from Ministerie van Binnenlandse Zaken (1919))

Following on the previous mentioned law of 23 October 1918 that defined the juridical organ (cf. Court of War Damage) and procedure for the determination of war damage already during the war, the new law for the recovery of war damage[65] (10 May 1919) saw the light. With this law the juridical organ and financial procedure was more elaborated (Belgisch Staatsblad, 1919i). However, people had to wait a long time on the promised money because many applications (already 1,000,000 in 1919) were submitted and had to be judged by the overwhelmed Court of War Damage (Hortensius, 1989).

This idea was further elaborated by an new law that recognised the partnerships that were authorised to pay these advances without any interference of the Court (11 July 1919)[66]. The amount of advance payments of these partnerships was defined to be maximum 70 % of the value of the property on August 1st 1914 (Belgisch Staatsblad, 1919c). These deposits were from July 1919 onwards official regulated on a local level by the '*Verbond der Samenwerkende Vennootschappen voor Oorlogsschade'* (Confederation of Cooperation Companies for War Damage). This Confederation that existed until 1927, was an overarching organisation of local partnerships that offered their services to the government to judge and assess possible advance payments (Hortensius, 1989). At least, the 'real' reconstruction of housing started from 1922 towards 1930 (Baert et al., 2009). It took years until everything was - after the already granted advance payments - official judged by the Court (Hortensius, 1989). However, in those years the government repeatedly undertook attempts to speed up the system by reforming the laws. For instance were the Chief Secretary of the State (1 December 1919)[67] and the Arbitrary Commission (25 May 1920)[68] introduced to expedite the system of the Court of War Damage (Belgisch Staatsblad, 1919b, 1920).

The *Koning Albertfonds (KAF)* (King Albert Fund) - already founded in 1916 (see previous) - did not accomplished anything (yet) in practice in the first months after the Armistice. Moreover, a good plan for the rebuilding also lacked. From 1918 onwards, the during the war 1,000,000 BEF (or 24,789 Euro) promised money by the Government shrunk to 600,000 BEF (or 14,873 Euro). This amount was only available from February 1919 onwards. Besides this amount, the KAF fund hoped to receive generous gifts from international relations (Agentschap Onroerend Erfgoed, 2017a). Essentially, they did receive (small) amounts from the Allies after the Armistice to build barracks (Figure 5-13) for the returned Belgian people and to reconstruct public buildings (e.g. townhouses, churches and schools). Barracks were also partly paid with war debts coming from Germany. At the end of 1920, only 30,000 barracks were available (Dendooven, 2006) for a total of 80,000 of destroyed houses in Belgium. The families that were given a barrack had to pay rent to the KAF in exchange for the maintenance of the barrack by the KAF (Hortensius, 1989). In 1920, the KAF decided to stop the production of barracks and wanted to built permanent houses instead. Therefore, they subsidised homeless people by

[65] Or '*Wet op Herstel van Schade Voortspruitend uit Oorlogsfeiten (10 Mei 1919)'* (Law for Recovery of War Damage) (Belgisch Staatsblad, 1919i).
[66] Or *Koninklijke besluiten op de voorschotten voor oorlogsschade 11 en 12/07/1919* (Belgisch Staatsblad, 1919c).
[67] Or '*Koninklijk besluit houdende instelling van de betrekking van Hoofdstaatscommissaris bij de rechtbanken voor oorlogsschade'* (Royal Decree establishing the position of Chief State Commissioner in the war damage courts) (Belgisch Staatsblad, 1919b).
[68] Or '*Koninklijk besluit houdende inrichting van scheidsrechterlijke kommissiën bij de rechtbanken voor oorlogsschade'* (Royal Decree setting up arbitration commissions at the war damage courts) (Belgisch Staatsblad, 1920).

providing them money for build materials to construct semi-permanent houses with the aim of living in these houses for 10 or 20 years. To enhance this system, the KAF provided wooden prepared frames for the houses that only had to be filled up with clay to create walls. However, the new system did not work because on the one hand locals had to pay an extra amount of money and on the other hand it was not interesting because many people did not own any building grounds but were rentals. Eventually, barracks were back in business from 1924 onwards. Hence, in 1925 the KAF wanted to sell the barracks instead of renting them out. Hence, the municipalities often refused to buy these because of the high prizes for the by the KAF badly maintained barracks. In 1927, The KAF decided to stop the rent and did not take care anymore of the barracks (Duvosquel et al., 1985; Hortensius, 1989). Steadily, some barracks became permanent houses. Even after WWII, barracks were still present in the landscape (e.g Poelkapelle) (see further) (Baccarne & Steen, 1965).

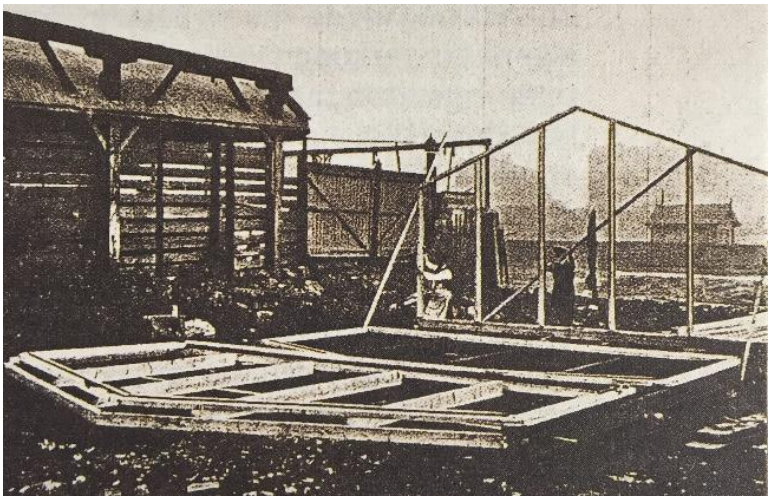

Figure 5-13 Construction of a barrack in Ypres, 1919 (Dendooven & Dewilde, 1999)

5.4.3.1.1.3 Countryside

The restoration of the countryside was achieved by help of several national commissions such as by the '*Commission Interalliée pour le Relèvement Industriel et Agricole de la Belgique* (CIRIAB)' (Inter-Allied Commission for Industrial and Agricultural Recovery of Belgium), which was already founded during the war in 1917 by the Belgian government and which planned together with the other Allies actions for the rebuilding after the Armistice. The CIRAB ensured 50,000 British horses and donkeys for the farmers. However, their actions only lasted until 1919.

The '*Service special pur la Reconstitution des Régions Dévastées par la guerre dans la Flandre'* (Special service for the reconstruction of devastated regions by the war in Flanders), was founded by the Ministry of Agriculture in 1918 and was mainly concerned about the restoration of the waterways. The in 1919 founded '*Office de la Reconstitution Agricole* (ORA)' (Office of Agricultural Reconstruction) - part of the central administration of the Ministry - was the successor of the CIRIAB and had to make plans for the reconstruction of the agricultural lands. Together with the '*Nationaal Hulp- en Voedingscomité'* (NHVC) (National Aid and Food Commission) (see previous) - they redistributed the by the German abandoned livestock amongst farmers (Demasure, 2013).

In the countryside, not all the farmers did return to their completely destroyed grounds or they did return and did not cultivate the grounds anymore because recovery payments were slowly handed out by the government (Hortensius, 1989). Consequently, a new system had to be set up by the Ministry of Agriculture that wanted the grounds to be cultivated as soon as possible. Before the end of the war, they established the '*Bijzondere Dienst voor de Heropbouw van de door de Oorlog Verwoeste Gewesten'* (Special Service for the Reconstruction of the War Devastated Regions), which was later in 1919 a part of the new '*Dienst voor de Herinrichting van de Landbouw'* (Service for the Rearrangement of Agriculture). This Service established the law for the restoration of devastated regions (15 November 1919)[69] - which was only operative in the front region. Following this law, farmers had four options: (i) restoring the lands by themselves or by their renters with fund of the government (ii), selling the grounds to the government based on an estimation of the pre-war and post-WWI value of the grounds, (iii) having the land restored by the government by giving them full autonomy whereby they compensated the owner a yearly amount (5 % of the ground its value) or (iv) to expropriate the land when it is no longer wanted anymore. Later, if the grounds were recovered by the government and the farmers were not interested anymore in the recovered fields, the government automatically expropriated the properties (Belgisch Staatsblad, 1919h). To recuperate the grounds, the Ministry levelled the grounds, recovered the roads and waterways and demolished military elements (e.g. bunkers, trenches). The by the war inundated grounds with salty seawater around Diksmuide and Nieuwpoort, were restored with lime to suppress the salty conditions (Hortensius, 1989). The government hired workers from other areas to help the locals in this affected region (Versavel, 1968). However, grounds were still soured after which the Ministry provided extra fertilizers, equipment and sheep (Baert et al., 2009; Dendooven, 2009). This system was operative until 1920 (Hortensius, 1989).

However, this law for the restoration of devastated regions (15 November 1919) was only set up in the year after the war. In the year before, few farmers had already begun to restore their lands by borrowing money that was available by the Law of Recovery of War Damage (10 May 1919) (Belgisch Staatsblad, 1919i), or by borrowing money from the '*Belgische Boerenbond'* (Christian Belgian Farmers' Union) (Hortensius, 1989). The latter established the '*Dienst voor het herstel van West-Vlaanderen*' (Service for the recovery of West-Flanders) which was headquartered in the city Roeselare, east of Ypres (Cornilly, 2008; Dendooven, 2006; Gilot, 1921). The Union saw the establishment of this new Service besides humanitarian reasons, also as an opportunity to gain more power in the province West-Flanders by carrying out propaganda. They assumed that the local pre-war agricultural unions such as the '*Brugse Eigenaars- en Landbouwersbond*' (Bruges Owner and Agricultural Association), would not be able to revive after the war. Consequently, they were hoping for a 'agricultural union' monopoly. Hence, attempts of the former unions were made but eventually were unsuccessful. The Service of the Belgian Farmers' Union had four assignments. Firstly, they set up an information office to provide information about the administrative steps to be taken in order to receive money from the Belgian authorities. Secondly, they anticipated on the government its shortage of advance payments on war compensations for civilians by providing also an amount of money to farmers. Thirdly, they cleaned up farmlands and recovered the waterways (see Figure 5-14). Last, they helped to re-design the houses and farms by seeking the help from the *Bouwdienst* (Building Service) which was set up by the Union (Baert et al., 2009; Dendooven, 2009; Van Molle,

[69] Or '*Wet op de herstelling der verwoeste streken'* (Law on the restoration of the destroyed territories) (Belgisch Staatsblad, 1919h).

1990). As this Building Service only made plans but did not actively rebuilt the houses, the '*West-Vlaamsche Bouwvereeniging*' (West-Flemish Building Association) was founded in 1920. This Association employed planners and construction services and was also established by the Union. Consequently, the previous established Building Service disappeared. Later in 1921, the West-Flemish Building Association changed its name to the '*West-Vlaamsche Heropbouwmaatschappij*' (West-Flemish Reconstruction Society) (Van Molle, 1990).

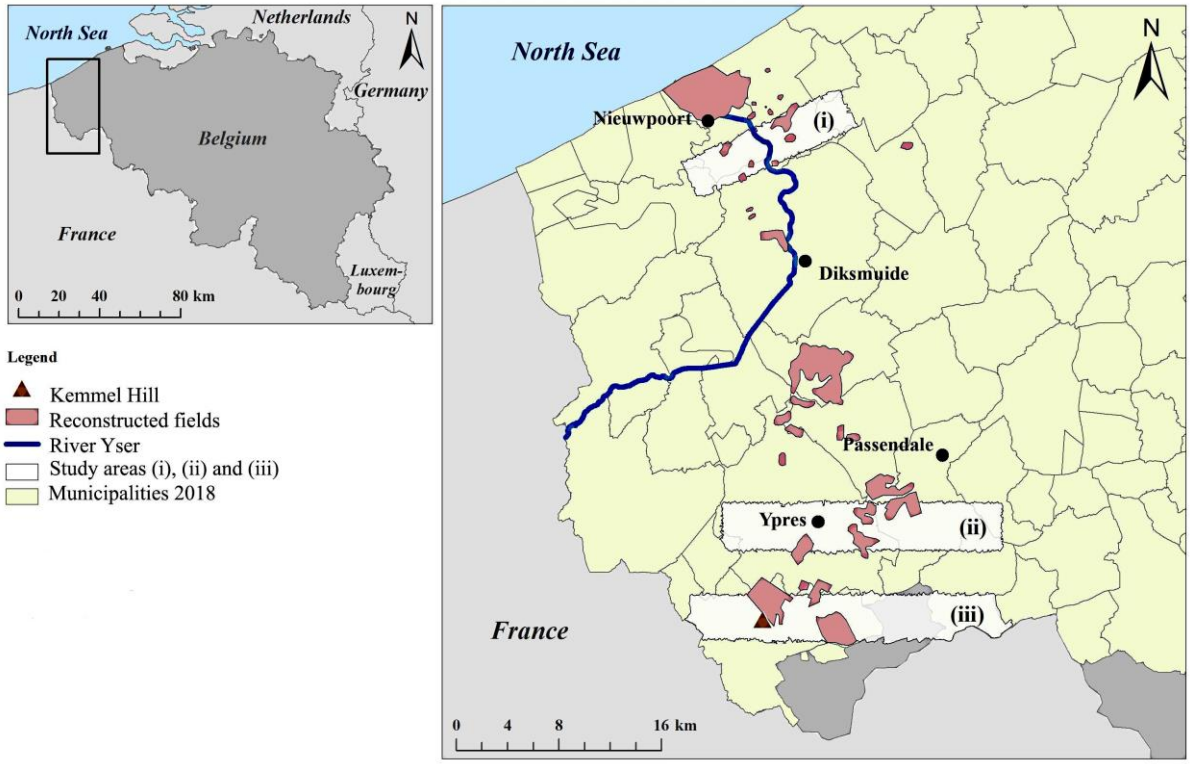

Figure 5-14 Recovered fields by the Famers' Union (1920) (Adapted from Gilot, 1921)

5.4.3.1.1.4 Munition

To clean up the shells, hand grenades and other munition types, an unofficial service was set up in 1920. Later on, the Belgian government realised that the cleaning up of the munition would be a long-term project. Consequently, they made this service official by giving it the name of '*Dienst voor Vernietiging van Munitie*' (Service for Destroying Munition) in 1923. In 1941, the name changed to the '*Dienst voor Opruiming en Vernietiging van Ontploffingstuigen*' (Service for Cleaning and Destroying of Explosive Equipment) (DOVO) (Belgian Defence, 2019).

5.4.3.1.2 WWI ruins and remains became national and international heritage policy

The WWI created a new type of heritage whereby the protection attempts of these WWI relics already began a few years after the war (Himpe, 2018). This was both nationally and internationally influenced. From international grounds, Sir Winston Churchill (UK) already suggested in January 1919 to protect several war sites in Belgium (Dendooven, 2006; Ingelbrecht, 2017). He was in favour for the consolidation of the ruins in the city centre of Ypres and called Ypres "A more sacred place for the British race does not exist" (Ingelbrecht, 2017, p. 191). The daily newspaper The Times (UK) confirmed this also in 1919 and described Ypres as a big memorial site that no other monument can surpass. British military authorities and veterans' associations also agreed with this point of view and saw Ypres as "holy ground" (Wilson, 1920, p. 2). This message was actively communicated by the

establishment of a sign board nearby the ruins (Figure 5-15) (Dendooven & Dewilde, 1999). Conversely, the returned citizen of Ypres were already actively restoring the city (Davies, 2008; Holt & Holt, 2007), because of their connection with the homeland or region that was strong and intense as "human see their own homeland as the centre of the world" (Tuan, 1977, p. 149). Indeed, during the emigration period in 1914-1918 to mainly France, Great-Britain, Netherlands and Switzerland, they were already dreaming of returning back to the fatherland (Duvosquel et al., 1985).

Figure 5-15 "Notice: This is holy Ground. No stone of this fabric may be taken away. It's a heritage for all civilised peoples" written on a sign board placed besides the ruins of the Lakenhallen, Ypres, 1919 (London, Imperial War Museum) (Dendooven & Dewilde, 1999)

On national grounds, the Belgian architect Eugène Dhuicque wanted to leave the ruins as they are (Vermeulen, 1999). Also the Belgian Ministry of National Defence undertook an attempt for the first protections of WWI traces in 1922. The Ministry wanted to preserve and protect several '*Sites de Guerre'* (war places) to exhibit these to the public (Figure 5-16, left). They selected 25 war sites from both Allied and German side that can funtion as an outdoor museum with an educative objective (Decoodt, 2014; Himpe, 2018; Service des Sites de Guerre, 1922; Vaesen, 2008).

Later, the British Colonel E.G.L. Thurlow worked together with the British Legion[70] and conducted plea to preserve the English bunkers or the so-called 'pill-boxes' (Figure 5-16, right). These were designed by engineers that were specialised in concrete constructions to protect soldiers against the fire of field guns and cannons. The impact of shellfire on the pill-boxes proved to be minuscule. In 1933, 180 of these constructions were still located on the Ypres Salient. The British stakeholders wanted to preserve these as they represented the symbol of the spirit of sacrifice during the war. They argued that these had to be conserved for the next generations (Thurlow, 1933). However, legal protections of WWI heritage was only realised in practice until after WWII (see further) (Himpe, 2018).

Notably, there was no legal protection system for monuments and landscapes in Belgium before the establishment of the '*Wet op het behoud van monumenten en landschappen'* (Law of Protection of Monuments and Landscapes) (7 August 1931)[71]. This law was already requested by the KCML in 1919 as this advisory Commission wanted to gain more decision power in relation to the protection of heritage (Stynen, 1985; Stynen & Draye, 1989). This law established the procedure to protect Belgian monuments (e.g. belfries, cathedrals and churches) and landscapes with national importance. Once monuments and landscapes were protected by the system, owners had to maintain and preserve these by help of governmental grants (Belgisch Staatsblad, 1931). The following 7 monuments were for instance protected between 1939-1940 in Ypres: The Hall and its belfry, the Vleeshuis (Meat Hall), the churches of St James (Sint-Jacobs), St Martin (Sint-Maartens) and St-Peter (Sint-Pieters), and the hospices of Sint-Jan and Belle. The selection of monuments to be protected was based on previous established list of the KCML in 1914. Notably, the government did not consider (yet) the WWI reconstructed buildings as heritage (Braeken, 2011). This will only be considered as heritage later on (see further).

[70] The British Legion is a British veteran association that helped and supported former veterans and families of WWI victims. They also supported war tourism on the Western Front (Decoodt, 2014).

[71] Or '*Wet op het behoud van monumenten en landschappen'* (Law on the Conservation of Monuments and Landscapes) (Belgisch Staatsblad, 1931).

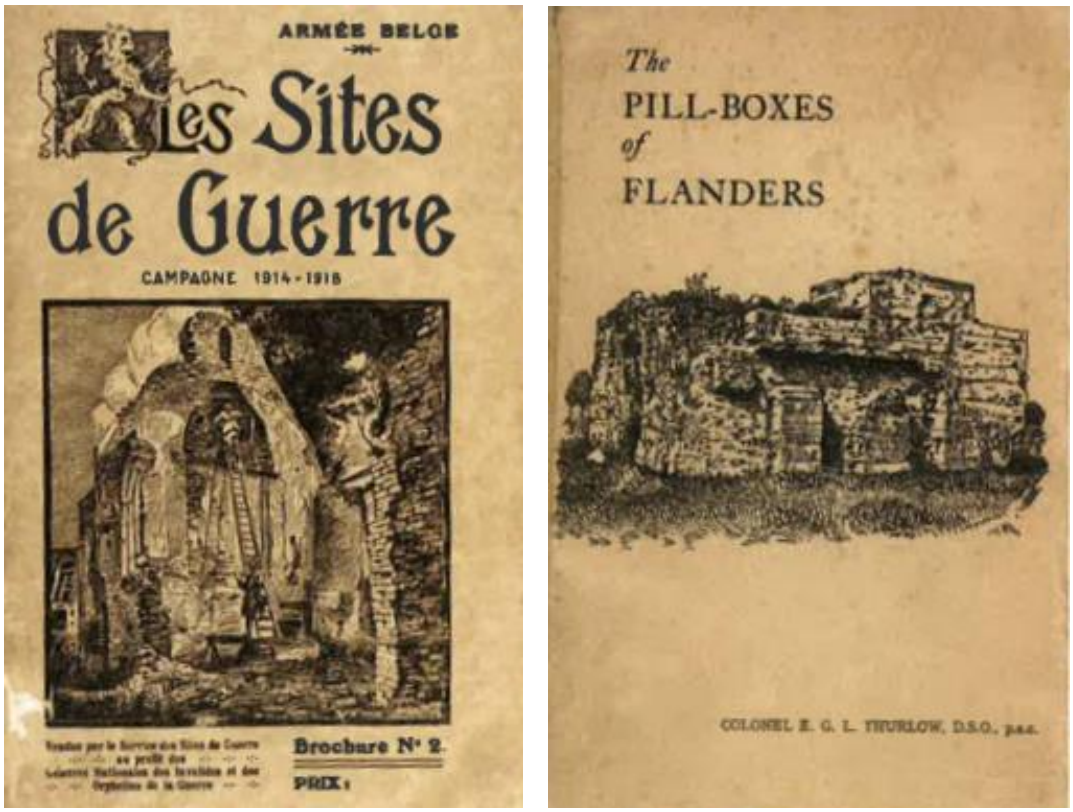

Figure 5-16 Left: Campaign for the protection of the Sites de Guerre 1914-1918 set up by the Belgian army (Himpe, 2018); Right: Document that describes the pill-boxes of Flanders (Thurlow, 1933)

5.4.3.1.3 International policy after WWI

International negotiations between the countries began soon after the Armistice on the Convention of Versailles (18 January - 28 June 1919) which was prepared to stimulate peace (Van den Wijngaert et al., 2006). Several countries made their policy documents from during the war public (e.g. France, Soviet Union) in order to exonerate themselves. Also Germany bundled 15,889 national documents into the publication '*Die Grosse Politik*' (The Great Politics). Hence, not everyone was always honest as documents were burned during the war or important political decisions were only made verbal to prevent evidence (Clark, 2013). In total, 32 winning nations were present on the convention and 440 articles were composed in four themes: territorial adaptations (e.g. Germany lost Elzas-Lotharingen), occupation and disbarment (e.g. Occupation Rijn area by allies), economic and financial agreements (e.g. war debts of Germany) and last moral provisions (e.g. punishments for politicians and serviceman) (de Vos, 2003). Nations found that the causer of the war Germany had to reimburse and had to discharge debts. Germany was unilateral accused on the conference of Versailles and felt excluded because following to them, other countries were also responsible for the war (Van de Meerssche, 2006). To determine the debts, a special commission in light of the Convention of Versailles had to calculate the sums of money needed to carry out the reconstruction in the war damaged countries. Therefore, Belgium established an appendix in one of its laws that encouraged Belgian municipalities to inform the commission how much money was needed to complete the

reconstruction (28 June 1919)[72] (Belgisch Staatsblad, 1919e). The handing over of German territory in favour of the Allies was a manner to pay the destruction debts to the affected countries. For Belgium, Germany handed over the cities Eupen, Malmedy and Sankt-Vith. Belgium saw this territory as an advantageous buffer between Germany and Belgium for future disputes. However, the much needed payments of Germany were delayed. To pressure Germany, military troops of France and Belgium occupied the area around the river the Rijn (or *Rijnland*) between 1923 to 1925. They confiscated coal and steel and saw this as a faster way to obtain war debts from Germany (Van den Wijngaert et al., 2006).

5.4.3.1.4 National policy before and after the Great Depression (1929)

In Belgium, the government was reformed by King Albert I. To continue the during the war founded political unanimity, he appointed in consultation with the leader of the NHVC (Emile Francqui), six Catholics, three Socialists and three Liberals to be Ministers. This collaboration evoked democracy. In 1919, the popularity of the socialist Belgium's Work Party (*Belgische Werkpartij, BWP*) grew. This party became as big as the other Catholic Party whereby the Liberal Party stayed behind. Until 1921, the three dominant parties stayed in positive interaction in the Belgian political system. Hence, from 1921 onwards, problems arose as the socialists were accused to make too much drastic changes in Belgium. Therefore, they were expelled from the government. Hence, due to the economic crisis or the 'Great Depression' in America in 1929 (see more information under section 3.2), the proportion of ruling parties changed again. Because of the economic crisis, Belgium started a deflation politics (1931-1935) executed with lower salaries and lower production costs, to be able to compete with the international market. However, the system did not work out where after political changes were evoked. The before liberal views on economics - that stood for no trade restrictions in a free market, no devaluation of the currency and no cartel formation between companies - were now questioned. More politicians believed that the trade had to be regulated to recover from the economic recession, which would be carried out by a controlling government. These thoughts were especially brought forward by the socialists with Hendrik De Man as a pioneer. He called his ideas the '*Plan van de arbeid*' (Plan of work) (Stutje, 2018). In the end of 1935, Socialism gained power again after many years of being not active and guided the Belgian economy with an operative devaluation of the currency back to a well-functioning economy (Van den Wijngaert et al., 2006).

Hence, the disputes between the ideas and point of views of the pre-war parties (Socialist, Liberal and Catholic Party) were since the Armistice no longer the only political landscape in Belgium. Firstly, communism - inspired on the ideas coming from Moscow - established the new small 'Communist party Belgium' (*Kommunistische Partij België*, *KPB*) in 1921. This Communist Party argued that the democracy was never being 'really' realised. The democracy was not real and was only a *façade* for the capitalist system in Belgium that never changed. Consequently, the party wanted to establish an union that grouped all the democrats (Communists, Liberals, Socialists and others) (Van den

[72] *Or 'Vredesverdrag tusschen de verbonden en geassocieerde Mogendheden en Duitschland en Protocol onderteekend te Versailles, den 28 juni 1919. Bijlage aan het Staatsblad van 7 maart 1920'* (Peace treaty) (Belgisch Staatsblad, 1919e).

Wijngaert et al., 2006). Secondly, fascism[73] also influenced the political landscape in Belgium. The Flemish orientated movement that already existed before the war established the 'Front Movement' during the war (see previous) (Van den Wijngaert et al., 2006). This movement used the myth of the Golden Spur Battle of 1302 as propaganda material for posters and paintings (Shelby, 2014). However, this Movement could only accomplish actions in Belgium by establishing a small political party in 1919, the 'Front Party' (or *'Frontpartij'*). This party evolved – with many side evolutions and developments which will not be discussed into detail (KVNV, Verdinaso, VNVP, KVNV, etc.; see De Wever (1994) for more information) - into the '*Vlaams Nationaal Verbond, VNV*' (Flemish National League, FNL). This League was founded by Staf De Clercq (previous member of Front Party) in 1933 and found its inspiration in the German Nazi Party and other extreme-right European movements. The League wanted to separate all the Dutch speaking areas from the French speaking areas. During the Belgian elections of 1936, FNL gained popularity. Flemish-Nationalism was radically against democracy and wanted equal rights for the Flemish speaking part of Belgium (Van den Wijngaert et al., 2006). The FNL collaborated together with Germany and offered their help in secret to the army of Germany in the event of a new war (De Wever, 2007). Additionally, fascism also influenced the Catholic Party. This party was after WWI influenced by the French speaking conservative Catholics. These were anti-Flemish and also against democracy. This group wanted to achieve more power for the Catholics in Belgium and found their inspiration especially within Italian Fascism. They were not pleased with the amount of grounds that were assigned to Belgium in the Peace Treaty of Versailles. Hence, the movement did not become a political party, but it gained support of leading members of the Catholic Party. This evoked the new movement 'Catholic Action', developed by the Belgian Church which was led by clergy and could be (cautiously) labelled as a 'clerical fascism' movement (De Wever, 2007). Later, a political party was established from the 'Catholic Action' movement, namely the party REX which was established by Léon Degrelle. This party was composed of radicalistic Catholics and gained a lot of votes in 1936 due to the economic recession (De Wever, 2007). This party with roots in fascism was a reaction on the post-WWI democracy. They mainly wanted more elite privileges and more influence in the government (Van den Wijngaert et al., 2006).

5.4.3.1.5 International policy and the economic depression

Notably, due to the economic crisis the international political landscape changed also in Europe. The most important change is the growth of the extreme right party in Germany with Adolf Hitler as a leader. The anti-Marxist Hitler was a nationalist-socialist that suffered from the defeat of Germany during WWI. He presumed that a new war was unavoidable on the one hand to regain the lost grounds of the Treaty of Versailles which had to be taken back for the *lebensraum* (living space) of their race as they would otherwise extinct, and on the other hand to purify the Aryan race[74] from Jews in order to save the Western civilisation. In 1933, he gained all the power and with his policy he saved the German economy from a downfall. Consequently, his extreme political party broke all the rules of the Treaty of Versailles and planned to regain the by the post-WWI lost grounds, which was only possible by excessive rearming Germany. To become an ally with Italy, Hitler donated South-Tirol to Mussolini, another fascist orientated leader (Boterman et al., 2014). The regime prohibited

[73] Fascism in this dissertation refers to the concept that comprehends Italian fascism introduced by the first fascist in Europe Benito Mussolini (Boterman et al., 2014) and German national-socialisms introduced by Adolf Hitler (see further), and other European nationalist movements (De Wever, 1994, p. 106).
[74] A race of carriers of the Greek, Roman and German civilisations (Boterman et al., 2014).

freedom of speech, press and assemblage. Jewish and communism were considered as anti-Nazism and were punished (Van de Meerssche, 2006).

Also on Russian side, politics evolved quickly after WWI into a Russian revolution. The multiple defeats of Russia against Germany during WWI raised the death toll. Food, weapons and logistics were lacking in the post-WWI Russia. Famines followed and encouraged the discontent of Russian civilians and soldiers causing them to massively strike. At long last, Tsar Nicolaas II abdicated in 1917 from his empire which gave the arise of the Soviet-Union led by the dictator Lenin and from 1924 onwards led by Stalin (Boterman et al., 2014). Previous ideas and plans were amongst other, the incentive for the start of WWII (Van den Wijngaert et al., 2006). Hence, we are not going to discuss this subject any further as we only want to give a brief overview of the incentives that led to WWII.

5.4.3.2 Economy

5.4.3.2.1 The post-WWI economic recovery of the industry and the countryside

After the Armistice, the Belgian economy suffered heavy losses. A economic recession period marked the years after the war (Gaus, 1992). Approximately 75 % of the blast furnaces was destroyed or dismantled, more than 50 % of the spinning machines were destroyed and the harbour of Ghent and Zeebrugge were severely damaged (Van den Wijngaert et al., 2006). Soldiers returned and were unemployed because the transition from a war industry focusing on war materials to normal industry did not go well (Bostyn et al., 2014). In total, 800,000 Belgian civilians were unemployed (Demasure, 2014). However, emergency food from the CRB (Commission for Relief) kept coming until 1919 (Martin, 1981). In total, the aftermath could be summarised into a loss of 18% of Belgium's national wealth (Bostyn et al., 2014). During the economic recovery, the Province West-Flanders was due to its location (e.g. distance to harbour of Antwerp) during the war always legging behind in economic evolutions compared with the other regions in Belgium (Dendooven, 2006).

With the belief that Belgium would receive payments of Germany - this before the Treaty of Versailles 1919 was compiled - the Belgian government payed large war compensations to private coals, steel and iron companies to restore the economy as quickly as possible. Later in 1919, the companies were fully recovered and could invest again. Consequently, they imported massively raw materials and machinery. Already in 1920, the production of the steal and metal industry reached 80 % of the pre-war situation. Private companies were convinced that the amount of pre-war productions had to be reached to be successful. Hence, they did not take into account that due to the war industry other countries were now also specialised in the production of coal and steel. This resulted in unsold products (Van den Wijngaert et al., 2006). Later, the financial status of Belgium was still unstable between 1919 and 1926. This created a constant uncertainty for new investments (Van den Wijngaert et al., 2006).

Also farmlands on the countryside were destroyed during the war and resulted into bad soil conditions, barren grounds, ammunition contaminated grounds, uneven grounds, destroyed drainage systems and infrastructure, no livestock, no crops and no capital. In the *Westhoek*, the region lost 90 % of its livestock (Demasure, 2013) and had a total of 80,000 to 125,000 ha destroyed arable lands (Hortensius, 1989). The total amount of money needed to recover these Devastated Regions (*Verwoeste Gewesten*) was estimated to be one billion BEF (25,000,000 Euro) (Leplae, 1920). Therefore, the first idea was to not to restore the former front area due to the high repair costs, the danger of explosions and the salted grounds (cf. inundation), but to forest the complete region. Hence, only two forests were planted (cf. Zonnebeke and Houthulst), because at the one hand locals were very dedicated to recover their grounds and on the other hand there was a shortage of trees (Dendooven, 2009). Consequently, arable lands (hay land and crops) and grassland (pasture) were mainly recovered by following the pre-war situation whereby fields had the same shape and sizes

(Heyde, 2014). In the process for recovery, food prizes were regulated by the government from 1918 to 1919. Also export restrictions were formulated and the people had to ration. From 1920 onwards, these restrictions were abolished again (Van Molle, 2002). However, the bad conditions of the agricultural lands were an incentive to conduct modern and better farming practices. Science, education, better fertilizers methods and the introduction of machines made this possible, where after the amount of farmland increased (Segers & Van Molle, 2004). In 1919, in total 23 % arable lands, 58 % stock breeding and 19 % horticulture were in production. Later in 1924, arable land increased even more to 27 % with a small decline in the horticulture (14 %) (Demasure, 2014).

5.4.3.2.2 Post-WWI financial status of the Belgian army

The financial status of the Belgian army and others was also deteriorated. Therefore, in the months after the war, military materials were gathered by help of Belgian, English and French forces. These gathered objects were recuperated by the armies (Hortensius, 1989). Especially forces from the United Kingdom were one of the biggest victims as they invested big amounts of money in this war (Bostyn et al., 2014).

Due to the economic recess, the Belgian army had to be reorganised. In 1923, the army was reduced from 12 infantry divisions and one cavalry division to eight infantry divisions. Later in 1926, the army was reduced again by abolishing several military regiments. In return for the lost divisions, repairs were carried out on the old fortifications around Luik and Antwerp. Also new fortifications were built in Luik to prepare Belgium for future possible attacks from Germany (Van den Wijngaert et al., 2006).

5.4.3.2.3 The economic crisis since October 1929

In 1929 the stock market in Wall street in the VS crashed. America started to decrease the import of products and evoked an economic crisis in many countries. Consequently, the countries protected themselves against a lower export market by introducing rising import taxes. This induced a price war around the world. Consequently, many companies were declared bankrupt which resulted in an even more decrease of the export of products. Also in Belgium prizes drastically decreased which induced a collapse in the production. Additionally, too many products were left unsold. The amount of unemployed people increased and bankruptcies followed. Many people were suffering from hunger. The peak of the crisis was reached in 1933-1934. The government carried out measures such as the these to save the economy from the crisis (see previous) (Van den Wijngaert et al., 2006). Hence, new industries arose in this period. The production and distribution of electricity increased and new products were developed in the chemical industry (Gaus, 1992).

Later, the rural landscape knew a modernisation. Belgium developed processes that intensified the agricultural production (Jespen et al., 2015). Modern drainage systems were implanted and enabled the transformation of wet pasture into dry arable lands. Woodland became less important. Especially the pre-war *bocage* (hedgerow) landscape marked by hedges and tree rows that surrounded fields (Stubbe, 2006), disappeared due to the introduction of already known before the war barbed wire (Heyde, 2014).

5.4.3.3 Socio-cultural

WWI cemeteries, monuments and memorials as well were now established in the landscape. These represent *lieux de mémoire* (sites of memory) and possess a symbolic meaning. These places are common acts of remembrance (Carden-Coyne, 2009). WWI cemeteries and monuments belong to the tangible heritage of the landscape. Inseparable from the tangible heritage of the landscape, there is also an intangible layer in the landscape which is most reflected into battlefield tourism (Miles, 2016b).

5.4.3.3.1 WWI cemeteries

At the end of 1927, in total 500 cemeteries were established by the Commonwealth War Graves Commission (see previous) in France and Belgium entailing 400,000 headstones, 1,000 Crosses of Sacrifice (white memorial cross) and 400 Stones of Remembrance (memorial stone with the subscription “Their name liveth for evermore”) (Figure 5-17). The Commission often decided to close the small cemeteries and to merge these with bigger ones (Longworth, 2003). Each cemetery and its related memorials are designed by several architects. The design always reflected the past. For instance, the names of the cemeteries were inspired on occurred battles and on the names of former trenches (Godden, personal communication, 4 September 2017). To reflect the communal experience and memory of the war as good as possible in the design of cemeteries, only empathetic architects that served during the war were allowed to make a design. Architect Edwin Lutyens (designer of the Stone of Remembrance which is placed on cemeteries), Sir Reginald Blomfield (designer of the Cross of Sacrifice also visible on cemeteries and the Menin Gate in Ypres) and Charles Holden (designer of cemeteries) are the most well-known designers in Flanders. The common architect style of the Commonwealth War Graves Commission was ‘stripped classicism’ in order to unify religions. Simple lines, minimalism and white classical marble of Greece ‘replaced’ the destructions of the war. For instance, the Stone of Remembrance is designed with a mix of modern abstraction, ancient monumentalism, a Christian altar and a classical piece, to allow the stone to be uniformly accepted around the world by different religions (Carden-Coyne, 2009). From the start of WWII, the commission's cemeteries grew even more. Today, the headquarter of the commission is located in Berkshire, the south of London. Another sub-office is located in Ypres that is responsible for the CWGC cemeteries and monuments in eleven countries (Belgium, Germany, Denmark, Netherlands, Austria, …). Investments in the CWGC come from the UK (75 %) and from other countries which are part of the Commonwealth (25 %) (Longworth, 2003).

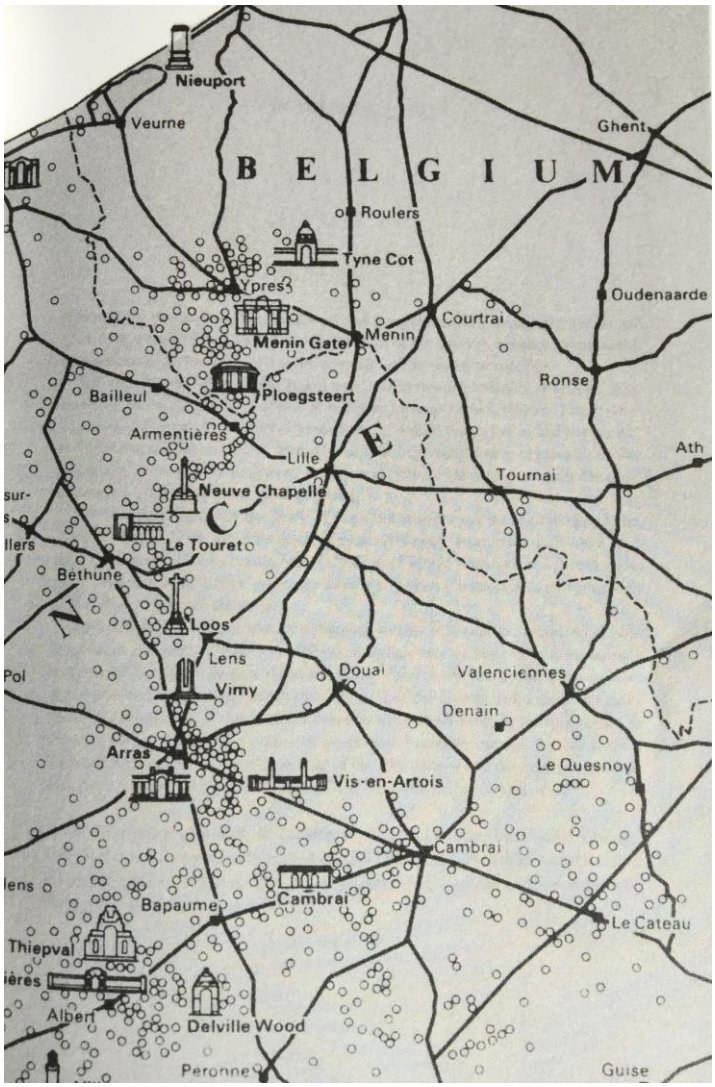

Figure 5-17 Commonwealth war cemeteries in Flanders and the northeast of France. Each point represents a CWGC cemetery (Longworth, 2003)

Besides the Commonwealth graves also French fallen were buried in Flanders. The fallen that no longer could be identified were grouped in '*ossuaires*' (ossuary's) (e.g. Kemmel). Others were buried on a French cemetery (e.g. St. Charles de Potyze, northeast Ypres). Hence, besides the cemeteries, French soldiers were also often buried on civil cemeteries of villages and on Belgian and Commonwealth cemeteries (Délégation permanente de la Belgique auprès de l'UNESCO, 2014; Horne, 2010).

During WWI, the Belgian fallen were scattered buried on small cemeteries next to the frontline or other places. Hence, these were relocated on official Belgian cemeteries by the help of the Belgian army. They provided place for both Flemish and French speaking fallen (Shelby, 2014). The differently designed Belgian cemeteries compared to the Commonwealth and French designs are found on nine places (e.g. Hoogstade, Adinkerke and De Panne) (Chielens et al., 2006). The by the government sponsored tombstones are on the top convex and represent an arch. The Belgian Flag with an overlaying small cross (in the yellow part of the flag) is displayed in the upper part of the tombstone. Hence, the Flemish-orientated soldiers' graves could still be found with another tombstone type (see previously explained *Heldenhuldenzerkje*). However, these tombstones were after the war threatened because the government wanted to uniform the design for all the Belgian graves. Consequently, these Flemish graves often disappeared and were transformed into the uniform Belgian design. Additionally, tombstones were often destructed by civilians and were used for other

constructions such as roads. Many protests followed and eventually the tombstones were protected in 1927 by the Minister of Defence. Afterwards, the fallen Flemish soldiers all received a *Heldenhuldezerkje* (Shelby, 2014).

German cemeteries were already established in 1914 after the Battle of the Yser. In 1919, 17 cemeteries were created in Belgium. Later between 1955 and 1958, the 68 cemeteries were grouped in four big cemeteries located in Vladslo, Hooglede, Menen and Langemark. These were from 1919 onwards maintained by the *Volksbund Deutscher Krigsgräberfürsorge* (German War Graves Commission) (Chielens et al., 2006; Volksbund Deutsche Kriegsgräberfürsorge, 2019).

Also an American cemetery was established in Flanders, namely the American Cemetery Memorial which is located in the city Waregem which was created during 1921 and 1922. From 1923 onwards, these graves were maintained by the American Battle Monuments Commission (ABMC) (Dick & Vandendriessche, 2018). This cemetery - which was designed by the French architect Greber - is the only WWI American Cemetery on Belgian grounds. These grounds were donated by the Belgian Government free of charge or taxation to the United States of America (American Battle Monuments Commission, 2019).

5.4.3.3.2 WWI monuments

Besides the cemeteries, plenty of WWI monuments were established in Flanders which also belong to the commemorative heritage (Miles, 2016b). Monuments have a social, political, personal, aesthetical and emotional function as well that tell the story of the war and its victims (Carden-Coyne, 2009). The in this section described monuments were not protected (yet) in the Interbellum.

Between 1921 and 1927, 22 demarcations stones were placed in Flanders on the former frontline to honour the Allied forces. These stones or columns were made of red granite and were designed by the veteran and sculptor Paul Moreau-Vauthier. Three different types of columns were designed: 10 Belgian columns which were placed between Nieuwpoort and Lizerne, 6 British columns which were placed in the Ypres Salient and 6 French columns which were placed between Boezinge and Kemmel Hill (Bogaert & Decoodt, 2003; Himpe, 2018). In addition to the function to honour the fallen Allies, these stones were also placed to attract tourists (Himpe, 2018).

The most 'famous' monument placed in the Interbellum is the *Menensepoort* (Menin Gate) in Ypres. This monument was established in 1927 for the never found soldiers and was designed by the previous mentioned architect Blomfield under lead of the Commonwealth War Graves Commission. In total, the names of 57,000 Missing are inscribed in the gate or arch (Carden-Coyne, 2009).

Besides previous two examples, plenty of other WWI monuments were established in the area and were designed for individual persons, military entities, particular battles or events, or for the heroic deeds and efforts of certain countries or regions (Chielens et al., 2006).

5.4.3.3.3 WWI tourism and pilgrimages

After the war, WWI caused a "long trauma" (Reynolds, 2013, Title book), and created "a central place in public and private culture" (Miles, 2016b, p. 5). Family and friends wanted to see the place where the fallen fought and died. By seeing these places, it helped them to cope with their losses. This was the start of the unending war tourism in Flanders that we know until today. Tourists visited the battlefields for a wide range of reasons: to honour the fallen, to remember the war, for militaristic and nationalistic interests, or out of historical fascination (Vanneste & Foote, 2013).

Many stakeholders observed the interest of people to visit the former battle fields and invested in the booming industry of travel guides. In the first two years after WWI, the already during the war started series of Michelin travel guides continued to publish new guides. In 1920, a guidebook was published that guided tourists to the battlefields in Ypres. First, the travel guide recommended some hotels. Afterwards, the guide explained into detail the history of the wide range of occurred battles in the area, illustrated with maps and photos. Last, the guide suggested a two-day program with a proposed route to several war sites. Photos illustrated the post-WWI landscape of these sites and are compared with photos, drawings or paintings of the pre-war situation (Michelin and Co, 1920). Later, also a Michelin travel guide appeared discussing the Battle of the Yser (1914) and the coast. This guide is prepared in the same way and starts also with the suggestions of accomodation before explaining the history of the battles and suggesting daily trips (Michelin and Cie, 1919).

Both guides which were written in English, induced the so-called 'dark tourism' (Murphy, 2015). This type of tourism is associated with tourists that travel to 'deathscapes' (cf. sites related to death) (Lennon & Foley, 2000, p. 5). According to Murphy (2015), two million travel guides were sold in various languages between 1919 and 1939. Moreover, between 1919 and 1921, 30 other travel guides (in English) were published who also discussed the former battlefields (Lloyd, 1998). Also travel guides were published by Belgian people such as Massart (1920) which guided tourists in the battlefields of the former Flemish front and the Belgian Ministry of the Railways (1921) which published a book that discussed particularly the Front region of de Yser.

Because it was not easy to visit a destroyed landscape, several tour operators organised trips to the former front (Walter, 1993). Battlefield tours (cf. commercial purposes) and pilgrimages (cf. showing respect to the fallen) to the former front were established and organised by for instance the travel organisation Thomas Cook which was the biggest travel organisation in that time and organised already its first trip in 1919. Also the British Legion which is an old comrades' association, the Ypres League which was founded in 1919 to support visiting pilgrims and the Society of St. Barnabas which organised pilgrimages for veterans, grieving mothers and widows, organised trips to the front (Connelly, 2009; Delepiere & Huys, 2014; Miles, 2016b; Walter, 1993). Additionally, the Red Cars company of Blankenberghe organised in 1925 excursions in a private or shared red car with an English guide which visited for instance the devastated cities Ypres, Ghent, Holland, Arras and Antwerp (Connelly & Goebel, 2018).

Other investments were made to maintain or exhibit WWI sites, such as the site of Hill 60 at Zillebeke. This site was bought in 1920 by an English national and was afterwards opened for tourists (Miles, 2016b).

As a result of previous initiatives, already ten thousands of tourists visited in 1920 the devastated city Ypres (Ingelbrecht, 2017; MacDonald, 1993; Miles, 2016b). Later, between 1920 and 1937 the number arose from 559,905 to 1,058,936 tourists (from the Commonwealth) which visited the former West front (Lloyd, 1998, p. 29).

Also the Flemish speaking Belgians induced a specific Flemish commemoration, namely the '*IJzerbedevaart*' (Yser Pilgrimage) which was founded in 1920. The pilgrimage commemorated all the fallen for Flanders. This pilgrimage helped to consolidate the identity of the Flemish orientated group by yearly organising the pilgrimage. Speeches were given on the pilgrimage for family and friends of fallen and for the veterans. The pilgrimage entailed a visit to various war sites along the Belgian Front. Visits were in the first five years made to the '*Heldenhuldezerken*' amongst others. From 1924 onwards, the pilgrimage was held at one site in Diksmuide nearby the river Yser with the amount of attendees going from 3,000 to 120,000. On that site, the monument the '*IJzertoren*' (Yser tower) was built. From 1930 onwards, this monument served as a remembrance and commemorative site for the fallen Flemish orientated veterans, and was seen as a '*Heldenhuldezerk*' for the whole region of

Flanders, as a symbol for the Flemish society, as a symbol for fascism and also as a symbol for peace (Shelby, 2014).

Following on the previous examples, it can be concluded that the way that tourists looked and experienced the WWI landscape is on the one hand a product of the war and its relation to the landscape (Miles, 2016b), and on the other hand a product of the by the war induced initiatives since many museums, hotels, pubs and shops were established in response to the increasing amount of tourism (Mosse, 1990; Saunders, 2001, 2006). On the contrary, tourism provided a '*raison d'être*' (reason for being there) for the preservation of tangible WWI heritage (Miles, 2016b, p. 9) in all its forms (pillboxes, bunkers, trenches, letters, art, …). This encouraged the 'power of imagination' of what exactly it has been like in that time (Miles, 2016b, p. 10), because by visiting the former battlefields, tourists can recapture the atmosphere and the experiences of the soldiers (Lloyd, 1998). However, WWI tourism evoked double feelings in Flanders. At the one hand, local civilians saw tourists as intruders or as obstacles in their daily life. On the other hand, the government and local authorities saw tourism as an opportunity to make money by investing in the infrastructure and accommodation (Miles, 2016a). Therefore, hotels and restaurants were established (Figure 5-18) (Connelly & Goebel, 2018).

It can be concluded that tourism and the landscape with its war heritage have a strong relationship with the memory as 'glue' between them (Miles, 2016b).

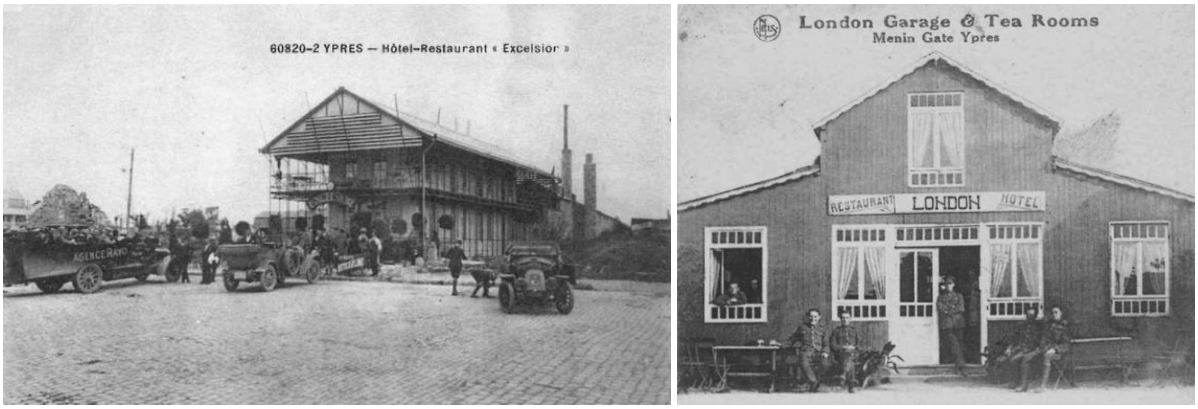

Figure 5-18 Left: Postcard hotel and restaurant Excelsior in Ypres (1920); Right: Postcard restaurant and hotel London nearby the Menin Gate Memorial (1927) (Connelly & Goebel, 2018)

5.4.3.3.4 Belgian patrimony

Because many laws were established to organise the reconstruction during and after the war, the '*Koninklijke Commissie voor Monumenten en Landschappen (KCML)'* its tasks expanded. For the adoption of municipalities by the '*Dienst der verwoeste gewesten'* (from 1919 onwards), the KCML had to give advice in these municipalities. Later, according to the law of '*Wet op Herstel van Schade Voortspruitend uit Oorlogsfeiten'* (10 May 1919) (see previous), the KCML was given more responsibility as they had to give advice to each application that was processed by the Court of War Damage. Belgian patrimony was instructed by the KCML to be reconstructed according to the pre-war situation or could be conserved as a ruin (Duvosquel et al., 1985).

The during the war formed Belgium Town Planning Committee worked four years on the modern reconstruction ideas. Afterwards, they planned to exhibit their ideas on the world exhibition in 1919, held in Brussels. However, these plans did not agree with the visions and advices from the KCML. The regionalist KCML called the ideas of them "unhandy experiments with concrete", "house groups that

are reminiscent of the suburbs of Marrakech" and "forms of Germanic inspiration" (Duvosquel et al., 1985, pp. 132-133). Disputes about the realisation of modern (cf. innovative construction concepts) and regionalist or traditionalist styles (cf. implementation of local architectural elements emphasizing the regional character) often occurred. To solve these disputes '*The Comité Consultatif d'Architecture'* (Advising Commission for Architecture) was established by Minister Renkin. This Commission had to divide the reconstruction projects between (i) architect associations, (ii) individual architects (such as the architects Coomans, Veraart and Viérin from the Royal Commission), and (iii) other stakeholders. Representatives from several devastated regions which had opposite ideas about the reconstruction (cf. modern or traditional) were equally represented in this commission (e.g. regionalist architect Coomans, modern architect Dhuicque and modern architect Verwilghen).

The restauration in the city of Ypres is a well-known example of the disputes between stakeholders about the reconstruction. Besides the group that wanted to preserve the ruins of Ypres as 'holy ground' (see previous), the mayor Colaert wanted Ypres to be rebuilt according to the pre-war example by duplicating the pre-war architecture style and street patterns. The reconstruction plans that agreed with this vision were already made in 1916 by the town architect Coomans of the KCML. These plans were established in the context of the law of 25 August 1915 whereby the making of construction plans was obligated (Figure 5-19). However, architect Dhuicque was specialised in monument conservation and restauration and addressed also his attention to the Ypres Belfry and *Halle.* He wanted to sustain the ruins as these have on the one hand sentimental values and on the other hand it was impossible to reconstruct these with the original materials (e.g. facing brick). The replacement of the latter with new materials would led to the disappearance of the last remained unique building material which was still visible in the ruins. '*The Comité Consultatif d'Architecture'* had to solve this dispute and organised a vote session with the members of the commission. A unanimous vote was not reached. In anticipation of a solution, the ruins were left in their state and money would be first spend to more necessary reconstruction projects (Duvosquel et al., 1985).

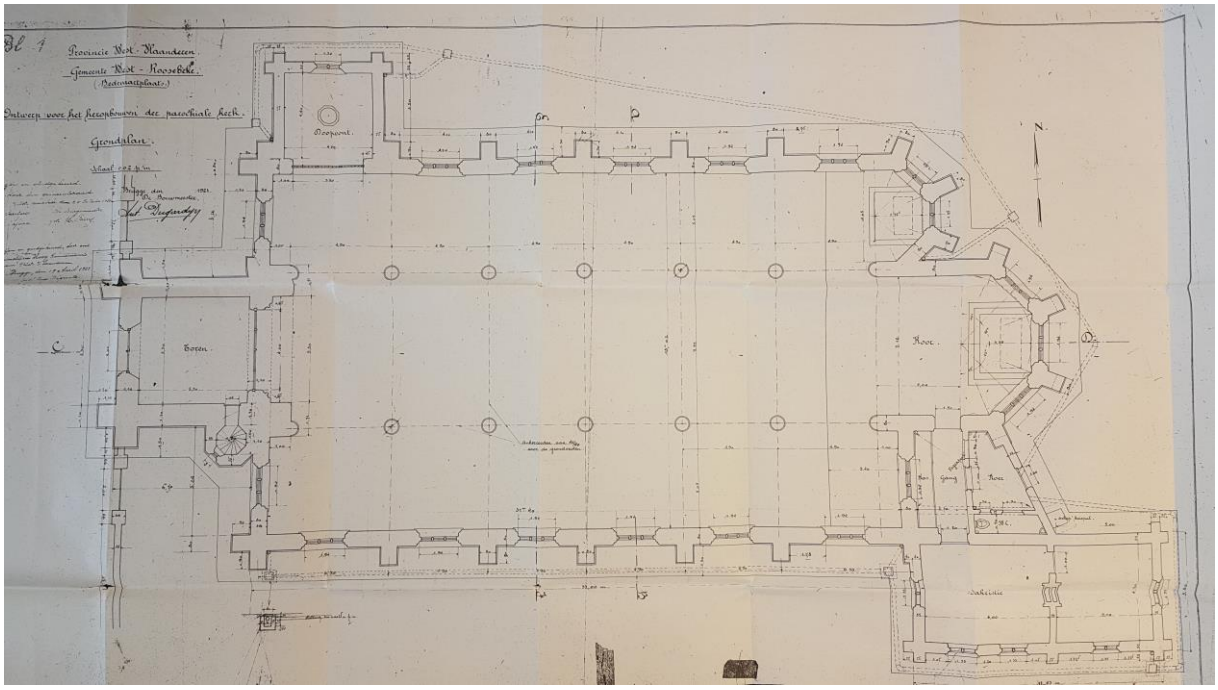

Figure 5-19 Example of a reconstruction plan of the Westrozebeke Church (1921), village northeast of Ypres (source: architect Dugaldyn, Brugge, 15 June 2019)

Later, the British and Belgian stakeholders that wanted to preserve the ruins no longer focussed on the conservation of these and put their attention on the Menin Gate monument instead (Dendooven & Dewilde, 1999). Consequently, the architects that wanted to reconstruct the pre-war established Belgian patrimony started with the reconstruction of the *Sint-Maartenkerk* (Ypres), the Belfry (Ypres) and *the Halle* (Ypres). Notably, the latter two would only be finished in 1966 because of a delay during WWII.

Hence, not all the innovating ideas of the modernists were ignored. In response to the post-WWI shortage of houses, several garden cities were established in Flanders. Following the example of the English garden cities (Howard, 1902), the first garden city 'Batavia' was established in the city Roeselare in 1919. This city was designed by modern architect Verwilghen and was an experiment for the establishment of future garden cities. To reduce the construction costs of these cities, less land was paved which were instead replaced by front gardens, cheap building materials were used such as concrete, and the houses were smaller. After Roeselare, many other cities followed this example such as the garden cities Kalfvaart (Ypres), Ligy (Ypres), Zaalhofwijk (Ypres), Sint-Pieterswijk (Ypres), Tuinwijk (Diksmuide), Cité (Zonnebeke) and Goedhuys (Nieuwpoort) (Figure 5-20 and Figure 5-21) (Duvosquel et al., 1985, p. 112). Also in the village Zonnebeke were modern reconstruction ideas executed. The architect Hoste saw the reconstruction as an opportunity to rebuilt a modern village and succeeded by designing modern buildings such as the progressive modern church (Jaspers, 2011).

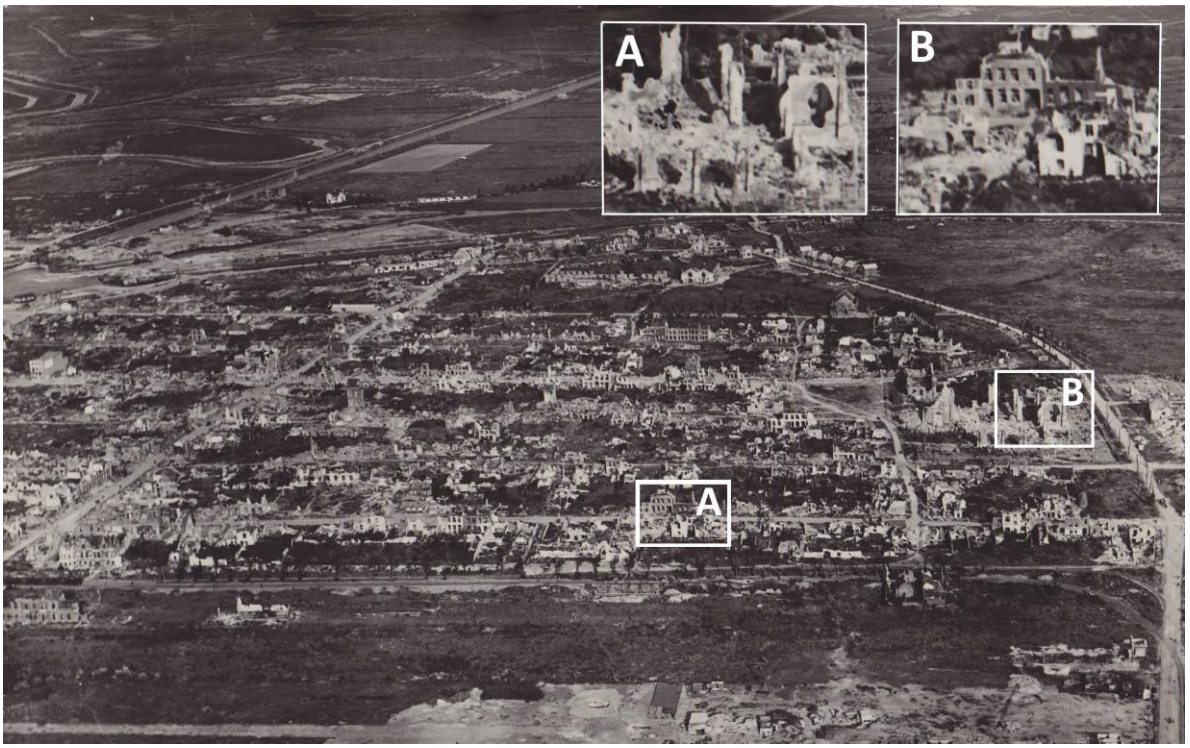

Figure 5-20 Photograph of the devastated city of Nieuwpoort with a. devastated church and b. devastated houses (Source: Modified from In Flanders Fields Museum)

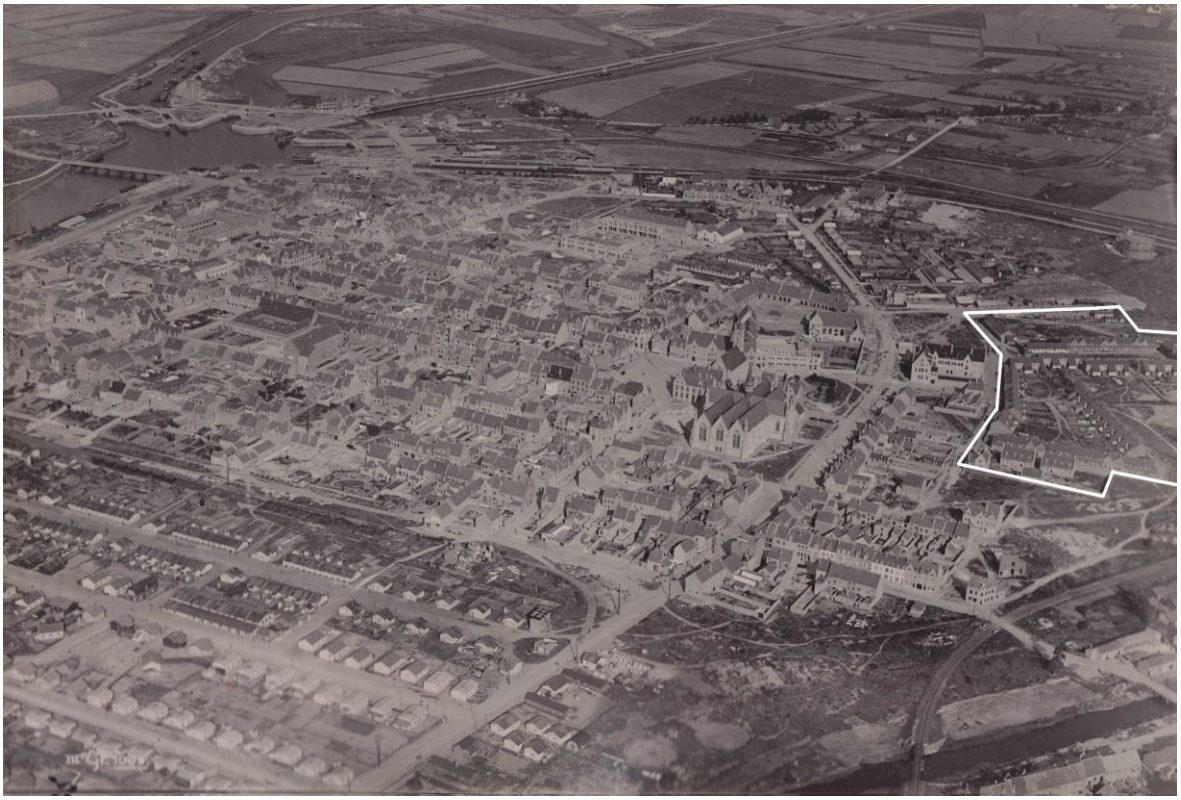

Figure 5-21 Photograph of the reconstructed city of Nieuwpoort with the establishment of the Goedhuys Tuinwijk marked with a white line (Source: Modified from In Flanders Fields Museum)

5.4.3.3.5 The rebuilding of castle domains

The castle domains were often severely and irreversible damaged. Consequently, not all the castle lords found the courage and money to reconstruct their properties. In total, nineteen castles were not rebuilt. These domains were replaced by agricultural lands, woodland or were used to built houses. For instance, the *Huttekasteel* in Ploegsteert which was positioned on Hill 63 during the war, was completely devastated and transformed into pasture and agriculture. Only the wall remains remind us of the majestic pre-war castle (Heyde et al., 2015).

However, castle lords could also obtain payments for the reconstruction following the Decision Law of 23 October 1918 (see previous). In this way, hedges, woodland, infrastructure, animals, material and ornamental flower beds or trees could be restored. Consequently, approximately 20 of the pre-war established castles domains were reconstructed. For instance, the reconstruction of the completely devastated castle park *Hooghe* already started in the spring of 1919. Bodies of fallen, munition, tree trunks, limbs, barbed wire and military infrastructure had to be removed from the park. Before the castle and the side buildings could be rebuilt, the cleaning and the levelling of ground were accomplished. However, the rebuilding of the castle was not possible on the same location because the grounds were unstable as tunnels were dug underneath the old ruins. Additionally, some mine craters in the domain (British mine craters of 6th June 1916) were preserved and served in the post-WWI situation as ponds (Heyde et al., 2015).

5.4.4 WWII: 1940-1944

5.4.4.1 Policy

5.4.4.1.1 Intake Belgium (May 1940 - October 1944): Short review

On 10 May 1940, Germany invaded Belgium and diffusely bombed cities and villages in Belgium (Braeken, 2011). The German forces made their way to the southern part of Belgium and reached the Province of West-Flanders nearby the coast. The Belgian and the British forces tried to stop the invasion on the same location as the former WWI frontline, namely on the higher West-Flemish ridge located near Passendaele. Hence, they could only hold them back until 28 May 1940 (Bostyn et al., 2014). To stop the German forces that broke through the defence line on the ridge, the pre-war established fortifications on the '*Ligne Magilot*' (Magilot Line) nearby the French border were used. This line started from the North Sea and went further to the south by following the French border all the way to the Mediterranean. However, the German army also broke through this line (Bostyn et al., 2014).

Because the intake of Flanders progressed fast, not a lot of the landscape was destroyed in the studied areas in the Westhoek. For instance, the city of Ypres was not badly damaged (Dendooven & Dewilde, 1999). Only few fields and houses were diffusely destroyed whereby no craterland was created such as during WWI (Van den Berghe et al., 2018). Hence, Flanders was during WWII regularly bombed by the Allies to supress the German (Braeken, 2011).

Approximately 7.6 % of real estate in Belgium was devastated. Around 50,000 houses were completely destroyed and 100,000 houses were damaged. Together with the already started shortage of houses before the war during the building crisis (Agentschap Onroerend Erfgoed, 2017b), in total 300,000 houses were needed (Braeken, 2011). Consequently, similar reconstruction laws as during the WWI had to be established. Civilians who wished to repair their houses already during WWII, could receive a 'repair loan'. However, the biggest reconstruction incentives of the government did not take place until after the war (Floré, 2011). As WWII is not the main theme of this thesis, we will not further elaborate on the political reconstruction incentives.

5.4.4.1.2 Belgium collaborators during WWII

During WWII, the Flemish National League (FNL) collaborated with the German occupiers to gain more power in Belgian administration procedures. In exchange, they had to help the German forces on the Eastern Front. Hence, the power of FNL stayed limited. Also the REX party wanted to obtain more power in Belgium with the help of the Nazis. Therefore, the leader of the REX became a soldier on the Eastern Front and reorganised the party into a party that specifically focused on the recruitment of collaborators. In 1943, the REX changed its name into the 'Greater-German Nazi Party of the Germanic Walloons' (De Wever, 2007). Also the leader of the Socialists, Hendrik De Man collaborated already in 1940 with the Germans (Huyse & Dhondt, 2007).

During the war, the Belgian Ministers which stayed in London from 1940 onwards, tried to suppress the collaborations with the Nazis by establishing (amongst others) the laws of 22 March 1940[75] and 17 December 1942. The law of 1940 prohibitted Belgians to perform propaganda or any other activity in Belgium or abroad that jeopardized the Belgian independence (Belgisch Staatsblad, 1940). The law described that political, economic and military collaborations with the enemy were forbidden. Additionally, this law indicated that carrying out tasks for Germany (e.g. transport, guardianship weapons) or the passing on of information to Germany was forbidden. Punishments went from the death penalty to large monetary penalties. Because different types of collaborations were now defined by law, hundreds of thousands of Belgians were guilty. The Court and judges were put in a difficult position as many collaborators were found guilty with the death penalty (Huyse & Dhondt, 2007). The whole procedure went laborious and chaotic. In the last year of WWII, a movement saw the light that agreed with the view of the Belgian Ministry. This movement evolved under lead of the left-wing Communists and had many conflicts with the collaborators causing often small civil wars (Van den Wijngaert et al., 2006).

In meanwhile, besides the previous REX and the FNL, the powerful Catholic party impressed the German occupiers as this party contained an extended network of schools, youth movements, organisations and institutions. Germany decided not to disturb the daily life of the Catholics in order to maintain order. Hence, the church also refused any collaborations and wanted to preserve the Catholic institutions as much as possible without any interference of the occupier (Maerten, Selleslagh, & Van den Wijngaert, 1999).

5.4.4.2 Economy

Belgium knew a similar economic recession during WWII as during WWI. This already started from the moment that Germany invaded Poland on 1 September 1939. Belgium responded immediately to this act and mobilised 500,000 man. This meant that these workers were taken from the economic system and 'waited' a half year on the invasion of the German forces on 10 May 1940 (Van den Wijngaert et al., 2006).

After the German invasion in Belgium - as similarly executed in the years before WWI - the National Bank transported money and printing plates from Brussels to South-France. This led to a similar shortage of money compared to WWI. Additionally, the Belgian economy was influenced by German rules. People had to hand in material and food which led to famine and also huge war taxes were imposed. Because of the bad economic conditions in Belgium, Germany saw the opportunity to offer the Belgians work in the German empire in exchange for good living conditions in Germany with food and houses. This proposal would led to a reduction in the number of employees in Belgium and consequently would cause an even more economic recession (Van den Wijngaert et al., 2006). However, the Belgian Government tried to sabotage their plans by establishing the Law of 10 April 1941[76]. This law obligated Belgian civilians to have any economic relations with Germany (Belgisch Staatsblad, 1941).

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[75] Or '*Wet betreffende de verdediging van de nationale instellingen'* (Law on the defence of national institutions) (Belgisch Staatsblad, 1940).

[76] Or '*Besluitwet betreffende het verbod van economische betrekkingen met den vijand'* (Decision law on the prohibition of economic relations with the enemy) (Belgisch Staatsblad, 1941).

Yet, in contrast to the previous established law, occupied Belgium was prepared to cooperate with Germany to avoid an economic collapse as experienced during WWI (see previous). In agreement with Germany, Belgian representatives (presidents of the national bank and an important investment company), restarted the National Bank in Brussels to overcome the shortfall of money. Additionally, Germany provided food for the Belgians in exchange for the export of raw materials to Germany. A 'positive' event for the Belgian economy was the intake of France by the German forces. This event prevented a shutdown of the import of raw materials coming from France and Spain (Van den Wijngaert et al., 2006).

However, the quantities of imported products were not as much as before the war which resulted in a bad running steel industry and an even worse running textile industry. Also the promised food from Germany was beyond expectations. Moreover, Belgium was exploited by Germany as they exported without notice a wide range of Belgian products to Germany. Also more money was printed in the National Bank to provide enough money for the Belgians that had to pay the high war taxes. The latter could lead to a deflation of the economy (Van den Wijngaert et al., 2006). Moreover, a part of the Belgium people were obligated to work in Germany from 1942 onwards (Bostyn et al., 2014).

5.4.4.3 Socio-cultural

5.4.4.3.1 Evolution WWI tourism

From 1940 onwards, WWI tourism changed. In general, the number of tourists declined significantly due to the German occupation. It took until 1960 before the number of tourists reached the same amount as before WWII (Miles, 2016b). Noteworthy, the German occupiers organised guided visits to the former WWI front region as a way to practise Nazi propaganda (Debaeke, 2013; Gordon, 1998).

5.4.4.3.2 Castle parks

During WWII, Flemish castle domains were occupied and exploited by Germany. In the castle park of Zonnebeke and Geluveld for instance, wood was used to make infrastructure such as weapons, tents and as camouflage for cars or artillery. In these parks, also hunts were organised. The castle park of Kemmel was damaged by unprecedented people – probably locals - who cut down the trees. One castle domain in the Palingbeek (south of Ypres) was completely devastated by the building of trenches and by the impact of projectiles during a battle in May 1940 (Heyde et al., 2015).

5.4.4.3.3 Protections WWI heritage

The first steps to protect WWI remains were taken during WWII. The first protection was the protection of the Newfoundland Memorial and its surrounding area in 1942 as a cultural and historical landscape. This Memorial is located in the hinterland of WWI nearby the city Kortrijk, southeast of Ypres near to the French border. The Memorial was installed on the location where the Newfoundland's regiment crossed the river the Leie during the liberation offensive in October 1918 (Agentschap Onroerend Erfgoed, 2018e).

Later in 1943, the German empire took initiative during the occupation of Flanders to preserve the '*Studentenfriedhof*' (student cemetery) in the village Langemark, north of Ypres. This cemetery was well-known amongst the Germans forces because a myth existed that had been started during the First Battle of Ypres (1914). The myth argued that very young German soldiers had broken the first Allied battle lines west of Langemark. This story was during WWI quickly published in the German press and was believed to be true. This message was clearly propaganda. However, the opposite happened and a huge number of German young soldiers lost the battle. These soldiers were sometimes younger than 16 years. Their graves are located on the student cemetery. Because of the

myth, this cemetery was still important for Germany during the WWII and was used (again) as propaganda. However, the Belgian government did discarded this protection attempt after WWII with the Decree Law of 11 December 1945 (Agentschap Onroerend Erfgoed, 2018b; Himpe, 2018) for the reason that the protection was an example of an fascist and nationalist move[77].

5.4.5 Post-WWII: 1945-today

5.4.5.1 Policy

5.4.5.1.1 Reconstruction policy after WWII

After WWII, approximately 300,000 new houses were needed. During 1945-1948, the government started the reconstruction by establishing a housing programme for miners, establishing measurements to stimulate constructions for war victims and by protecting civilians against high rents. Also a new law was needed that regulated the amount of war compensation for victims. The regulations went laborious and only in 1947 an agreement had been reached. Civilians that took the initiative to reconstruct their houses received a compensation for this[78]. Small houses received a full compensation and larger buildings a smaller compensation. The private reconstruction projects undertaken by the residents themselves were not sufficient enough to compensate the housing shortage. Therefore, collective housing programs called the '*nationale werven*' (National Building sites) were established. The government built a series of houses on land purchased by them in the most affected regions (e.g. Ghent, Waver, Mons and Malmédy)[79]. Later on, the first law (August 1948) was drawn up that tackled the housing shortage by providing building materials. This was regulated by the Ministry of Reconstruction with the communist Minister Jean Terfve and the Catholic Minister Robert De Man as organisers. The Ministry provided building materials and technical and administrative advice (Floré, 2011).

5.4.5.1.2 Belgium collaborators supressed

By the end of WWII, the Belgian government came back to the fatherland and suppressed the anti-nationalistic parties (REX and FNL) and other collaborators. Between 1944 and 1949, 400,000 files of collaborators were opened. Other Belgians lost their political and civil rights for lifetime. The leaders of the REX and VNV were sentenced to death. Later on, the punishment was transformed into a life sentence. Some followers of the Flemish resistance escaped the punishments as they fled to Germany. In the following years, the repression law of Belgium collaborators changed and less collaborators were convicted. They obtained a pardon from the nation for their behaviour during WWII or got conditionally freedom from prison such as the leader of the FNL.

Because of the fall of the Flemish-nationalism, the collaboration of the socialist leader Hendrik De Man and the successes of the resistance in the last year of WWII (under lead of the Communists), the Belgian Communist Party of Belgium (KPB) gained popularity. Due to the misstep of Hendrik De Man,

[77] For more information about the other three German cemeteries in Flanders, see Freytag & Driessche, 2011.
[78] For an extended overview of the WWII archives with the associated damage files, see Tallier (2012).
[79] For more information about the locations, architecture and designs of these sites, see Floré (2011).

the Socialist Party had to reform in order to regain the confidence of the Belgians. The name of the Belgian Workman's party (BWP) was replaced by the Belgian Socialist Party (BSP). Catholics also reformed by introducing younger policy members in the op Catholic Party. They started the '*Katholieke Volkspartij (CVP)'* (Catholic People's Party) (Van den Wijngaert et al., 2006).

5.4.5.1.3 Politics and the impact on the landscape during the Cold War

In the post-WWII period, the third war of the century began: The Cold War (1947-1991). This war had an impact on the policy in Belgium. Political elections were held for the first time again in 1946. The CVO and BSP were elected to the largest parties. Despite the fact that the communists (KPB) were also very popular during these elections, they were excluded from the government in 1947 because Communists were regarded as enemies of the country because of the Cold War (Van den Wijngaert et al., 2006).

In the study areas, the landscape during the Cold war did only physically changed by the building of one specific bunker: The Kemmel bunker. This bunker was built underground by initiative of France, Great-Britain, Belgium, The Netherlands and Luxemburg to provide an air defence system during the Cold War against the Soviet Union. It would serve as a commando bunker. From 2009 onwards, a museum of the Cold War has been set up in this bunker (Bostyn et al., 2014).

5.4.5.1.4 A federal state

After many years of cultural and political agitation mainly induced by Flemish activists, Belgium evolved into a federal state between 1970 and 1993 through five state reforms. This meant the subdivision of Belgium into three regions (The Flemish region, The Walloon region and the Flemish and Walloon region in Brussels) where the demand for autonomy in the economy was the main driver of the subdivision. Also three separate communities were established based on the culture and language: The Flemish Community, the French Community and the German-speaking Community. Each community and region has specific authorities. This subdivision was a compromise for the ongoing cultural, geographical and political differences between French- and Flemish speaking Flanders (Belgische Federale Overheidsdiensten, 2019; Shelby, 2014).

5.4.5.1.5 A half of a century of WWI heritage protections

Initiatives to protect WWI heritage steadily became into progress after WWII and can be subdivided into four phases whereby each phase is characterized by a specific incentive for the conducted protections. These protections entail both the protections of heritage directly linked to WWI (e.g. military constructions, monuments, cemeteries and ruins), and heritage protections linked with the reconstruction period (e.g. rebuilt houses or churches in a particular architecture style).

5.4.5.1.5.1 Phase one (end WWII – 1980): A slow start

In this phase, only one protection of WWI heritage was made[80]. The war site Oud-Stuivekenskerke was protected in 1959 as a landscape according to the Law of Monuments and Landscapes established in 1931. This site entails the ruins of the church and the chapel and a red granite stone (Himpe, 2018). The latter symbolizes the place where the German army in 1914 was stopped (cf. demarcation stone) (Bogaert & Decoodt, 2003).

Also in this phase, the '*Bestuur van de stedenbouw en ruimtelijke ordening'* (Governance of urban and spatial planning) wanted to raise awareness that more landscapes than the before already protected landscapes by the KCML[81], also deserved protection and care. Therefore, the governance published an inventory of valuable landscapes in 1963 to promote their ideas. In this inventory, the emphasis was put on the one hand on landscapes in the countryside and also on the other hand on monuments in cities and their related surroundings. They appointed the latter landscape in the inventory as a '*stadsbeeld van de heropgebouwde stad'* (cityscape of the rebuilt city) having an esthetic, touristic and historical value. Examples in the inventory are the WWI rebuilt city centers of Ypres, Nieuwpoort and Diksmuide (Kesteloot, 1963). This example shows that the interest in monuments and the associated surroundings steadily grew by which both heritage types were seen as a 'whole' that strengthened each other values (Stynen & Draye, 1989).

Notably, this type of heritage (cf. cityscape and surroundings) was already officially recognised as a heritage 'type' following the new established Law of 1954 (9 April 1954)[82] which confirmed that a cityscape is also a landscape by describing that a landscape can also be seen as a work of man. Hence, these were only recognised as a heritage type but were still appointed as a protected landscape; this following the Law of Monuments and Landscapes of 1931. In 1976, the new Decree of Monuments (3 March 1976)[83] provided a new instrument for this type of heritage. In this first Flemish Decree[84] tackling heritage, the previous described heritage was officially introduced as '*stads- en dorpsgezicht'* (city and village view) and was defined as a group of one or more monuments with the associated surroundings[85]. The already protected landscapes according to the Law of Monuments and Landscapes of 1931, could be reformulated by request into the newly

[80] Also other protections happened of landscapes and monuments besides the WWI heritage. In total 889 landscapes and 2,932 monuments were protected in Flanders between 1931-1980 (Rosiers et al.,1990).
[81] This includes also landscapes that are not related with WWI.
[82] Or '*Koninklijk Besluit betreffende de leden van de Koninklijke Commissie voor Monumenten en Landschappen, die aangesteld worden om de uitvoering van sommige werken, bedoeld in de wet van 7 Augustus 1931 op het behoud van monumenten en landschappen, te volgen'* (Royal decision concerning the members of the Royal Commission for Monuments and Sites who are appointed to monitor the execution of certain works referred to in the law of 7 August 1931 on the conservation of monuments and landscapes) (Belgisch Staatsblad, 1954).
[83] Or '*Decreet tot bescherming van monumenten en stads- en dorpsgezichten'* (Decree on the protection of monuments and city and village views) (Belgisch Staatsblad, 1976).
[84] The federalisation started in 1970 dividing Belgium in Flanders, Brussels end Walloon Region (Belgische Federale Overheidsdiensten, 2019; Shelby, 2014).
[85] More extensively seen it can entail a group of one or more monuments and/or immovable properties with the surrounding elements such as plants, fences, waterways, bridges, roads, streets, squares. Also the direct connected visible environment that reinforces the monument can be a part of this type of heritage (Belgisch Staatsblad, 1976).

established statute of a '*stads- en dorpsgezicht'*. These were inventoried by a collaboration between the department of '*stads- en dorpsgezichten'* of the KCML and the owners of the heritage with the aim of protecting these later on (Belgisch Staatsblad, 1954). Notably, a '*stads- en dorpsgezicht'* can be seen as one 'type' of landscape heritage. However, the new Decree handles only this 'type' and no other forms of landscape heritage such as for instance heritage landscapes in the countryside. For all the other types of landscape heritage, the protection law of Monuments and Landscapes of 1931 was still followed.

Besides the topic of '*stads- en dorpsgezicht'*, the Decree of 1976 established also a formal inventory of architectural heritage which listed buildings with an architectural value. New architectural heritage could be inventoried by a collaboration between the KCML and owners of these buildings, with also the aim of protecting these later on (Belgisch Staatsblad, 1976). Notably, inventoried monuments and '*stads- en dorpsgezichten'* that were not protected did not have any attached legal conservation conditions until the law of 27 March 2009 (see further).

5.4.5.1.5.2 Phase two (1980 – 2002): Many initiatives

During the second phase (after 1980 - beginning of the 21th century), many diverse initiatives for the protection of WWI heritage were made in the light of the increased interest in WWI:

- The first initiative occurred in the years after 1980 and included the protections of monuments with an outstanding value. The following examples were protected in the studied areas: The Menin Gate (1986), the British military cemetery Bedford House in Zillebeke (2002) and the British cemetery Tyne Cot in Passendale (2003) (Agentschap Onroerend Erfgoed, 2018a, 2018d, 2019i).

- In 1992, a second initiative came from the Province of West-Flanders which proposed a list of WWI monuments to be protected. This entailed amongst others, some of the proposed '*sites de guerre'* (war sites) from 1922 (see previous) (Himpe, 2018). The following examples from the list were protected in the studied areas: WWI landscapes in Sanctuary Wood (1992), Lankhof Farm in Zillebeke (1992) and the Spanbroekmolentrechter or Pool of Peace in Wijtschate (1992) (Agentschap Onroerend Erfgoed, 2019j, 2019e, 2019f).

- Third, threatened WWI sites were also protected such as the dugout Bremen Redoubt in Zonnebeke (1994). However, the protection has been cancelled due to its physical decay. Later, the dugout collapsed (2000) and was reconstructed in a museum (Braeken, 2011; Himpe, 2018).

- Fourth, random (re)development projects in the context of tourism initiated the protection of WWI sites such as the protection of the German trenches Bayernwald in Wijtschate (2001). This site has been fully developed to tell the story of a German soldier on the frontline (Agentschap Onroerend Erfgoed, 2019g; Himpe, 2018; Netwerk Oorlog en Vrede in de Westhoek, 2013).

- Fifth, initiatives were made to identify the constructions from the reconstruction period as heritage. The University of Leuven performed this initiative and researched and revaluated this subject extensively. Results of the research were presented in an exhibition 'Resurgam: The Belgian reconstruction after 1914' (1985). The information obtained was used to add new buildings from this period to the Inventory of Architectural Heritage (1976) or to add additional information to the buildings already on the list. Added buildings of the reconstruction period for the district of Ypres were made public between 1987-1991 and

were based on the results of this exhibition. However, only very exceptional buildings were listed in the inventory (e.g. church of Zonnebeke designed by architect Hoste). The list did not (yet) entail all aspects of the reconstruction period. Later, the government broadened their view and did not only focus anymore on exceptional buildings but focused also more on ensembles of reconstruction heritage that became a part of a '*stads- of dorpsgezicht'* (Braeken, 2011; Duvosquel et al., 1985).

In this phase, new legislative developments took place. All the previous discussed protection initiatives from before (and after) 1996 which were seen as a heritage landscape, had to follow from this year onwards the new established Decree of Landscape Care (16 April 1996)[86]. This law is the first Flemish Decree that handled besides the official procedure for the protection of previously defined '*stads- en dorpsgezicht'* by the Law of Monuments of 1976, also the protection procedure of other Flemish landscape 'types'. Additionally, this law clearly defined the concept 'landscape'[87] (Belgisch Staatsblad, 1996).

In 2001, an important adjustment of this Decree took place (21 December 2001), which launched a new inventory of landscapes including the traditional landscapes in Flanders. This atlas was introduced as the *landschapsatlas*[88] (atlas of landscapes) and was the result of a research that already started in 1995 (Van Eetvelde & Antrop, 2011). These traditional landscapes are witnesses of the past culture in Flanders. This atlas was going to be used to achieve a better landscape management and planning whereby the Government provided financial support. Hence, no juridical consequences were imposed for the landscapes included in this atlas (21 December 2001)[89]. Several 'types' of landscapes or elements of it with value were defined in this atlas: *ankerplaats*[90] (anchor place), relic zone (e.g. traditional fields), point relics (e.g. old tree) and line relics (e.g. Romanic road). Anchor places are the most valuable landscapes in Flanders (Antrop, 2007; Hofkens & Roossens, 2011). This atlas defined besides WWI landscapes (e.g. battlefield Bellewaerde) also separate WWI relics (e.g. military cemeteries) (Agentschap Onroerend Erfgoed, 2001).

The following Decree of 2004 (13 February 2004)[91] adapted the Decree of 2001 and was established in the light of the European Landscape Convention that aimed the conservation of landscapes by an integrated landscape policy (Council of Europe, 2000b). This Decree introduced the new concept

[86] Or '*Decreet betreffende de landschapszorg'* (Decree on landscape conservation) (Belgisch Staatsblad, 1996).
[87] Definition of the landscape: "A limited land area with low building density and interconnectedness and of which the appearance and coherence are the result of natural processes and societal developments" (Belgisch Staatsblad, 1996).
[88] More details of this landscape atlas will be discussed later.
[89] Or '*Decreet tot wijziging van het decreet van 16 april 1996 houdende bescherming van landschappen'* (Vlaams Parlement, 2001).
[90] Complete definition of an '*ankerplaats'*: "The most valuable landscape sites consisting of complexes of varied heritage elements that form a whole or an ensemble. They are exceptional in terms of integrity or representativeness and occupy a spatial position that is important for the care or restoration of the landscape environment" (Hofkens & Roossens, 2001, p. 29).
[91] Or '*Decreet houdende maatregelen tot behoud van erfgoedlandschappen'* (Belgisch Staatsblad, 2004)

'*erfgoedlandschap'*[92] (heritage landscape) which is an '*ankerplaats'* (anchor place) or a part of it. With this Decree, '*ankerplaatsen'* were not anymore only appointed as valuable landscapes but are now also juridical implemented into the Flemish spatial policy as an extra way to protect landscapes besides the basic protection Decree of Landscapes (16 April 1996) (Belgisch Staatsblad, 2004; Van Eetvelde & Antrop, 2011). When a *'ankerplaats'* becomes completely or partly '*aangeduid*' (designated) by the Flemish government - first temporal and afterwards definitive – it becomes legally of spatial importance in all the spatial implementation plans ('*ruimtelijke uitvoeringsplannen'*). When the '*ankerplaats'* is implemented in these plans it is not called anymore an '*ankerplaats'* but an '*erfgoedlandschap'*. '*Ankerplaatsen'* as the most valuable landscapes in Flanders, obtain with this law priority in spatial plans (Van Eetvelde & Antrop, 2011).

Also in this phase, the protection of archaeological patrimony was for the first time legally described by the Decree of 30 June 1993[93]. Following this Decree, an inventory was introduced consisting of zones with archaeological value (Belgisch Staatsblad, 1993). Recently, the battlefields of Bellewaerde (east of Ypres) were added to this list as archaeological heritage (Agentschap Onroerend Erfgoed, 2019a).

5.4.5.1.5.3 Phase three (2002-2006): The inventory

The third phase was initiated by the government which made an inventory of all WWI heritage (2002 – 2006) in West-Flanders. This inventory was drawn up to prepare the application for UNESCO heritage that handled specifically WWI heritage in the Province of West-Flanders and North-France (see further). Additionally, this inventory was used as a policy instrument in several (re)development projects (Braeken, 2011). For instance, the project '*Oorlog en Vrede in de Westhoek (2008-2013)*' wanted to set up a spatial plan for touristic purposes and had also the protection of WWI heritage as an objective. These protections were specifically based on the new established inventory of WWI heritage (see more information about this project further on) (Netwerk Oorlog en Vrede in de Westhoek, 2013).

[92] Full definition of '*erfgoedlandschap*': "*Ankerplaats* or part of an *ankerplaats* designated in the spatial implementation plans or the construction plans, in accordance with the procedures of the Flemish Spatial Planning Code (*Codex Ruimtelijke Ordening*)" (Belgisch Staatsblad, 2004).
[93] Or '*Decreet houdende bescherming van het archeologisch patrimonium'* (Belgisch Staatsblad, 1993).

5.4.5.1.5.4 Phase four (from 2006 onwards)

In phase four, thematic protections were mainly carried out across Flanders which followed the Decree of Monuments (1976) and the Decree of Landscapes (2004). The selection of WWI heritage in the Province of West-Flanders was based on the previous established WWI inventory (2002-2006). Some examples of thematic protections are protections of military cemeteries (162 protections) or protections of bunkers and shelters (175 protections) (Decoodt, 2007, 2014; Himpe, 2018). Also heritage of the reconstruction period such as the 'temporary' barracks built with the King Albert Fund (KAF) were thematically protected (Agentschap Onroerend Erfgoed, 2017a). An example of a protected barrack in the study area can be found in Ypres. This barrack was built in 1919 in the Slachthuisstraat and has a wooden frame which was filled with bricks. It was built to provide a 'temporary' house (Figure 5-22) (Agentschap Onroerend Erfgoed, 2018f; Dendooven & Dewilde, 1999).

Figure 5-22 Temporary' barrack built in 1919, Slachthuisstraat, Ypres (Agentschap Onroerend Erfgoed, 2018f)

In 2010, research was conducted in several WWI landscape sites after which 26 remembrance sites were selected and spatially defined. These sites were mainly focused on the former battle field, notable visual axes and archaeological values (Himpe, 2018; Verboven, 2012). To investigate the archaeological value of the sites, several '*proefsleuve*n' (tests slots) were dug on 18 places in the landscape (Figure 5-23) to reveal the preservations conditions and the amount of preserved WWI heritage and artefacts. The location of these was determined on the basis of information from historical maps and aerial photographs. *Bellewaerde* farm and the *Palingbeek* were two examples of researched sites (Agentschap Onroerend Erfgoed, 2014). The intention of studying these sites was to protect them later on (Himpe, 2018; Verboven, 2012).

Notably, these 26 selected WWI remembrance sites were implemented in the atlas of landscapes which was established in 2001 (see previous). The already selected WWI sites in the atlas received much recognition, but no attention was given to the mutual spatial delimitation of the sites. Therefore, after the extra conducted research from 2010 onwards, several defined WWI sites in the landscape atlas were now in the atlas clustered into one site. Moreover, also new WWI sites were added in the atlas such as the battlefield of Passendale (Zonnebeke) and the battlefield of Pilkem Ridge (Ypres). In this phase, the WWI landscapes in the landscape atlas are after a legal procedure

officially recognised as *erfgoedlandschappen* (heritage landscapes), which means these are implemented in spatial plans (Himpe, 2018).

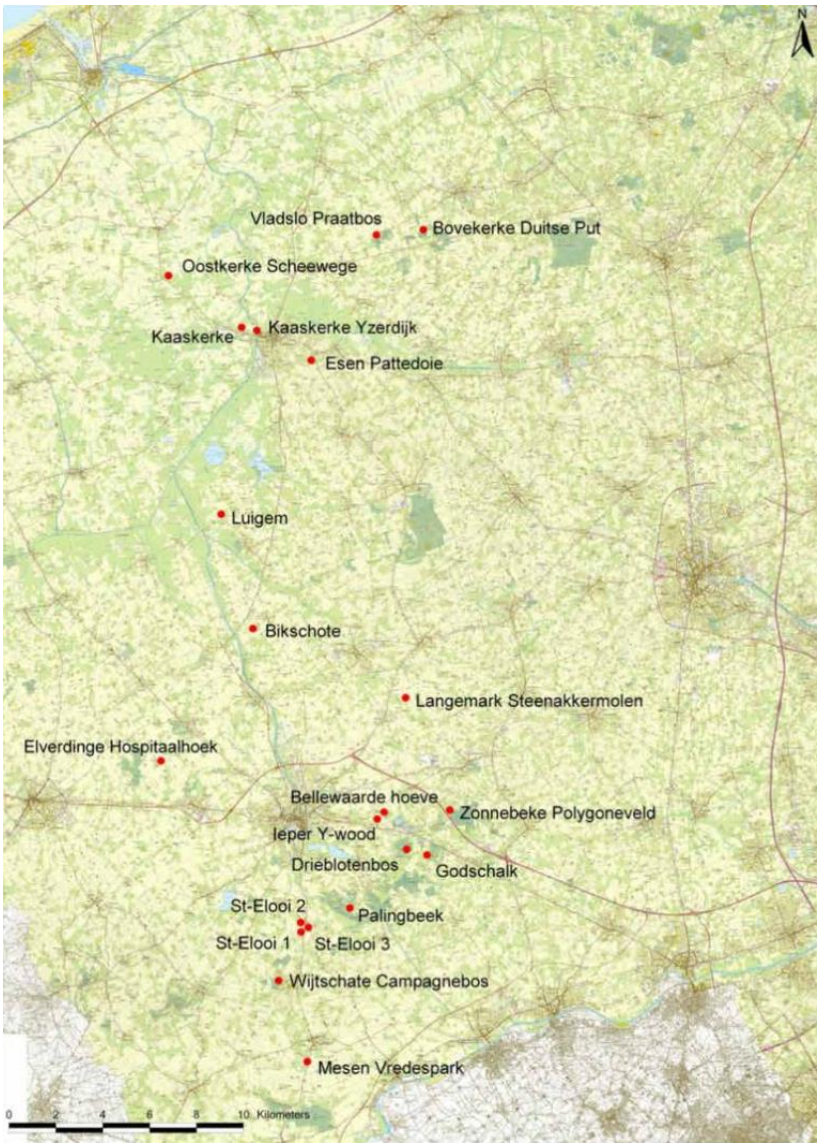

Figure 5-23 Location test slots of WWI sites (Agentschap Onroerend Erfgoed, 2014)

In this phase, the law changed again with the introduction of the Decree of Immovable Heritage (12 July 2013)[94]. This decree collected and organised the information of previous established Belgian and Flemish decrees: Decree of Monuments and Landscapes (1931), Decree of Monuments (1976), Decree of Archaeology (1993) and the Decree of Landscapes (1996) (Agentschap Onroerend Erfgoed, 2019b).

[94] Or '*Decreet betreffende het onroerend erfgoed*' (Decree on Immovable Heritage) (Belgisch Staatsblad, 2013).

Additional elements were also added to this Decree. First, from 2013 onwards all the heritage items in the previous established inventories such as the Atlas of Landscapes (2001) and the Inventory of Architectural Heritage (1976), could be '*vastgesteld'* (fixed) after scientific and public research. Once it had been '*vastgesteld*', the heritage had legal requirements. Second, it was no longer possible to '*aanduiden'* (designate) an '*ankerplaats'* from the Atlas of Landscapes following the adapted law of 2004, this to recognise these as '*erfgoedlandschap'* in spatial plans. These could only be '*vastgesteld'* (fixed) as all the other heritage items on the lists. Previously already designated '*ankerplaatsen'* prior to 2015, were automatically assimilated as fixed '*ankerplaatsen'*. Hence, '*ankerplaatsen'* could still be implemented in spatial plans by a new established system. All the already '*aangeduid*e' (designated) '*ankerplaatsen'* prior to 2013, were equalized with a new concept of '*onroerenderfgoedplan'* (immovable heritage plan). This plan was used to spatially define the new concept of '*erfgoedlandschap'* (heritage landscapes) in spatial plans. Third, the KCML definitive disappeared and was replaced by the Flemish Commission for Immovable Heritage (Belgisch Staatsblad, 2013).

To conclude, many relics of WWI are protected and conserved today by the Flemish government '*Agentschap Onroerend Erfgoed'* (Agency of Immovable Heritage). WWI heritage can be conserved by several imposed legal instruments: '*invenstarissen'* (inventories), '*vastgestelde inventarissen'* (fixed inventories), '*beschermd'* (protected) or as '*erfgoedlandschap'* (heritage landscape).

5.4.5.1.6 Present-day international policy of WWI heritage

It is important to notice that the actions and Decrees of the Agency of Immovable Heritage are based on the international heritage partnerships with the Council of Europe, the European Union and UNESCO (Agentschap Onroerend Erfgoed, 2019c).

The first influence in the established heritage policy of Belgium comes from the '*Raad van Europa'* (Council of Europe). Belgium is a member of this Council amongst 46 other countries. The Council was founded in 1949 by Winston Churchill (former Prime Minister United Kingdom) and Paul-Henri Spaak (former Prime Minister Belgium) amongst others. It was founded to enforce human rights and cooperation between countries. A blue flag and 12 stars are the symbol of the Council and refer to the twelve first member states. The Council deals with three main themes: democracy, rule of law and human rights (e.g. children's rights, gender equality, abolition of death penalty, fight against racism, youth policy). The Council monitors the member states' progress in these themes and makes recommendations. To enhance democracy, the awareness of culture and cultural heritage is essential. This awareness helps people to respect identity and diversity and helps the mutual understanding between communities. This identity and diversity is reflected in landscapes as the landscape is our living natural and cultural heritage. With previous thoughts as incentives, the Council organised from 1949 onwards several conventions for the protection, management and planning of cultural heritage and landscapes, such as the Convention or the protection of architectural heritage (Granada, 1985), the Convention for the protection of archaeological heritage (Valletta, 1992), the Convention on the value of cultural heritage for society (Faro, 2005) and the European landscape Convention (Florence, 2000) (Directorate General of Democracy, 2019).

In light of the landscape Convention in Florence (2000), the States are recommended to implement the protection, management and planning of landscapes in the legal system. Hence, this implementation in the legal system is not obligated (Council of Europe Landscape Convention, 2019). Since this convention, the attention and interest for landscapes grew in many European countries. For Belgium, the European Landscape Convention was operative from February 2005 onwards (Antrop, 2007; Veerle Van Eetvelde & Antrop, 2011). The previous mentioned Flemish Landscape Atlas (one of the listed inventories), was seen as the first instrument that followed this landscape Convention (Van Eetvelde & Antrop, 2011). This Atlas was presented to the public in 2001 (see

previous) (Hofkens & Roossens, 2001). To implement more the directives of the landscape Convention in its content, the Atlas was recognised in 2004 as a policy instrument to enhance the integration of landscape policy in spatial policy. The anchor places were legally defined as the most valuable landscapes which were labelled as heritage landscapes from 2004 onwards (see previous) (Van Eetvelde & Antrop, 2011).

Also the Conventions of Faro (Council of Europe, 2005), Valetta (Council of Europe, 1992a), and Granada (Council of Europe, 1985), were implemented in the Flemish Decree of monuments, and archaeological and cultural heritage (Agentschap Onroerend Erfgoed, 2019c). An overview of the implemented cultural and heritage policy in Flanders can be found in the policy report of the European Heritage Network (HEREIN). This report indicates for instance that the protected '*stads- en dorpsgezicht*', the protected cultural historical landscapes and the protected archaeological sites (see previous), are related to the Conventions of Granada and Valletta (Council of Europe, 2019).

The second international influence in the heritage policy of Belgium comes from the European Union. The Union recommends an integrated approach for managing and protecting cultural heritage in Europe. The Union considers cultural heritage as a non-renewable source that enriches the individual lives of citizens. Therefore, cultural heritage is a strategic resource for a sustainable Europe (Agentschap Onroerend Erfgoed, 2019c; Council of the European Union, 2014; Europese Unie, 2014). The European Union assists the Member States in protection heritage. By doing so, they ensure that cultural heritage is not lost (European Union, 2007).

The third international influence comes from the United Nations Educational, Scientific and Cultural Organisation (UNESCO), established by the United Nations (UN). The Flemish Immovable Heritage Agency helps to conserve and protect Flemish sites on the world heritage list following the World Heritage convention of 1972 that entailed the protection of cultural and natural heritage over the world. Belgium only ratified this convention and its programme in 1996 (Agentschap Onroerend Erfgoed, 2019c; UNESCO, 1972). Since 2003, Flanders has a Flemish UNESCO commission whereof the Flemish Immovable Heritage Agency is a member off. This commission is subsidised by the Flemish government and promotes the UNESCO program in Flanders (Vlaamse Gemeenschap, 2003). The commission has several partners such as the non-governmental International Council on Monuments and Sites (ICOMOS) which handles the conservation of monuments and sites and gives advice to UNESCO (ICOMOS, 2019), and the non-governmental UNESCO Platform Flanders which is the contact point for more information about UNESCO (UNESCO platform Vlaanderen vzw, 2019). Belgium has 13 world heritage sites, whereof belfries (1999) and beguines (1998) (UNESCO, 2019).

In 2014, Belgium and France wanted to acknowledge WWI heritage as world heritage with an outstanding universal value. For this, a tentative list of WWI Heritage of the Western Front (cf. inventory list), had to be prepared to determine which elements on this list could be submitted to UNESCO for a nomination (Délégation permanente de la Belgique auprès de l'UNESCO, 2014). To prepare the tentative list, the Flemish agency of immovable heritage prepared a WWI inventory between 2002 and 2005 (see previous) which entails all the WWI heritage in the Province of West-Flanders. This was accomplished in partnership with the governance of the Province of West-Flanders. This list gives a complete overview of the wide range of WWI remains in the landscape. Many of these are protected and/or established in an inventory following the legal system. For instance is the Essex Farm Cemetery in Ypres both a protected monument and is also established in the list of architectural heritage (Figure 5-24) (Decoodt & Bogaert, 2005).

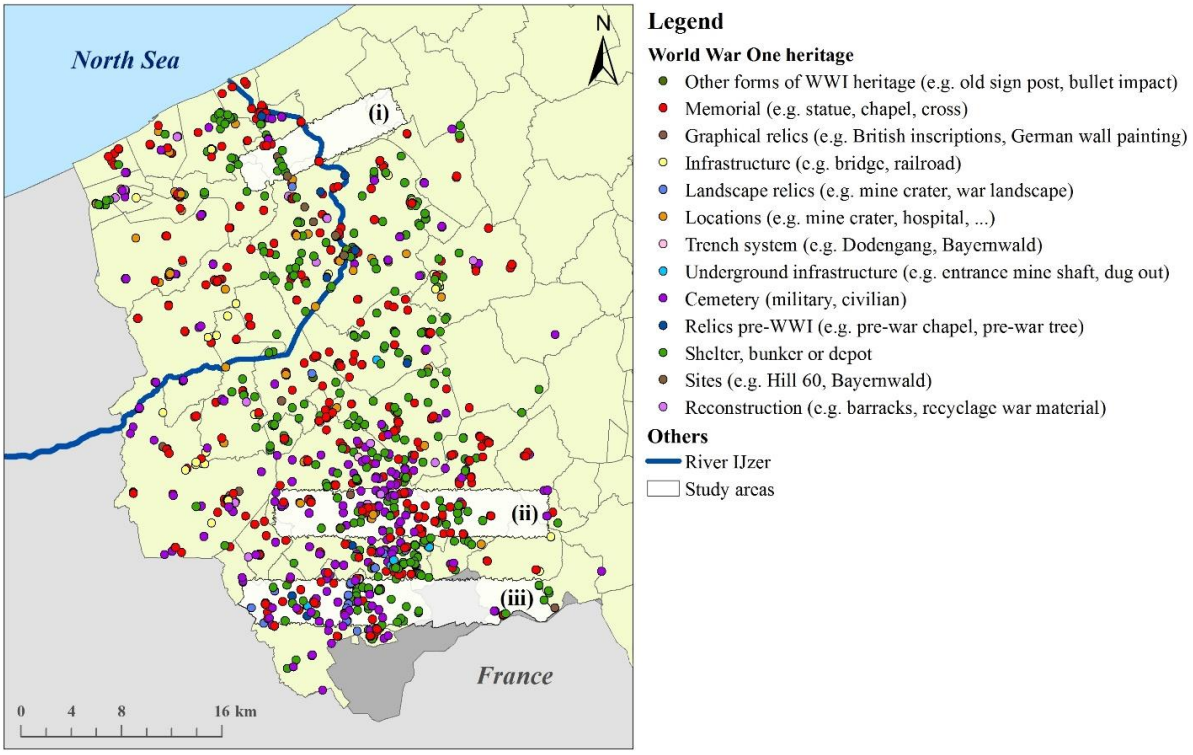

Figure 5-24 WWI heritage in the study area (adapted from Decoodt & Bogaert, 2005)

From this WWI inventory, sites were selected in Belgium for the tentative list "Funeral and memorial sites of the First World War (Western Front) (Belgium and France)" (Figure 5-25). Together with France, the list contained 105 carefully chosen WWI heritage which could afterwards be transformed into a nomination file (Délégation permanente de la Belgique auprès de l'UNESCO, 2014). After the nomination, the advisory committee of UNESCO (cf. ICOMOS) gave a negative advice for the recognition of WWI sites as world heritage. They found it difficult to recognise the heritage of a recent conflict as world heritage because the heritage is on the one hand still biased and on the other hand is the memory of the conflict still evolving. Post-conflict processes are still happening and may change the outstanding universal value on the moment of subscription on the world heritage list. When this conflict is compared with other conflicts that also lost many people and/or were executed around the world, the added value of the conflict its heritage is unclear and doubtful. ICOMOS advised the World Heritage Committee to investigate the recent conflict sites with experts in order to examine how these WWI sites fit in within the objectives and intentions of UNESCO. Because of this advice, additional information was added to the file and the content of the nomination was reformed by the stakeholders to defend their case (ICOMOS, 2018b, 2018a). Later that year, on the 42st session of the UNESCO World Heritage Committee (24 June - 4 July 2018, Bahrein), the final decision would then be taken. However, the committee did not acknowledge the WWI sites as world heritage by relying on the report of ICOMOS. The UNESCO Committee was concerned about related negative memories to the sites. Following the Committee, a comprehensive reflection is needed before the annual 44th session of the Heritage Committee in 2021, "whether and how sites associated with recent conflicts and other negative and divisive memories might relate to the purpose and scope of the World Heritage Convention and its Operational Guidelines" (World Heritage Committee, 2018a, p. 219). Belgium and France are advised to work together with experts to review this case (World Heritage Committee, 2018a, 2018b).

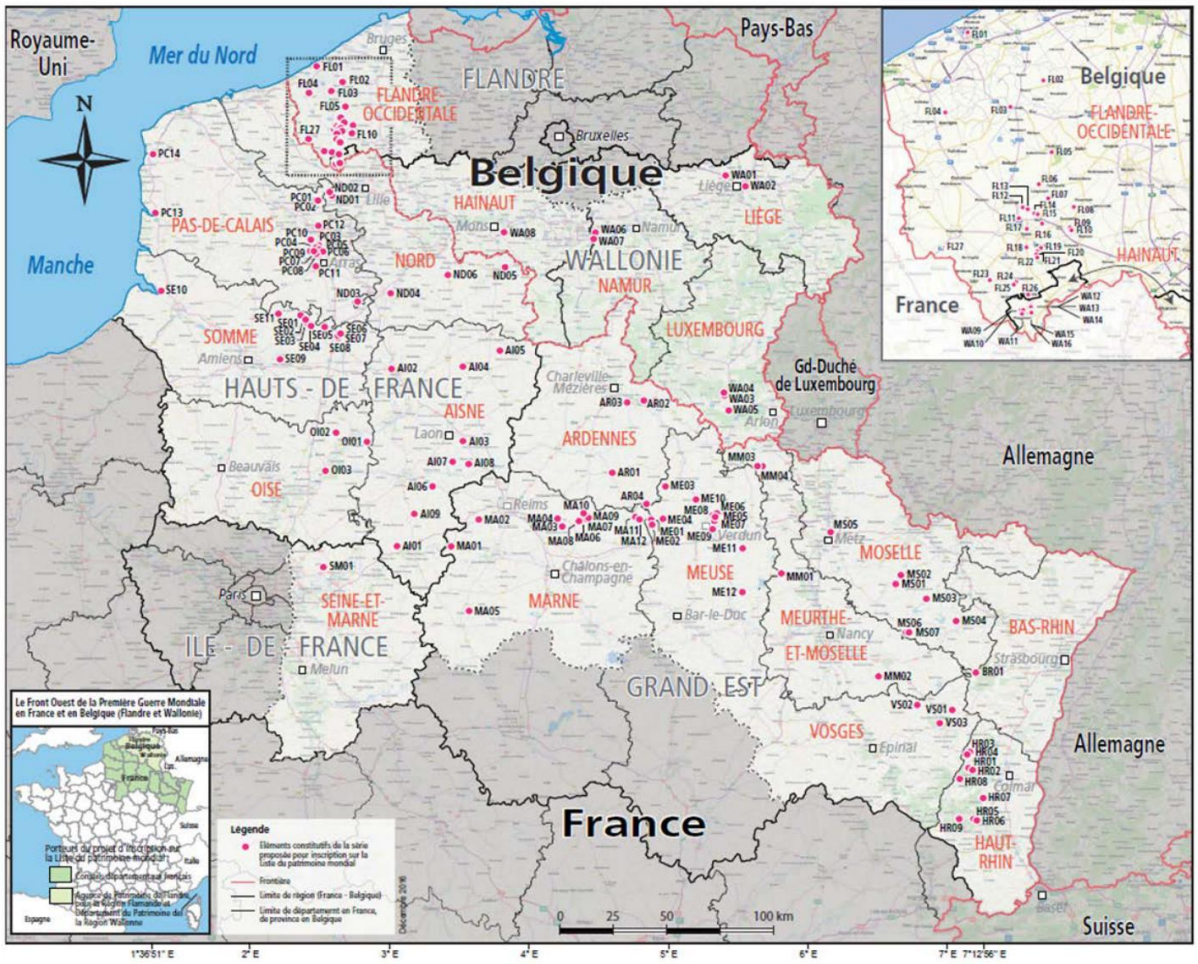

Figure 5-25 Locations of nominated WWI heritage (ICOMOS, 2018a)

Besides the UNESCO nominations, Belgium also contributed to the Convention of Den Haag in 1954 which included the protection of heritage in times of war (UNESCO, 1954) and the Convention of Paris in 1970 that forbid the trade of heritage (UNESCO, 1970).

5.4.5.1.7 WWII heritage

A new type of heritage is visible in the landscape of Flanders: WWII heritage and reconstruction buildings from the post-WWII period. For instance, shelters in the Panne were protected in 1962 as a landscape (Agentschap Onroerend Erfgoed, 2018g). Also a German battery in De Haan was protected in 1985 as a cityscape and village (Agentschap Onroerend Erfgoed, 2012). All other military constructions were later protected or inventoried in the beginning of the 21st century (Agentschap Onroerend Erfgoed, 2019d). For instance, the established statue in Heuvelland for the fallen of both wars was inventoried in 2002 and designated in 2011 (Agentschap Onroerend Erfgoed, 2003). Notably, some protections or the inclusions of it into an inventory were executed relatively 'early' after the end of WWII, compared with the time that was needed to recognise WWI constructions as heritage.

One might ask the question whether buildings of the reconstruction period after WWII (1945 – 1970) can be considered as heritage since these are not as old as a human lifetime. In general, some examples can be seen as heritage and others may not. Only reconstruction projects with outstanding architectural values are identified as post-WWII reconstruction buildings in the heritage list. An example of the post-WWII reconstructions in the Province of West-Flanders are the previous

mentioned established '*nationale werven'* (National building sites) by the government. These can be seen as witnesses of the WWII reconstruction period. These were in the 1980s inventoried as architectural heritage or are established in the inventory (Agentschap Onroerend Erfgoed, 2017b). However, no more heritage was inventoried which refers specifically to the WWII reconstruction period of West-Flanders. In other provinces, a few other examples are available such as a reconstructed house in the city of Antwerp which was inventoried in 2010 and protected since 2019 (Agentschap Onroerend Erfgoed, 2017d), and the residential area Malem in Ghent which was established for war victims and their families which was inventoried in 1983 and established in 2014 (Agentschap Onroerend Erfgoed, 2017c). Hence, most of the reconstructed buildings after WWII are not specifically seen as reconstruction heritage as they are building projects that followed a complete new era. These buildings were established in the light of the World Fair Expo in 1958 held in Brussels and are not specifically linked with WWII reconstruction projects (Braeken, 2011).

5.4.5.1.8 WWI munition and reconstruction

The '*Dienst voor Opruiming en Vernietiging van Ontploffingstuigen (DOVO)'* (Service for Cleaning and Destroying Explosive Equipment) is a military service of the Government (see previous) and is employed to clean up and destroy munition of WWI and WWII. For the *Westhoek*, the dismantling installations are positioned in the village Poelkapelle (Houthulst, northeast of Ypres). The soil in this area is still saturated with munition and can be seen as a "ticking time bomb under the Westhoek" following Marc Van Meirvenne, researcher of the University of Ghent (Nieuwsblad, 2015, p. 13).

The working area of this military station extents over the area of the Westhoek and Henegouwen. The rest of Belgium is under lead of the military station of Meerdaal or the Zeemacht. The military station or site in Poelkapelle is divided into several zones especially designed to dismantle the found ammunition step by step. The following buildings are present: an administrative building, a shed for the cleaning and labelling of collected ammunition of the area, a building for the dismantling of chemical ammunition and an active explosion zone for non-chemical ammunition. During WWI, each type of munition was painted in a specific colour and revealed the content inside. Different types of ammunition exist due to the fact that many nationalities have fought in the Westhoek. Each nationality developed a different technology (e.g. ignition head). Hence, the paint on each ammunition type (e.g. shells) completely disappeared after a period of 100 years, making the dismantling of ammunition dangerous. Therefore, the chemical dismantling building which serves for the dismantling of all chemical found munition in Belgium, is placed far away from other buildings and has thick walls of reinforced concrete. If farmers or other civilians find ammunition, firstly, they have to call the local police. If the police judges the ammunition to be dangerous, they call DOVO for the picking up and dismantling of the munition in Poelkapelle (personal visit DOVO, 2017). The help of DOVO is needed each day resulting in thousands of annual requests for the picking up of ammunition (Figure 5-26 and Figure 5-27). DOVO is convinced that the appearance of ammunition will certainly be a problem for the next 500 years due to very slow movements in the soil (cf. soil moves 1 mm each year) (personal visit DOVO, 2017).

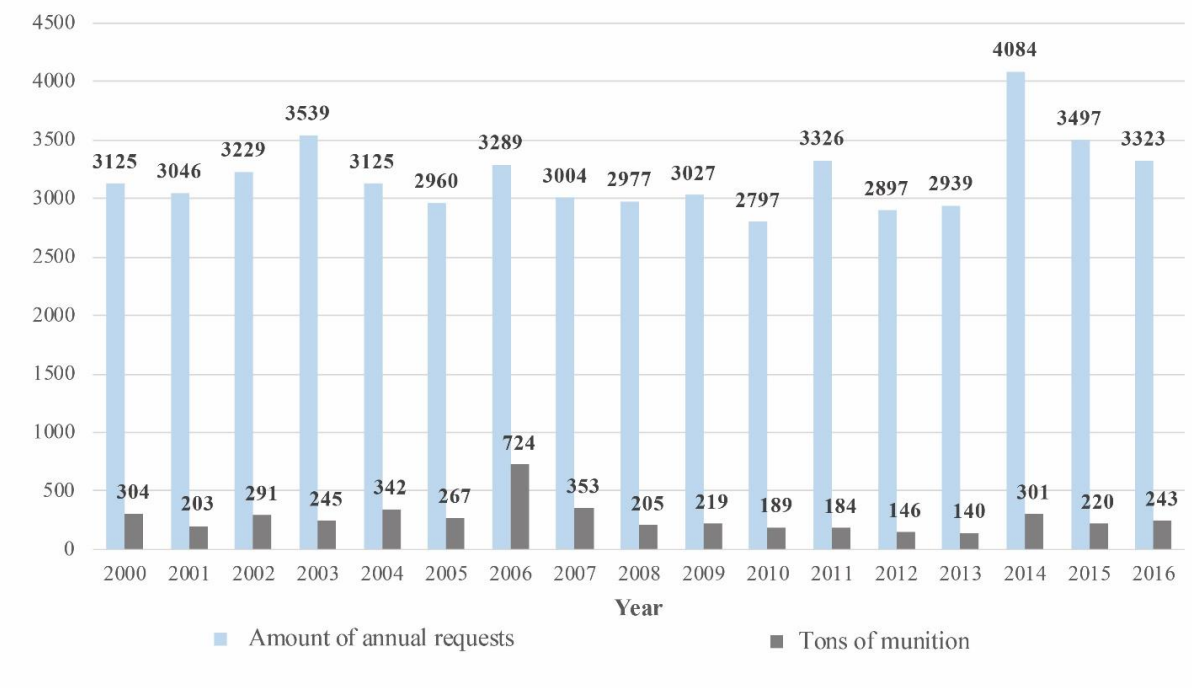

Figure 5-26 Inflow munitions: annual requests and collected tons (personal visit DOVO, Poelkappele, 2017)

Figure 5-27 Collected munition by DOVO (personal visit DOVO, Poelkapelle, 2017)

Also the rebuilding of the WWI devastated monuments was a project that lasted until the end of the century. The composed damage files after WWI were after WWII taken over by the in that period competent authorities (Tallier, 2012). For instance, the Lakenhallen in Ypres were further reconstructed after WWII and were afterwards reopened in 1967. Also the restauration of the *Ieperse vestingen* lasted until 1990, this with the budgets that were drawn up after WWI (Dendooven & Dewilde, 1999).

5.4.5.2 Economy

5.4.5.2.1 Economy after WWII

From September 1944 onwards, Belgium was liberated and could initiate the recovery of the economy. To avoid a badly running economy and a deflation several measurements were imposed.

The withdraw of the redundant money from the economy was carried out, by making the 100 BEF note (2.48 Euro) illegitimate (Van den Wijngaert et al., 2006). Also Ministerial Decisions were also developed such as the Ministerial Decision that induced a ration on meat (29 December 1944)[95], the Ministerial Decision that helped municipalities to recover the war destructions (22 December 1944)[96], the Ministerial Decision that regulated vegetables prices (30 December 1944)[97] and the Ministerial Decision that regulated an equal distribution of fertilizers in Flanders (30 December 1944)[98] (Belgisch Staatsblad, 1944a, 1944d, 1944c, 1944b). Additionally, imports of products were quickly restored as the harbour of Antwerp was undestroyed (Van den Wijngaert et al., 2006).

In summary, the economy was less damaged than after WWI because Belgium cooperated with the Germans and less grounds were destructed (Gaus, 1992). Belgium 'only' lost 8 % of the national wealth compared to the 18 % of loss after WWI (Bostyn et al., 2014). Therefore, Belgium recovered and evolved into a country with the BEF as the "Dollar of West-Europe" (Van den Wijngaert et al., 2006, p. 167). Hence, Europe and thus also Belgium, was economically seen less developed compared to the superpowers Soviet Union and the United States. The United States were able to develop its economy in the past decades as they gained a lot of money from the war industry during WWI and WWII (Bostyn et al., 2014).

From 1960 onwards, the agricultural economy changed because farms territories became bigger, the productivity increased (due to an increasing use of pesticides, machines and fertilization) and the agricultural policy of the European Economic Area (EEG) started. The latter decided from 1967 onwards that commercial prices for products needed to have the same price for all neighbouring countries of Belgium. Because of this system the farmers could not be unemployed anymore. However, the arranged prices were higher than in other countries in the world, making it not possible anymore to sell it abroad. The latter created for instance a 'Boterberg' ('mountain' of butter). As a solution, the government decided to limit the production in Belgium. Nevertheless, the economy in the 1960s was marked as the 'Golden sixties'. This era was induced because several laws were established enhancing the economic growth that attracted foreign capital. As a result, many multinationals were established in Belgium. Consequently, Belgium labourers could work in these companies (Gaus, 1992). Later in 1970, the agro-industry grew and processed various products from farmers. Fabrics of this industry gave farmers the opportunity to produce for them. In this way, they were not sensitive to over-production, however, in exchange they lost independence (Gaus, 1992).

5.4.5.2.2 Economic dimension of heritage

There are economic aspects linked to cultural heritage that are important for the local economy. This economic dimension can be divided into three main themes (Figure 5-28). First, the heritage has a

[95] Or '*Ministerieel besluit betreffende de rantsoeneering en de toebedeeling van vleesch'* (Belgisch Staatsblad, 1944a).
[96] Or '*Ministerieel besluit gemeenten als geteisterd door oorlogsgeweld te beschouwen voor wat de Staatstusschenkomst betreft in opruimings- en aanrazeeringswerken'* (Belgisch Staatsblad, 1944d)
[97] Or '*Ministerieel besluit houdende regeling der prijzen van cichoreiboonen en van verpakte cichorei'* (Belgisch Staatsblad, 1944c).
[98] Or '*Ministerieel besluit betreffende de verdeeling der stikstofmeststoffen, fosforzuurmeststoffen en potaschmeststoffen'* (Belgisch Staatsblad, 1944b).

functional component by providing space for residences or offices. Second, the heritage possesses a recreational aspect because of the attractive power of the heritage. Individuals intentionally move or travel to the place of the heritage for recreational purposes. From an economic point of view, this component can be divided into two aspects. On the one hand, direct touristic incomes are obtained by for instance requesting an amount of money to enter and visit the heritage, by organising events or by selling souvenirs. On the other hand, indirect touristic incomes are obtained by providing recreational facilities such as pubs and restaurants. To provide the tourists their comfort, the municipality can provide touristic infrastructure. A third component of the heritage anticipates on the society by 'being there' (cf. social component) for everyone as civilians can enjoy nice views and buildings (Rosiers et al., 1990).

To conclude, even though the landscape was completely devastated, the tourism afterwards upon today brought new economic opportunities which had an impact on regional developments (Miles, 2016b). The city of Ypres for instance, is completely economic orientated towards WWI. Some argue that "without the British tourists, the half of the city would be broke" (Gazet van Antwerpen, 2003, p. 10).

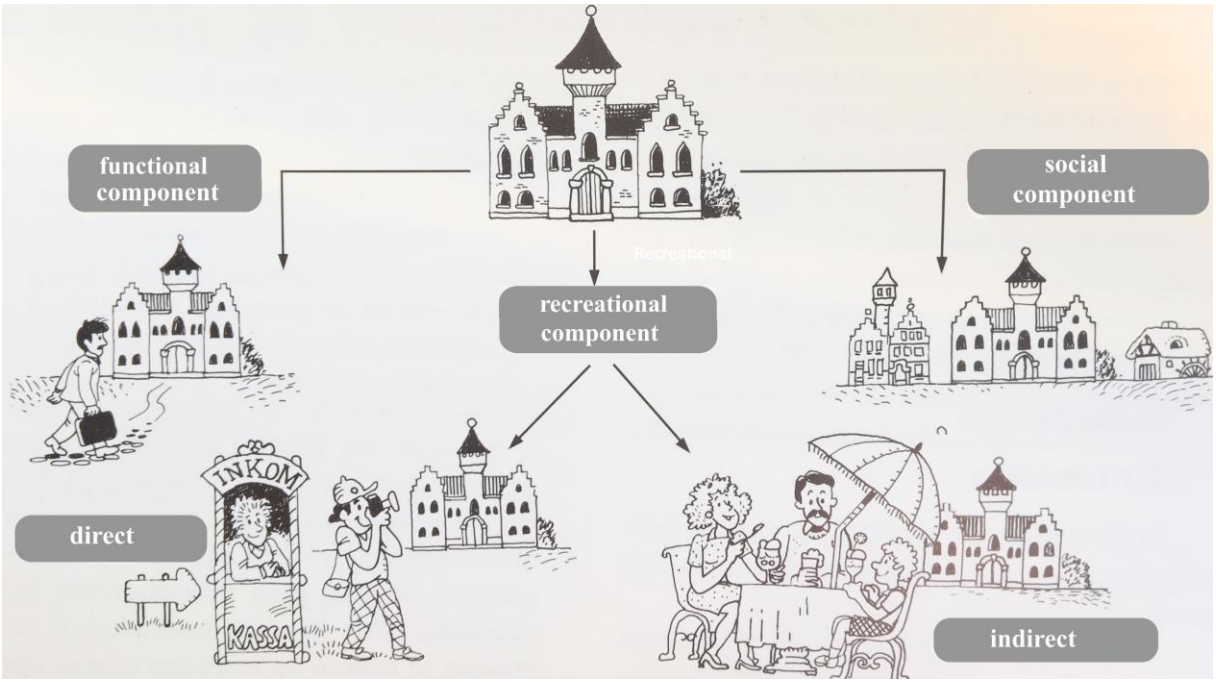

Figure 5-28 Economic components of heritage (adapted from Rosiers et al., 1990)

5.4.5.3 Socio-cultural

5.4.5.3.1 War tourism after WWII to a centenary pique

After the war, the Commonwealth tourism returned (Vanneste & Foote, 2013). In 1960s, several factors restarted the at full speed running tourism. This decennium, the 50th anniversary of the war shed new light on the commemoration and tourism. Hence, something changed in the way tourists commemorated the war as most of the WWI veterans died in this period (Walter, 1993). Consequently, the 'living' memories faded away and were replaced by cultural artefacts (Reynolds, 2013; Walter, 1993).Therefore, the emphasis was from now onwards put on historical interpretations instead of personal stories (Vanneste & Foote, 2013). From 1980 onwards, educational school trips were organised to Flanders and France. Also widows from fallen were subsidised by the UK to visit the graves (Walter, 1993). During the 1990s, several companies organised together a total amount of 200 different tours in Flanders and beyond. In this period, also

other factors made the tourism industry grow such as documentaries about WWI which made WWI the first “television war”. Also soldiers on retirement had more time to visit Flanders and many WWI books were published (Saunders, 2001, p. 45). Consequently, tourists numbers increased in the decennia after (Walter, 1993), and became “industrial in scale” (Miles, 2016b, p. 23).

The provincial government of West-Flanders also launched several activities related to WWI tourism. They organised the ’Exhibition for Silent Witnesses’ in 1964, published the book ‘In Pace, Soldiers cemeteries in Flanders’ in 1974, founded 25 memorial stones between 1984-1988 for King Albert I and the fallen, and launched an Irish Peace Village in Mesen in 1997. From then on, also many other initiatives were taken by other stakeholders or in cooperation with the provincial government. For instance, In Flanders Fields Museum opened its doors in 1998 which exhibited both the atrocities and the peace aspects of the war. In 1999, a travel guide was prepared that guided tourists around the city of Ypres. Also other museums opened the doors, such as the IJzertoren (Yser tower) which was reorganised in 1999. Later in 2000, the visitor’s centrum in ‘De Bergen’ in Kemmel and ‘Westoria’ in Diksmuide opened and both represented the theme of war and peace. In 2001, the site of the Pool of Peace was reorganised and was made more accessible to tourists. Also new touristic car and bicycle routes were launched to explore WWI in Flanders such as the Yser Front Route (74 km), the in Flanders Fields Route and the Route of Peace for Bicycles. To advertise previous initiatives and to guide tourists in the region, many touristic and educational brochures and publications were published (Dendooven & Dewilde, 1999; Oorlog en Vrede in de Westhoek, 2013). Such as the war memorial inventory ‘They, that felt as heroes…’ and the educational route for scholars ‘The reconstruction of Ypres, a walk’ were published to guide tourists (Dendooven & Dewilde, 1999; Jacobs, 1996).

WWI tourism entered a new phase when the centenary of WWI approached (2014-2018). In the years before, plans were made to sustain and/or increase the tourism during the centenary for educational, cultural and industrial purposes. Flanders saw also this event as an opportunity to increase the international attention and connections. Many local, regional and national stakeholders were involved such as for instance tourist agencies (e.g. Westtoer), the governor of the Province of West-Flanders, In Flanders Fields Museum, Memorial Museum Passchendaele 1917, Network War and Peace, politicians from cities involved (e.g. Diksmuide, Mesen), *Toerisme Vlaanderen* (Flemish Board for Tourism), partners of the Commemoration Park project and local experts of the military history (Vanneste & Foote, 2013).

Discussions followed between the stakeholders about the sustainability of these planned financial inputs in tourism. It was questioned whether these financial inputs would be sustainable after 2014-2018. They were wondering if tourists would still be interested in visiting the Province of West-Flanders after the centenary. Nevertheless, despite the discussions investments were made in the infrastructure, accommodations, attractions and marketing. Many plans, reports and discussions followed to prepare the centenary. The organisation of the centenary entailed local, regional, national and international partnerships and had two overarching organisations: Project office ‘The Great War Centenary (2014-2018)’ and the network ‘War & Peace in the Westhoek’ (Figure 5-29) (Vanneste & Foote, 2013).

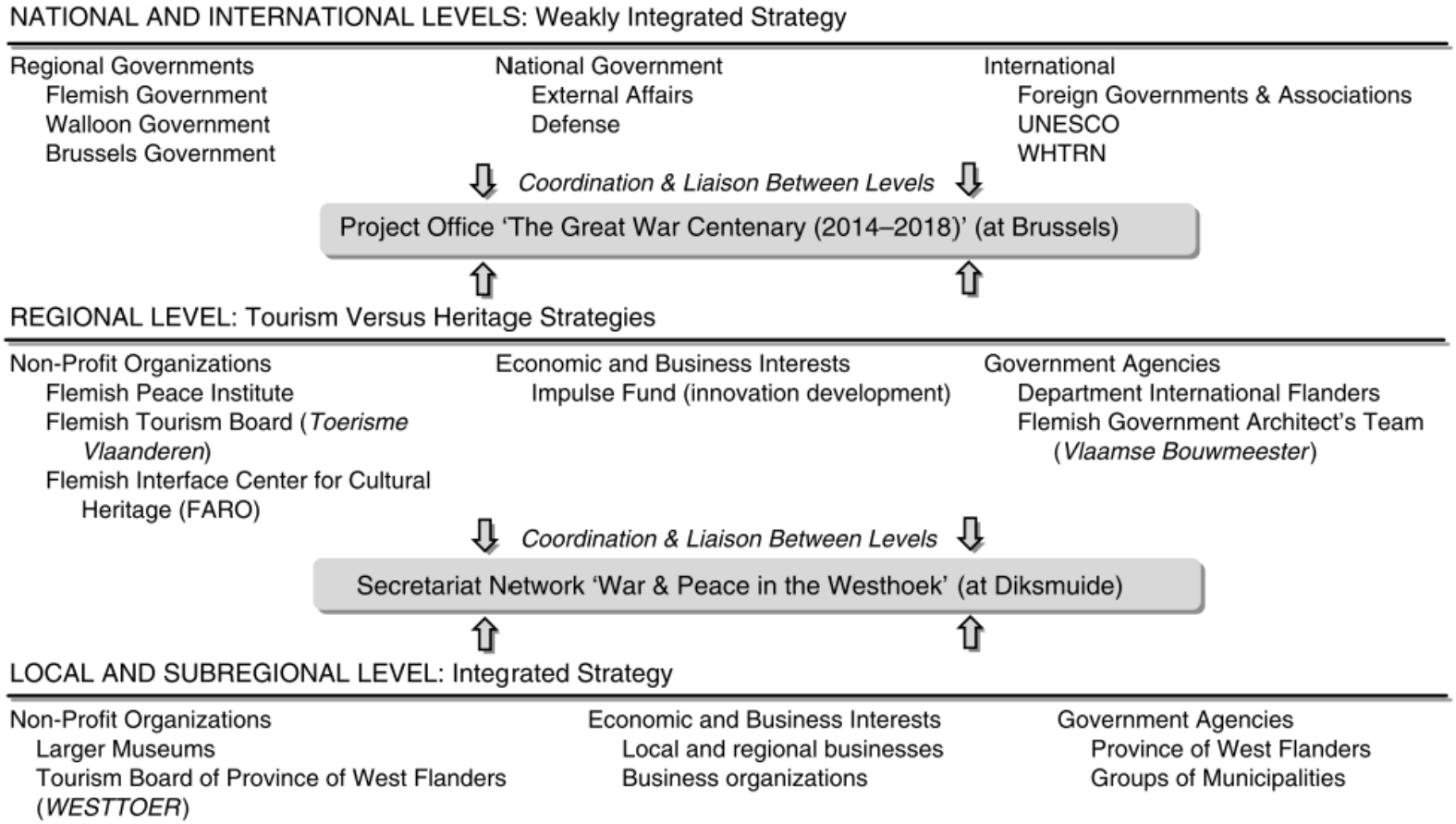

Figure 5-29 Stakeholders involved in the planning of the centenary (Vanneste & Foote, 2013)

The first overarching organisation that influenced the plans of the centenary is the in 2002 established supra-local network 'War and Peace in the Westhoek' which coordinated initiatives of partners around the theme of WWI. All local and regional initiatives and partners of WWI (e.g. museums, associations, local governments) were assembled in one network. The establishment of the network was requested by the partners as a manner to integrate the cultural historical purposes (bottom-up policy). The experience of the landscape and the visible WWI remains were one of the main topics of the network. To prepare the centenary, a policy plan of the network (2008-2013) was developed and was divided into five themes: scientific research, care of heritage, culture historical valorisation, the war for educational purposes and the announcement of the network War and Peace (Netwerk Oorlog en Vrede in de Westhoek, 2013). Achievements were amongst many others the collection of knowledge and the inventory of WWI heritage which was also used for the selection of elements for the nomination of UNESCO (see previous) (Decoodt & Bogaert, 2005), the optimization of the infrastructure of WWI sites and the complementarity of the contents exhibited in each museum. Also the unique experience of the war landscape and the remains were protected for touristic pressure by establishing a plan that evenly distributed the number of tourists across the region. This would be achieved by offering different alternatives to visit. On the various war sites, references would be made to other sites which would emphasize the unity of the landscape (Netwerk Oorlog en Vrede in de Westhoek, 2013). Distributing the tourists was not an easy task as the British front around Ypres more commonly known than the Belgian front around Diksmuide and Nieuwpoort. This could be solved by offering complementary information in both parts making it clear that both regions together tell the whole story of WWI (Vanneste & Foote, 2013).

The second overarching organisation in the light of the centenary is the national organisation established in 2010, namely the project office 'The Great War Centenary (2014–2018)'. This regional office of the Flemish government was established to follow-up all the policy actions in Belgium and abroad in relation with WWI. This organisation could achieve actions that were not feasible at a lower political level. The main purpose was twofold: on the hand to increasing Flanders' visibility on international level and on the other hand highlighting the link between war and the theme of world peace. Both were achieved by fine tuning the many initiatives on national, regional and local level. Other examples of initiatives from this project were proposals for international commemorative ceremonies, a plan to nominate the war landscape as UNESCO heritage in cooperation with the government of West-Flanders (see previous), and the creation of a plan for a park of remembrance on regional scale in the Province of West-Flanders (Government of Flanders, 2010). This park would highlight the connection between the landscape and the war remains by creating for instance vista's, strategic points (Figure 5-30), panorama's, information panels and by developing the infrastructure and redesigning war sites (e.g. Hill 60, Pool of Peace). This plan was developed by an international team of experts (Flemish Heritage Agency, 2012).

The Province of West-Flanders and the local governments used this plan as a guide for the creation of more detailed designs of the war landscape and its sites. For instance, the realised designs of the site Hill 60 (Ypres), The Pool of Peace (Heuvvelland), Polygoonwood (Zonnebeke) and the site of the IJzertoren (Diksmuide) were based on this plan[99] (Provincie West-Vlaanderen, 2013b).

Later, the Masterplan 'The legacy of Paschendaele' established and included touristic facilities such as walking trails in the context of the WWI in Zonnebeke and Passendaele. Also the castle park Zonnebeke was renamed into 'Passchendaele memorial gardens' (Heyde et al., 2015).

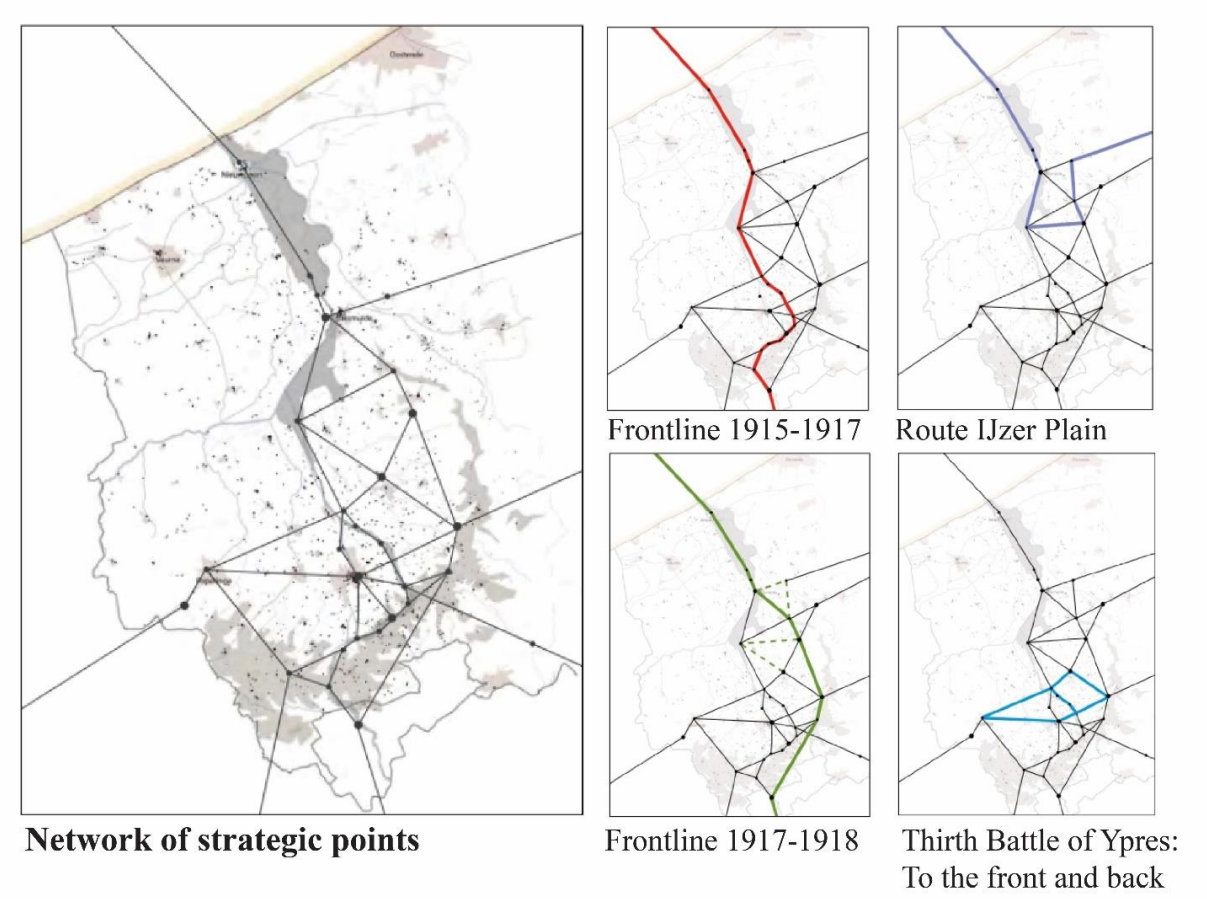

Figure 5-30 Network of strategic nodes (according to Flemish Heritage Agency, 2012)

Modern information boards (Figure 5-31), sanitary, information centres, vista's, plantations of hedges and trees, green buffers, extra parking places, new benches, new walking paths, new

[99] Before plans can go in practice, they have to be formulated into a '*Ruimtelijke Uitvoeringsplannen*' (spatial implementation plans). These explain into detail the predetermined purposes of the detailed design and have to be approved by the government. An example of such a spatial plan is the '*Provinciaal Ruimtelijke Uitvoeringsplan Palingbeek, Hill 60 en omgeving*' (Provincial spatial implementation plan Palingbeek, Hill 60 and the surroundings) which was approved in 2012 by the government (Provincie West-Vlaanderen, 2013b, p. 39).

accommodation (Provincie West-Vlaanderen, 2013a), etc. developed in the area, making the war landscape and its sites a touristic and economic success. Products were often commercialised to the centenary, such as the Passchendaele beer (Figure 5-31) and many national and international commemorative events followed (e.g. lightening of the frontline, WWI play on the German cemetery in Vladslo).

All the planned initiatives and actions gained much (inter)national attentions in a wide range of newspapers[100]. Already in the first months of 2014, 70 % more tourists visited Flanders compared with the first months of 2013 (Miles, 2016b, p. 25). During the centenary, approximately 3 million tourists visited the Westhoek (De Standaard, 2019a). To conclude, even though the landscape was completely devastated, the tourism afterwards upon today brought new economic opportunities which had a major impact on regional developments (Miles, 2016a).

Figure 5-31 Left: Advertisement in a magazine for Passchendaele Beer in the theme of WWI (source: city magazine Diksmuide); Middle: Modern interactive tourism at the Palingbeek (source: author, September 2017); Right: Modern information board at Hooghe Crater (sour

5.4.5.3.2 The castle parks

In the decennia after WWII, the modernist provisions of food and energy (oil, natural gas, fertilizers) endangered the economic value of castle parks. Wood, fruit and vegetables from the domains were less importance. Consequently, paying the staff of the domain (e.g. gardeners, woodworkers, yachtsman) became difficult. These fundamental changes meant that the function of the castle parks entered a different era. Many were sold to built houses on or were transformed into recreational parks. For instance, the domain the Palingbeek became a golf course, the domain Hooghe became partially the theme park 'Bellewaerde' and the domain Malou became partially a place for new houses. Also the domain Zonnebeke was partially bought by the municipality Zonnebeke and became a public park with the Memorial Museum Passchendaele 1917 in the castle. In the side buildings of this castle a library and a catering business were established.

During the period 1979-2013 many abandoned and neglected castle parks were recovered by help of landscape and garden architects to regain the unique ecology, sustainability and experiential values

[100] After entering the word 'Groote Oorlog' (Great War) in GoPress Academic, 12,045 newspaper articles were found (only) in the Belgian press between 2000 and 2018 reporting actions, initiatives and commemoration events in relation with WWI (https://academic.gopress.be/, 16/04/2019).

of the domains The landscape designs of the parks are a combination of modern needs and cultural historical values. The following was taken into account while making plans: the old location of buildings, the topography and plant species of the past and present situation (Heyde et al., 2015). Other domains are still not renovated such as the Couthof in Proven but very recently the reconstruction plans have also started here. This domain still includes remnants of a WWI shelter for soldiers (Figure 5-32 and Figure 5-33).

Figure 5-32 Left: Abandoned castle park Couthof (Proven); Right: WWI shelter in the castle park of Couthof (Proven) (source: author, 8 September 2018)

Figure 5-33 Left: Restored pigeon loft in the castle park of Couthof; Right: Starting of the renovation of the castle Couthof with the help of a scaffold (Source: author, 8 September 2018)

5.5 Discussion

5.5.1 Brief overview actor analysis

The four composite cross-functional flowcharts (Appendices 5A, 5B, 5C and 5D) – arguably speaking for themselves - represent into detail the 'warscape' biography. In this section, you can find a short summary of the actor analysis. I briefly highlight the results per time period in the following paragraphs.

5.5.1.1 First World War (1914-1918)

During WWI (Appendix 5A), the complete landscape was wiped away by many successive battles coordinated by top-down policy. An economic exhaustion and crisis took place resulting in famine (Hoover, 1951; Van den Wijngaert et al., 2006). However, the economy of war machines and military constructions flourished (Bostyn, et al., 2014; de Vos, 2003), supported by scientists and policy members of all combatting nations.

In impossible circumstances, the safeguarding and reconstruction of the pre-war Belgian patrimony such as the belfries and churches in "*Das Land der Kathedralen"* (the land of cathedrals according to the German occupier) (Cortjaens, 2011), was crucial for the exiled Belgian Royal Commission of Monuments and Landscapes (KCML). Indeed, safeguarding this pre-WWI heritage legitimized the right to exist for the in 1830 newly found Belgian Nation (Duvosquel et al., 1985; Stynen, 1985). Remarkably, also the German occupier wished to reconstruct and preserve Belgian monuments as a manner to perform propaganda (Cortjaens, 2011). Each rebuilt monument would be seen as symbol of German victory (Ernst, 1915), and was an opportunity to practice innovative German building skills in a country that was according to the occupier lagging behind in spatial planning. The German argued that the KCML was weak and conservative (Cortjaens, 2011), which was (seen apart from the war) maybe also true since the KCML had only an advisory function (H. Stynen, 1985). However, latter is arguably understandable during wartime.

This desire to rebuilt the patrimony was part of the larger desire to return to the 'blooming' Belle Époque. These pre-war decennia were marked by political stability with successful developments in science and technology (Dick & Vandendriessche, 2018). There was a strong believe in 'man's ability'. Hence, some actors wanted not only the patrimony but the entire Belgian pre-war landscape to be rebuilt.

The planning of a reconstructed traditional (or regionalist) landscape according to this pre-war situation started already during wartime. However, oppositely, modern reconstruction ideas increasingly gained influence. For example, the Belgian Town Planning Committee supported innovative spatial plans and the use of modern building materials. Moreover, these modern ideas were even linked to the resulting – at that time still in the making – 'warscape'. As one at that time already foresaw the upcoming of 'war tourism and economy', one argued that there would be a need for well-designed infrastructure, capable of 'welcoming' the growing amount of faster driving vehicles in order to better connect the economic and WWI-touristic places. These ideas were strongly supported by the exiled Belgian government, incorporating these ideas within the reconstruction law. Controversially, the KCML was assigned to realize this (Duvosquel et al., 1985).

5.5.1.2 Interbellum (1918-1940)

After the war, the reconstruction (of the build environment and the economy) went into full speed. As shown in Appendix 5B, an arguably international eclectic group of collaborating actors made this possible (Cornilly et al., 2009; Demasure, 2013; Dendooven et al., 1999). Hence, rather obvious, disagreements about the reconstruction occurred. While the 'traditionalists' and 'modernists' were already discussing during the war, now a new 'kind' of actors arose, namely the 'preservers'. This group wished to retain WWI-ruins and/or military constructions in favour of the commemoration of the fallen, for educational purposes or for esthetical reasons, focusing on buildings or landscapes. For instance, Winston Churchill (UK) suggested the consolidation of the ruins in the city centre of Ypres, since "a more sacred place for the British race does not exist" (Ingelbrecht, 2017, p. 191). Also Colonel Thurlow's (UK) plead to preserve the English bunkers or 'pill-boxes' as a symbol for the spirit of sacrifice (Thurlow, 1933), and the Belgian Ministry of National Defence undertook an attempt to

preserve several war places or 'Sites de Guerre' as open-air museums (Decoodt, 2014; Service des Sites de Guerre, 1922).

These preserving ideas were not successful for two reasons. First, Flanders – as the rest of Europe – experienced an economic crisis with an enduring unstable financial status between 1919-1926 (Van den Wijngaert et al., 2006). Therefore, protections – implying a division of means – were not important enough. Instead, the laws aimed to support economy recovery after the war. For example, loans and temporal houses (barracks) were provided to the civilians having lost their properties. Notably, the height of the loans was based on the pre-war value of the property (Federal Public Service Justice, 2019). In other words, the given amount of money was enough to exactly rebuilt what was destroyed, hence making the eventual reconstruction traditional orientated.

Second, the now returning inhabitants had to restore their properties as quickly as possible (Davies, 2008). Because materials were sparse, houses were reconstructed with the materials recuperated from ruins, supplemented with materials from military constructions. This again made the reconstruction traditionally orientated. In addition, it is important to stress out that the returning 'angered' inhabitants wanted to 'erase' the memory of war, as it was linked to significant personal as material losses (Duvosquel et al., 1985).

While a foremost traditional reconstruction enrolled itself, also some 'modern' ideas were realized, although limited. For example, because of the imminent shortage of houses - especially within cities - several large scale neighbourhoods were built, the so-called 'garden cities' (Howard, 1902).

Because both the traditional and modern ideas aimed for social and economic recovery, the British 'preservers' did no longer demanded the conservation of WWI landscapes. Rather than focussing on the large scale, they started to focus on the building of monuments such as the Menin Gate, inaugurated in 1927 (Dendooven & Dewilde, 1999), becoming quickly a touristic and pilgrimage destination (also called 'dark' tourism) (Murphy, 2015; Vanneste & Foote, 2013). This conservation idea fitted better with the economic recovery, because locals and other stakeholders (e.g. travel companies), benefited from this by opening for instance tea houses and hotels in the front area (Michael Connelly & Goebel, 2018; Walter, 1993).

5.5.1.3 Second World War (1940-1945)

During WWII, arguably similar landscape and political trends were noticeable (Appendix 5C): destructions, economic and financial exhaustion and famine (Braeken, 2011; Van den Berghe et al., 2018b). Consequently, during the war, political measurements aimed foremost the provision of houses and food for civilians (Floré, 2011).

Even though an economic crisis occurred, oddly enough the first protection of WWI heritage became in force: The British Newfoundland Memorial (1942) (Agentschap Onroerend Erfgoed, 2018b). Moreover, also the German took initiative during the occupation of Flanders to preserve the German WWI *Studentenfriedhof* in Langemark (student's cemetery) (Himpe, 2018). Noteworthy, during the occupation German soldiers participated in guided tours to these battlefields, to glorify Nazism (Debaeke, 2013; Freytag & Van Driessche, 2011; Gordon, 1998). Consequently, Flanders discarded these specific conservation measures after WWII (Agentschap Onroerend Erfgoed, 2018b; Himpe, 2018). Despite The Newfoundland Memorial, in general the protections of WWI remains turned into an empty shell, amplified by the decline of WWI tourism and pilgrimages. It took until 1960 before tourism recovered as during the Interbellum (Miles, 2016).

5.5.1.4 Post-WWII (1945-today)

During the first decades after WWII (Appendix 5D), the housing shortage in Flanders was severe. Similar as after WWI, legislation focussed foremost on economic recovery and supporting the civilians. Also new neighbourhoods - the National Building Sites - were built (Floré, 2011). Legislation focussed foremost on economic recovery (Federal Public Service Justice, 2019).

Different though, was that Belgium 'only' lost 8 % of its national wealth compared to 18 % after WWI (Bostyn et al., 2014). Because of less severely destructed areas and infrastructure compared to WWI (e.g. the port of Antwerp was undestroyed), the economy recovered quickly (Gaus, 1992a; Van den Wijngaert et al., 2006). Famine and house shortages disappeared and the agricultural economy revived by using modern pesticides, machines and fertilization. This period of boom eventually made the so-called 'Golden Sixties' (Gaus, 1992a).

Partly because the economy ran well, and the fading 'living' memories increasingly became indirect memories (e.g. cultural artefacts), the 'anger' of losses and destructions of WWI (mostly) disappeared (Reynolds, 2013; Walter, 1993). Consequently, WWI remains became increasingly regarded as heritage (Federal Public Service Justice, 2019). Simultaneously, commemoration events (e.g. 50th anniversary of WWI), educational school trips and documentaries appeared (Walter, 1993). Tourist's numbers increased, eventually even "industrial in scale" (Miles, 2016, p. 23).

The protection of the WWI-war site Stuivekenskerke (1959) marked the start of consecutive protections by bottom-up and top-down initiatives in the next decades. Military remains threatened by modern changes became valuable memorial sites (Decoodt & Bogaert, 2005; Himpe, 2018). Notably, the protection of remains entailed both features directly linked to the war (e.g. ruins) and to the reconstruction period (e.g. rebuilt houses). However, former progressed slower than latter, making thus WWI remains disappear. Additionally, a new wave of WWII-remains - also with the associated reconstruction period - was introduced, making the landscape a layered feature of war-remains. The protection of WWII-remains developed faster than WWI remains, seen from the termination of each war. Abundant WWII-remains and only few buildings of the WWII-reconstruction period (1945 – 1970) were protected (Braeken, 2011).

Following, this flourished last few decades WWI-tourism, in particular towards the WWI-centenary (2014-2018). To prepare the "memorial marathon" (Knack Historia, 2014, p. 3), two overarching organisations were established: 'The Great War Centenary (2014-2018)' and the 'War & Peace in the Westhoek' (Vanneste & Foote, 2013). Different actors in these organisations launched plans to sustain and/or increase tourism during the centenary for educational, cultural and industrial purposes, this with potential international attention. Divers local, regional and national stakeholders were involved and invested in the development and organisation of the area such as the tourist agency Westtoer, In Flanders Fields Museum, Memorial Museum Passchendaele 1917, partners of the Commemoration Park project and local experts. Modern information boards, information centres, parking places, walking paths, new accommodation (Provincie West-Vlaanderen, 2013a) etc. massively developed in the area making the area 'centenary'-ready. Moreover, local products were commercialized to the theme, such as the Passchendaele beer.

During 2014-2018, direct (entrances museums, selling souvenirs) and indirect (pubs, restaurants) touristic incomes made the local economy flourish. Many national and international commemorative events took place (e.g. lightening of the former frontline, educational excursions). The better accessible landscape and sites became a touristic and economic success (Rosiers et al., 1990). All the commemorative initiatives, resulted into 70 % more tourists visiting Flanders already in 2014, compared to 2013 (Miles, 2016, p. 25).

5.5.2 Synthesis actor analysis

Reflecting on the four different 'warscape' biographies focussing on the human role in the landscape, arguably the connecting thread between the four, is in one way or another 'heritage' and how one dealt with it, cf. heritage policy. We found that the latter reflects well the applicant social, economic, political and cultural circumstances. For example, if one wants to understand why directly in the years after WWI, the Belgian population foremost wanted a 'traditional' and 'erasing' heritage policy - this almost completely in contrast to the most recent decades - one has to understand the at that time existing context, in other words 'anger' in contrast to 'proudness'.

By using heritage policy as framework, we are now able to answer our research question: *What were the human decisive actors - or the 'warscape' - that lead to the preservation of the resulting militarised landscape of today?* Therefore, we present the overall timeline of heritage policy (Figure 5-34), based on the four cross-functional flowcharts (see Appendixes). We argue that during WWI, the 'general' focus was traditional and modern at the same time. This resulted in a progressive traditional - but limited by means - focus during the interbellum. We appoint WWII as a standstill, but not a 'going backwards' phase. The lack of severe destruction explains why after WWII, we can observe the upcoming of first a traditional rebuilding programme, then a blooming heritage policy and eventually a centenary peak.

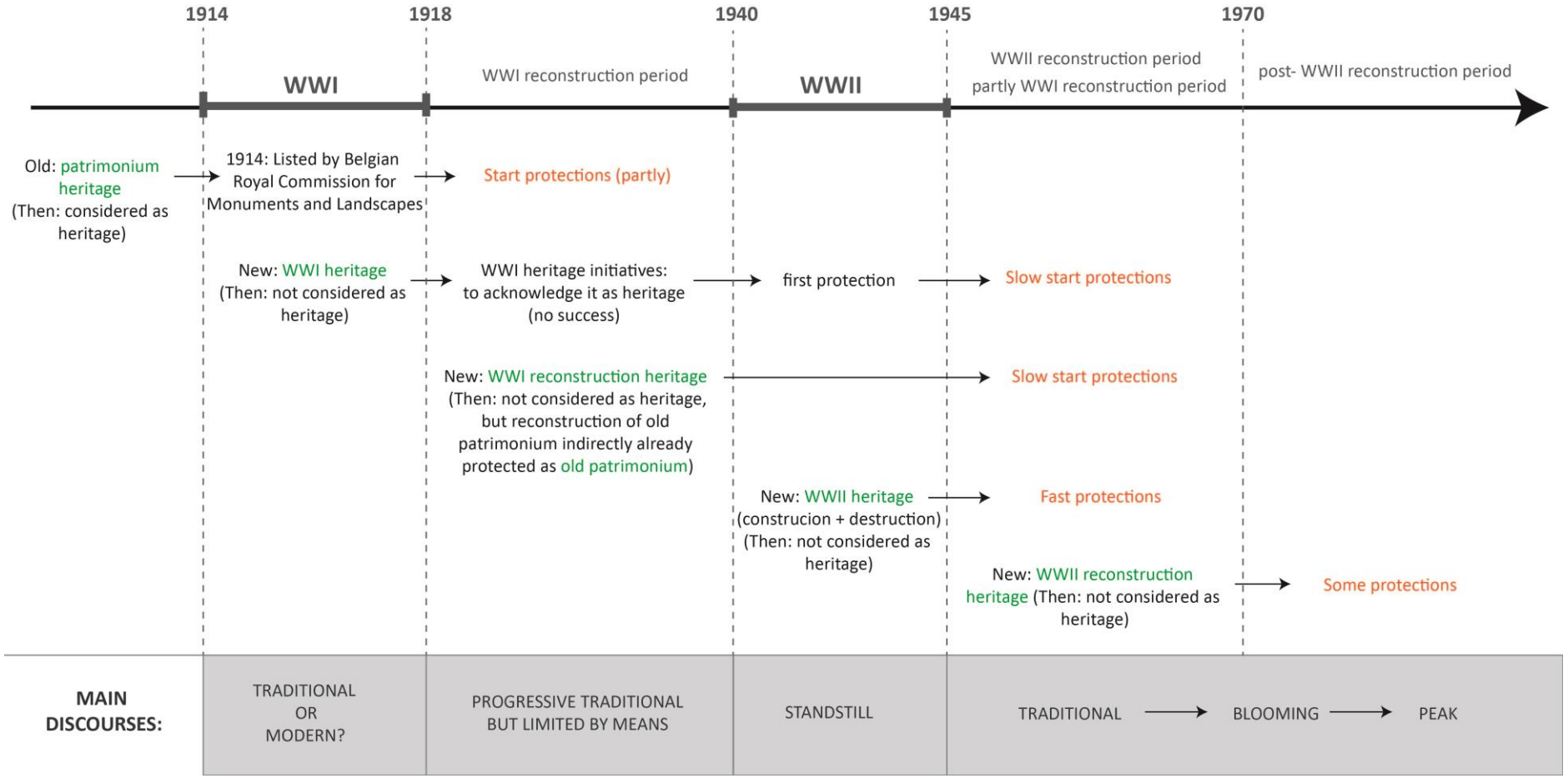

Figure 5-34 Timeline of heritage policy of pre-WWI patrimony, WWI and WWII heritage with the main discourses below (Note: besides the discussed war heritage, other heritage unrelated to the war exists also but is not discussed in this figure)

It is important to understand the past and present as much as possible for the future planning, since the present holds the past and the future together. However, actors in the future landscape cannot be expected to be the same as in the past. As Naveh (2005, p. 353) points out, it is not possible to "predict the future of our landscapes and their rapid sometimes even chaotic changes by simply extrapolating from the past and present into an uncertain future" (Loupa Ramos, 2011). However, this study contributed in the understanding of the past landscape to explain the (still) existing WWI remains after a period of one hundred years, in order to help future planning.

5.6 Conclusion

This study showed how the evolution of the WWI militarised landscape of Flanders upon today can be more profoundly understood by linking landscape changes to (inter)national economic, politic and socio-cultural human actors. These evolutions are readable like a 'text' (Cosgrove, 1998). The way we 'read' the landscape was defined by our conceptual framework that relied on geographical perspectives. This framework analysed two aspects: changing landscape trends defined in several time periods and the types of actors responsible for these changes. This framework makes it possible to link landscape trends to a wide range of decisive actors, this by their actions and the relations between these (or the 'warscape'). Each studied actor in this paper can be seen as a contributing 'co-author'. Exactly by positioning these within their time period, we can better take into consideration the relevant context (Samuels, 1979). What we confirmed is that a landscape is a "living entity, whereby the form and meaning constantly changes for new generations […] in many different ways" (Saunders, 2006, p. 153). By schematizing and linking all this into relational schemes, we are able to better understand the remaining militarised landscape today.

Eventually, we argued that heritage policy is a relevant proxy to summarize the four schemes. Policy is namely not long-standing and under influence of ever-changing social, economic, political and cultural discourses. However, heritage policy is a rather special type, as it deals with more long-lasting and static entities, in our case militarised landscapes. Hence, what we have shown, is how the Flemish militarised landscape has been used or disused to perform policy measures. This paper only focussed on the human authors. We do recognize that also non-human actions (e.g. droughts or floods) do have an influence. However, for future research avenues, we think our framework and our focus on heritage policy is able to deal with this as well. Eventually, this chapter has tried on the one hand to put 'heritage' (cf. landscape) into perspective, and on the other hand to explain the subjective definition of this heritage by linking it to the (inter)national policy dealing with it (cf. 'warscape'). Latter stands in a reciprocal way with temporal and context dependent economic, social, cultural and thus also physical mechanisms (Sayer, 2000).

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CHAPTER 6 – DISCUSSION

To study the WWI militarised landscape of Flanders, this dissertation was methodologically orientated to answer the several predetermined research questions. At the same time, it represented an exploration of the potential use of historical aerial photographs both for methodological and future planning. In the previous chapters, land use/land cover, the possible preservation of WWI remains with landscape trajectories, the explanation of this preservation by means of land use/land cover pathways, changing patterns and responsible actors for landscape change have been examined for the past century. In this chapter, we discuss these outcomes. In section 6.1 the methodological characteristics are discussed. Section 6.2 discusses the relevance of this dissertation in a broader perspective. This chapter concludes with section 6.4 that contains recommendations for future research of the militarised landscape in Flanders.

6.1 Methodological assessment

The presented research opens up a new manner to analyse and interpret the WWI militarised landscape in Flanders by integrating and applying several techniques and methods from different research perspectives, creating an innovative geographic analysis of a former conflict landscape. The general methodological characteristics of this research are discussed below.

6.1.1 Military landscape as the 'lens' of research

In this section, we return to our assumption as formulated in the introduction (section 1.4), namely that one should study the WWI militarised landscape in Flanders by using the landscape as the 'lens' of research. In this way 'landscapes of WWI' are approached as a totality of elements (cf. holistic) (Antrop, 2000). Generally seen, this militarised landscape was created by the (inter)action of both natural (biophysical) and human (socio-cultural) factors (section 1.2.1) which is intrinsically dynamic (section 1.2.2) (Council of Europe, 2000; Pearson et al., 2010). This (inter)action between both factors creates a unique militarised landscape character (section 1.2.2.2) (Natural England, 2010), which can be studied with the following concepts (Table 1-2): continuous landscape, anywhere in the landscape, anyone is involved, actions of the combat and others, and effects of harm and benefit which can be obvious or invisible (Russell, 2010).

This dissertation approached WWI through this predetermined lens of the research. The dynamic actions and interactions between natural and human factors were analysed by studying the militarised landscape from its 'creation' towards today (Chapters 2, 3, 4 and 5). The way human factors (socio-cultural) altered the nature factors (biophysical) was quantitatively (Chapters 2, 3 and 4) and qualitatively studied (Chapter 5). Reciprocally, the influences of this (changing) biophysical environment on human factors was addressed when the study areas were introduced and in the actor analysis as well (Chapters 1 and 5). Also vertical and horizontal landscape relationships were tackled. The vertical relation was on the one hand studied between the LULC history 'on site' (cf. on one specific place) and by linking this with the preservation of above- and underground war remains (Chapter 2). On the other hand this was studied by analysing the relationship between the microtopography of shell holes and the occurring LULC (Chapter 3). A horizontal relation was analysed between the spatially different military impact going from the frontline to hinterland and the related preservation of shell holes in the microtopography (Chapter 3).

The predetermined concepts that have been formulated to analyse a militarised landscape have also been taken into account (see Table 1-2). The militarised landscape was approached in a 'continuous' (cf. dynamic) manner by studying the landscape from its 'creation' until today. This continuous concept was easily confirmed from the fact that the military remains are still perceptible both in a

physical (cf. remains) and mental way (cf. commemoration) (Chapters 2, 5). Furthermore, the military landscape was studied 'everywhere' (cf. anywhere in the landscape) from a spatial point of view, including both the biophysical aspects (cf. LULC, linear structures, patterns, microtopography) of the front zone and hinterland (Chapters 2, 3 and 4) and by analysing the network of (inter)national actors involved in this militarised landscape who conducted combat and political actions amongst other. These involved actors that are responsible for the landscape changes could be 'anyone' as we did not exclude any stakeholders for analysis; this by incorporating political, cultural, social and economic actors (Chapter 5). Both the 'harm' (or damage) and 'benefit' (or advantages) of combat were also analysed in the landscape by studying military destructions and constructions and by analysing touristic and economic benefits (Chapter 2). Both distinct and invisible effects of the conflict upon the landscape were analysed. The distinct effects were observed in the changing landscape during and after WWI. Invisible effects were also studied by incorporating the microtopography of shell holes in the present-day landscape (Chapter 3) as well as landscape patterns (Chapter 4) that cannot be determined at first glance. Moreover, invisible effects in the society were also investigated by analysing the discourses of actors (Chapter 5).

The previously described landscape concepts and elements that are related to the conflict and are studied through the landscape as the 'lens' of research are summarised in Figure 6-1.

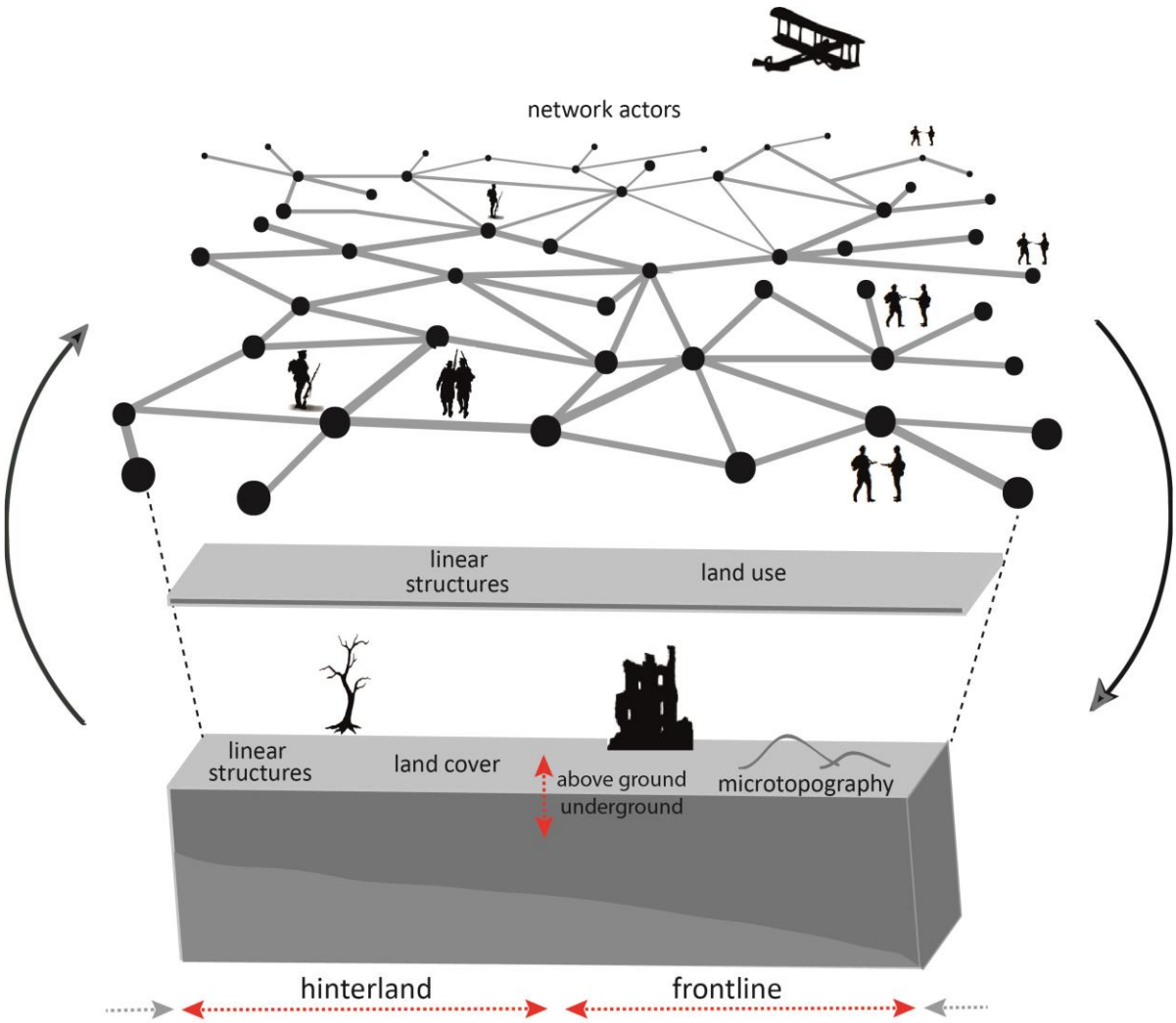

Figure 6-1 Studying the militarised landscape with a military landscape approach, represented for the hinterland and frontline during wartime. Below: the biophysical part of the landscape with vertical and horizontal relations, above: the human part of the landscape represented by a network of social relations (Note: this is a schematic representation displaying only the dynamics of one specific snapshot (cf. war time), also without the display of the complete militarised landscape beyond the hinterland and frontline)

This research examined several aspects of the conflict with the landscape as nexus. Yet, the 'landscape' is a broadly defined concept which can be seen as a 'whole' of elements (Council of Europe, 2000). Therefore, the militarised landscape can always be studied in a more holistic manner by incorporating other and more landscape components to understand the militarised landscape in a more profound manner (e.g. geology, hydrology, topography, geomorphology). However, in this dissertation, the focus was particularly on the study of land use/land cover (see below in section 6.1.5). Most of this dissertation was also focused on the influence of human (socio-cultural) factors on the natural (biophysical) factors. These were discussed in detail and supported with quantitative and qualitative results. Moreover, the influence of the natural factors on human factors was discussed briefly and concisely to better understand the observed landscape dynamics in land use/land cover. To conclude, studying the militarised landscape can always be extended by analysing more landscape features.

6.1.2 Inter- and subdisciplinary 'touches'

In this dissertation, several techniques, sources and software were used, each containing or processing different landscape information of interest. These often crossed interdisciplinary[101] and subdisciplinary[102] boundaries as the use of techniques, sources and software of a single discipline were insufficient to solve and understand all the processes and changes of interest in the studied militarised landscape. Therefore, an integrated approach was needed that combined interdisciplinary and subdisciplinary scientific knowledge and techniques. After all, the (militarised) landscape is a boundary crossing subject (Antrop & Van Eetvelde, 2017; Tress et al., 2003; Woodward, 2014). Moreover, the approach of the (militarised) landscape in a holistic manner as performed in this dissertation (section 6.1.1), allows for cooperation between different approaches (Palang & Fry, 2003).

As described in the introduction (Chapter 1, section 1.4), few disciplines already studied WWI by using the landscape as the 'lens' of research to adress military landscapes. They analysed the same landscape with their own specific techniques and sources whereby the WWI landscape was the object of interest[103]. Because these disciplines shared their object of interest with this dissertation, techniques and insights coming from these disciplines amongst others were well-suited to provide extra information of the WWI militarised landscape. This section provides a brief overview of the interdisciplinary and subdisciplinary influences in this dissertation. Afterwards, a reflection will be given on the discipline to which this thesis has contributed.

[101] Interdisciplinary research integrates several academic disciplines (e.g. ecology, geology, biology). By doing so, the different disciplines cross subject boundaries to solve a common research goal (e.g. climate change) (Tress et al., 2003).

[102] Subdisciplines and other disciplines are here seen from the perspective of the discipline geography, as this dissertation approached the landscape from the perspective of military geography.

[103] This is called 'multidisciplinary' research. These disciplines have a common research (e.g. the militarised landscape) that is investigated by disciplinary specific approaches, hence results are not integrated (Antrop & Van Eetvelde, 2017).

6.1.2.1 Origin of techniques, sources and software

In chapter 2, a spatio-temporal database consisting of land use/land cover and linear structures was set up by analysing historical and contemporary aerial photographs with the concepts of the Historic Landscape Characterisation (HLC). This technique entailed both historical and archaeological viewpoints on a landscape scale to determine the overall historic character of an area. The study of the past landscape is seen as more than only a mere description of the physical part, by also incorporating human agency. The actual landscape is mapped by studying the complete historical dimension giving in the end insights in the time depth of the landscape; this performed by analysing historical aerial photos (such as also applied in this dissertation), maps and ecological data. This technique aims to give an entire historic overview of the landscape as advice towards spatial planning. This approach is closely related with the viewpoints of the European Landscape Convention (ELC) that seeks to study the landscape in the broadest sense (cf. human and natural factors) (Clark et al., 2004; Fairclough, 2003). The HLC resulted from the aggregation of insights and knowledge from three disciplines: historical geography, landscape archaeology and historical ecology (Antrop & Van Eetvelde, 2017). The subdiscipline historical geography studies the evolution of (mainly cultural) landscapes by analysing economic, political and cultural processes with maps, plans, written sources and iconographic material (Baker, 2003; Morrissey et al., 2014). An example of a conducted research by historical geography is the study of toponyms in the past landscape (Wilson, 2011). The subdiscipline landscape archaeology[i] (with its origins in human sciences), focusses on the view of human on the past landscape and how they interacted with their surroundings. In general, two aspects are studied: remains of human objects, constructions or remains of humans in the landscape, and the spiritual link or viewpoint of humans towards the landscape. This subdiscipline seeks often help of other disciplines (e.g. geography, geology and anthropology) (David & Julian, 2008b). Last, historical ecology examines the complex relationships between species and earth in the past over the long term. This research framework which is not specifically defined as a subdiscipline of ecology has roots in archaeology, ecology, history and geography amongst others (Crumley et al., 2018). Humans are also considered as one of the studied species (Antrop & Van Eetvelde, 2017).

Results in chapter 2 also relied besides the HLC on the Landscape Change Trajectory Analysis (LCTA) that focused on the changing landscape in time and space (Käyhkö & Skånes, 2008; Van Eetvelde & Käyhkö, 2009). Landscape change trajectories are arguably based on the concepts and theories of time-geography (Hägerstrand, 1985), in which trajectories are described as a web of life-lines of individuals, objects and actions. These are often represented in a space-time 'aquarium' or in other words in a 3D model of space (Thrift, 1977). In geography, the trajectories were more conceptualized in Geographical Information Systems which was called 'temporal GIS' (Langran, 1993; Van Eetvelde & Käyhkö, 2009). Hence, trajectories knew an evolution in landscape change studies that were also referred to as 'land-use-history' profiles (Käyhkö & Skanes, 2006), land cover transitions (Cousins, 2001) or time depth of places (Antrop & Van Eetvelde, 2017). In landscape ecology for instance, land-cover trajectories have been analysed to gain insights into the effects of land cover changes on ecological landscape functions and processes (Christensen et al., 2017; Cousins, 2001; Cushman & Mcgarigal, 2007; Hietel et al., 2004; Ruiz & Domon, 2009). In physical geography, trajectories were applied to analyse the actions of humans on the environment (e.g. deforestation) (Mertens & Lambin, 2000). Arguably, in this dissertation were the concepts and ideas of trajectories in landscape ecology (Käyhkö & Skanes, 2006) and from time-geography (Langran, 1993) both applied to analyse

the WWI militarised landscape. More specifically, we used the predetermined LCTA of Käyhkö & Skanes (2006), which includes both aspects.

Chapter 3 analysed the present-day shell hole landscape with perceivable information from airborne DAR. This technique belongs to geomorphometry (cf. geomorphology, terrain analysis) which uantifies aspects of the land surface (Mark, 1975; Pike et al., 2009). Airborne LiDAR is rather new Meylemans & Petermans, 2017) and is one of the applied techniques in the field of remote sensing[104], hich in turn is a part of geomatics[105] (Konecny, 2003). The field 'remote sensing' was introduced for the rst time in the 1950s since in this time period sensors were developed that relied on the lectromagnetic spectrum to detect, record and measure the characteristics of the earth's surface. ventually, also LiDAR (Light Detection and Ranging) developed in this field and measured the earth's urface by calculating the distances based on the time differences between transmitting and receiving ser signals from sensors (Dong & Chen, 2018). In the beginning, LiDAR was a ground-based technique the 1960s. Later in 1978, LiDAR applications were used for the first time on small aircrafts, which gave irth to 'airborne LiDAR'. In 1994, scholars went a step further and developed 'space borne LiDAR' Meitkamp, 2005). In Flanders, airborne LiDAR data was taken from 2004 onwards by the initiative of the emish government (Meylemans & Petermans, 2017). Surface information derived from airborne LiDAR often used in landscape, archaeological, cultural and historical studies to indicate the presence of rchaeological structures, to analyse the natural and cultural-historical landscape or to model landscape rocesses (Creemers et al., 2011; De Man et al., 2005; Getzin et al., 2017; Kokalj et al., 2011).

To analyse the airborne LiDAR visualisations in this dissertation, the approach was adopted from scholars in landscape archaeology[106] who conducted archaeogeomorphology[107] (Gheyle et al., 2018). These scholars made a similar landscape analysis of the microtopography of shell holes within the same studied area in previous conducted research. However, in this dissertation we decided to perform the analysis again because it was important to collect landscape information from the same perspective (cf. geographical perspective). Therefore, to analyse the LiDAR visualisations from the same perspective as the other derived digital data in the previous chapter (Chapter 2), the shell hole landscape was reanalysed. To conclude, the analysis of the microtopography in this dissertation was an analysis using data resulting from remote sensing, whereby the analysis of the visualisations was (partly) prepared by landscape archaeologists and observed from a geographical perspective in order to analyse the microgeomorphology.

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[104] Remote sensing is "collecting and interpreting information on targets without being in physical contact with the objects" (Ho, 2009, p. V), this using a naturally existing or artificially created force field (Konecny, 2003).

[105] Geomatics (geos: Earth, matics: informatics) is defined as "a systemic, multidisciplinary, integrated approach to selecting the instruments and the appropriate techniques for collecting, storing, integrating, modelling, analysing, retrieving at will, transforming, displaying and distributing spatially georeferenced data from different sources with well-defined accuracy characteristics, continuity and in a digital format" (De Maeyer & Van de Weghe, 2007; Gomarasca, 2013, p. 2). The use of computers within geomatics plays an important role. This field includes for instance photogrammetry, remote sensing, topography, geodesy, topography, cartography and geographic information science (De Maeyer & Van de Weghe, 2007).

[106] These scholars also participated within the project (see section 1.6).

[107] Archaeogeomorphology investigates the cultural landscape on a landscape scale, by consulting both techniques from archaeology and geomorphology. Geomorphology is a part of physical geography (Matthews & Herbert, 2013), and uses for instance LiDAR as a technique to obtain morphological information (Thornbush, 2012).

In chapter 3, besides the analysis of LiDAR data, also the relation between modifications of land use and the preservation of shell holes in the microtopography was studied. This study only focused on the management of fields with the intensification of these as an objective (Vuorela & Toivonen, 2001). This was defined as human input (e.g. deep-ploughing, pesticides, mowing gardens) in land use to improve the output and returns (also called input intensification) (Lambin et al., 2000; Turner & Doolittle, 1978). Intensity values were linked to the LULC types specified for each time phase (Vuorela & Toivonen, 2001). This approach was adopted from landscape ecology.

To analyse the original shell hole landscape of 1918 in chapter 3, a shell hole density map was used. This map was made by Note et al. (2018) which compiled the maps with information from historical aerial photographs. This map was validated by geophysical measurements and was mainly set up by the other two groups in the project: remote sensing archaeology and geophysical soil sensing (section 1.6). The latter was conducted by a geomaticus specialised in topography (Note et al., 2018).

Chapter 4 analysed the landscape patterns in the militarised landscape with landscape metrics, specifically calculated with the software Fragstats. This software has its origins within landscape ecology and was developed to describe and quantitatively measure the landscape structure (cf. composition and configuration) (McGarigal & Marks, 1995). The study of landscape structure forms besides the study of the landscape function and change[108], one of the main subjects in landscape ecology (Christensen et al., 2017; Forman & Godron, 1986; Turner, 1989). The development of this software was on the one hand stimulated by the development of spatial techniques (GIS, spatial analysis, geostatistics) and the increasing availability of digital data of the landscape in the 1980s (Antrop & Van Eetvelde, 2017). On the other hand, this software was developed because many concerns over the loss of biodiversity at that time occurred and needed to be studied. These changes in the pattern were caused by different landscape processes. Therefore, knowledge of landscape processes and patterns would enhance better landscape planning and management and would prevent more biodiversity loss (McGarigal & Marks, 1995).

Chapter 5 analysed the militarised landscape by combining two approaches, first by using the concepts of a landscape biography and second by conducting the relational approach. Landscape biographies study the 'life-path' or 'story' of local and regional landscapes which constantly change in time (Antrop & Van Eetvelde, 2017). It describes the landscape in time and space and is interdisciplinary by nature. In the context of the latter, the 'story' of the landscape is approached from different perspectives (e.g. geology, archaeology, biology) and subjects (e.g. political, social, and economic context). This 'story' often results in several formats such as monographs, maps, figures and tables amongst others (Antrop & Van Eetvelde, 2017). The study of the biography of a landscape existed already for few centuries, but was not specifically referred to as a landscape biography. In regional studies, Alexander von Humboldt (1769-1859) for instance, made already a similar description of the landscape of Cuba and Mexico. Also, the geographer Granö (1850–1913) told the landscape 'story' of the Altai (Antrop & Van Eetvelde, 2017). Hence, the real concept of a 'landscape

[108] The landscape function is defined as "the interactions amongst the spatial elements, that is, the flows of energy, materials, and species amongst the component ecosystems" and the landscape change as "the alteration in the structure and function of the ecological mosaic over time" (Forman & Godron, 1986, p. 11).

biography' saw the light in human geography and was introduced by Samuels (1979) in the 1980s. He saw the landscape as the result of an 'expression' of authors and as human life worlds (cf. space in which humans lives) with a reciprocal relation between these life worlds and humans (Samuels, 1979). At that time, however, this concept was never used on a large scale and came on the background (Kolen et al., 2015). Later in the mid-1990's, the concept was reintroduced in landscape research by the archaeologists Appadurai and Kopytoff, hence without being aware of Samuels work. These archaeologists studied the cultural biography of specific objects or properties (e.g. goods and land properties) by analysing the transport, context, and use (Appadurai, 1986). These objects or properties connect the people's life histories (Appadurai, 1986; Kopytoff, 1986). Later, previous ideas were used in archaeological studies which focused on sites and monuments (Holtorf, 2002; Pollard & Reynolds, 2002; Roymans, 1995). This was the start of the abundant use of the concept 'landscape biography' in archaeology. However, compared to the landscape biography approach of Samuels (1979), the concept 'landscape' in these studies was not well-defined. Consequently, most of these archaeological studies focused only on one specific place ('on-site') and not on the landscape (Kolen et al., 2015). Since 2001, the Dutch landscape biography approach saw the light and steadily developed (Bloemers et al., 2010; Kolen et al., 2015). This approach sought inspiration in the concepts of human geography (cf. Samuels) but also incorporated influences of anthropology (cf. Appadurai and Kopytoff) (Appadurai, 1986; Kolen et al., 2010; Kopytoff, 1986). This Dutch biographical approach was developed in an integral manner by incorporating knowledge of archaeologists, historical geographers, and historians. The construction of the Dutch approach was firstly a reaction on the ongoing subdivision between disciplines as scholars were researching separate aspects of the historic landscape without exchanging findings and information. Secondly, this new established approach was a reaction on the way current landscape planning dealt with historical knowledge of cultural landscapes. The difficult connection between knowledge of old landscapes and new landscape plans had to be resolved (Kolen et al., 2015) by encouraging planners and other stakeholders to take into account the past landscape to a greater extent (Antrop & Van Eetvelde, 2017). The main objective of the Dutch approach was "to explore how landscapes have been transmitted and reshaped from prehistory to the present, viewing landscape at each point in time as the interim outcome of a long-standing and complex interplay between agency, structure and process" (Kolen et al., 2015, p. 28).

In this dissertation 'short' (cf. 1914-today) and 'partly' (cf. humans and spatial relations) performed landscape biography in chapter 5, the 'relational approach' was adopted to describe the specific relations between humans in the landscape and their influences on the observed landscape changes from the previous chapters. Briefly summarized, the relational approach developed within geography in the 1980s and came as a reaction on the previous and still ongoing 'quantitative revolution', in its turn developed in geography in the 1950s and 1960s[109] (Barnes, 2001; Matthews & Herbert, 2013). This 'quantitative revolution' (Gould, 1979) was positivist (Hubbard & Kitchin, 2010) and dominated by calculations and the measurements of (regional) factors (e.g. distance) (Murdoch, 2006). The end goal was to make an abstraction of the performed studies in search of abstract universal models (Bathelt & Glückler, 2003). These models were seen as 'spatial codes' to interpret geographical information (Gould, 1979; Murdoch, 2006, p. 11).

[109] This revolution was in his turn a reaction on the landscape research studies (or regional geography), and was designed to make geography more scientific instead of descriptive (Matthews & Herbert, 2013).

The quantitative revolution and positivist representations of space were criticised. It was argued to be 'naïve' by representing space to simplistic (Bryant et al., 2011). Therefore, firstly, scholars argued that other factors of other disciplines had to be included to describe the space such as geology, biology and physics, (Gould, 1979) and secondly by taking into consideration the previous mentioned relational approach (Barnes, 2001; Bathelt & Glückler, 2003; Murdoch, 2006; Tickell et al., 2007). In this relational approach scholars argued that human relations (cf. economic, politic, social) that shape the region have to be taken into account. Indeed, an understanding of how social groups and social actors work together to 'create space and place' was missing (Murdoch, 2006). Such relations are continuous being constructed and reconstructed in time and space. Consequently, regions are also differently being developed in time and space (Massey, 1979; Meegan, 2017). Thrift (1990, 1991, 1993) argued that space absorbs human actions and is therefore a continue process. The context of these human actions should always be considered when studying the relationship between human and nature (Thrift, 1990). He also argued that one has to see "people as agents, places as contexts, and causality as an iterative procession of fast-moving actions and slower-moving structures of interaction (Thrift, 1991, p. 456). Without going further into detail, in this dissertation stood the role and context of the human central.

The use of Geographic Information Systems (GIS) as part of the geographic information science[110] (De Maeyer & Van de Weghe, 2007) is common in all the chapters (Figure 6-2). These systems are "a powerful set of tools for collecting, storing, retrieving, transforming and displaying spatial data" (Gomarasca, 2013, p. 11). The use of these systems is part of the field of geomatics[111] (Konecny, 2003). In the context of geography, GIS can be seen as an 'assistant' to analyse geodata (De Maeyer & Van de Weghe, 2007; Lilley, 2016; Svenningsen, 2015). GIS arose from several fields: cartography (automating the map-making process), computer graphics (particularly to design buildings, machines, and facilities), remote sensing (digital image data had to be processed) and databases (created the mathematical structure to handle the problems in cartography and computer graphics) (Konecny, 2003). In chapter 2, the HLC and LCTA were based on geodata (cf. LULC) in GIS. In chapter 3, the shell hole landscapes were analysed on LiDAR, also in GIS. In chapter 4, LULC maps from GIS were implemented in the software Fragstats. Last, in chapter 5, LULC changes and patterns that were analysed in GIS were used as one of the elements in the conceptual framework of the landscape biography.

[110] This is also sometimes described as 'GIS' (De Maeyer & Van de Weghe, 2007). Hence, in this dissertation I mean with 'GIS', the systems and not the sciences.
[111] See footnote 105.

Table 6-1 Overview sources, techniques and software with the associated subdisciplinary or interdisciplinary relation or subfield

Sources	Related discipline	Chapter
Historical and contemporary aerial photographs[112]	Historical geography Landscape archaeology	2
LiDAR	Landscape archaeology Remote sensing (geomatics) Geomorphology	3
Shell hole map	Landscape archaeology Topography (geomatics)	3
Literature	Historical geography	5
Techniques	**Related discipline**	**Chapter**
Historic Landscape Characterisation (HLC)	Historical geography Landscape archaeology Historical ecology	2
Landscape Change Trajectory analysis (LCTA)	Time-Geography Landscape ecology	2
Modifications of LULC	Landscape ecology	3
Landscape biography	Human geography Historical geography Archaeology	5
'Relational approach'	Regional geography Human geography	5
Software	**Related discipline**	**Chapter**
Fragstats	Landscape ecology	3
Geographic Information Systems (GIS)	Geomatics	2,3,4,5

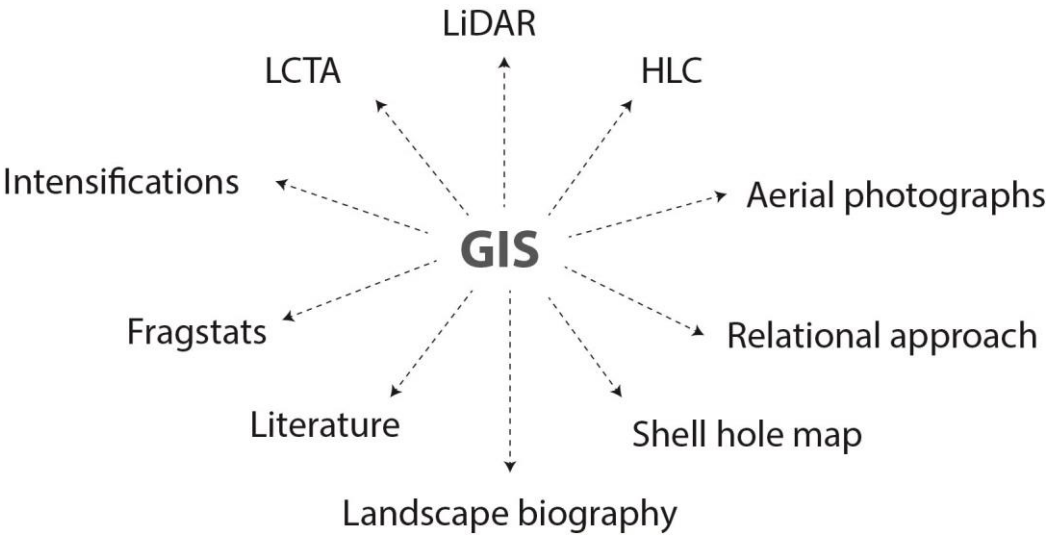

Figure 6-2 GIS as the central role

[112] Approached following the Historic Landscape Characterisation.

6.1.2.2 Contribution of the dissertation

After describing the previous relation towards other disciplines, the following question arises: To what discipline is this thesis a contribution? Arguably, this research was conducted within the discipline military geography and used other geographical techniques coming from historical geography, regional geography, human geography and time-geography (Table 6-1); this to study the conflict (Woodward, 2005) with GIS techniques that had their origins in geomatics.

Hence, the main subject of interest in military geography is the landscape which contains many aspects to study (Table 1-2) (Russell, 2010). By studying all these aspects, the landscape was approached in a 'holistic' manner (Antrop & Van Eetvelde, 2017). However, to study these aspects techniques were - besides the already used geographical techniques - necessary of other disciplines, making this a boundary crossing subject (Palang & Fry, 2003; Tress et al., 2003). These techniques had their origin in geography (historical, human and regional), (landscape) archaeology, landscape ecology and geomatics (Table 6-1). Hence, this dissertation is arguably still basically (military) geographically orientated being a part of the landscape studies that is using besides the geographical techniques, also aspects and techniques of other described disciplines that are also being 'landscape orientated'.

We must be aware that the previous description of the conducted discipline in this dissertation (cf. military geography) is made from the viewpoint of the researcher of this dissertation, namely a landscape researcher educated in geography. This viewpoint sees the current research activities in this dissertation as the standard benchmark against which other previous and existing research is compared. In other words, this opinion of a geographical approach is socially structured and immanent in the sense that this opinion is limited to personal experiences. Another viewpoint would be one of a person standing outside the studied discipline and who would study the applied techniques generally seen form his point of view (Scott, 2000). Eventually, since knowledge is always socially related (Latour, 1991), it is not possible to perfectly describe the discipline that is approached within this dissertation, as 'classifications' are always wrong and subject for discussion (Scott, 2000).

6.1.3 Expanding GIS-database

In previous section, we argued that GIS has a central role in this dissertation. The start of this notable role started already at the beginning of this dissertation (Chapter 2) and 'predicted' already the subsequent importance of GIS in the consecutive parts of the dissertation (Chapters 3, 4 and 5). More specifically, the choice of the composition of the spatio-temporal database (land use/land cover and linear structures) in GIS at the start of this research, defined the path that one had to follow in the dissertation. This meant that all the landscape research questions could be answered by use of the spatio-temporal database and the associated context in which this database was created, namely GIS.

GIS was used to analyse (Chapter 2, 4 and 5) and integrate datasets (Chapter 3). By analysing the spatio-temporal landscape dynamics in the consecutive parts of the dissertation, the GIS spatio-temporal database continued to expand (Figure 6-3). Spatial joins, dissolves, intersects, calculations, conversions, data management tools, etc. were frequently executed, resulting in a constant growing amount of spatio-temporal information. By doing so, this constructive database 'released' always more valuable landscape information in the context of WWI in Flanders. The consecutive landscape information contributions completed towards the end the understanding of dynamics in the militarised landscape.

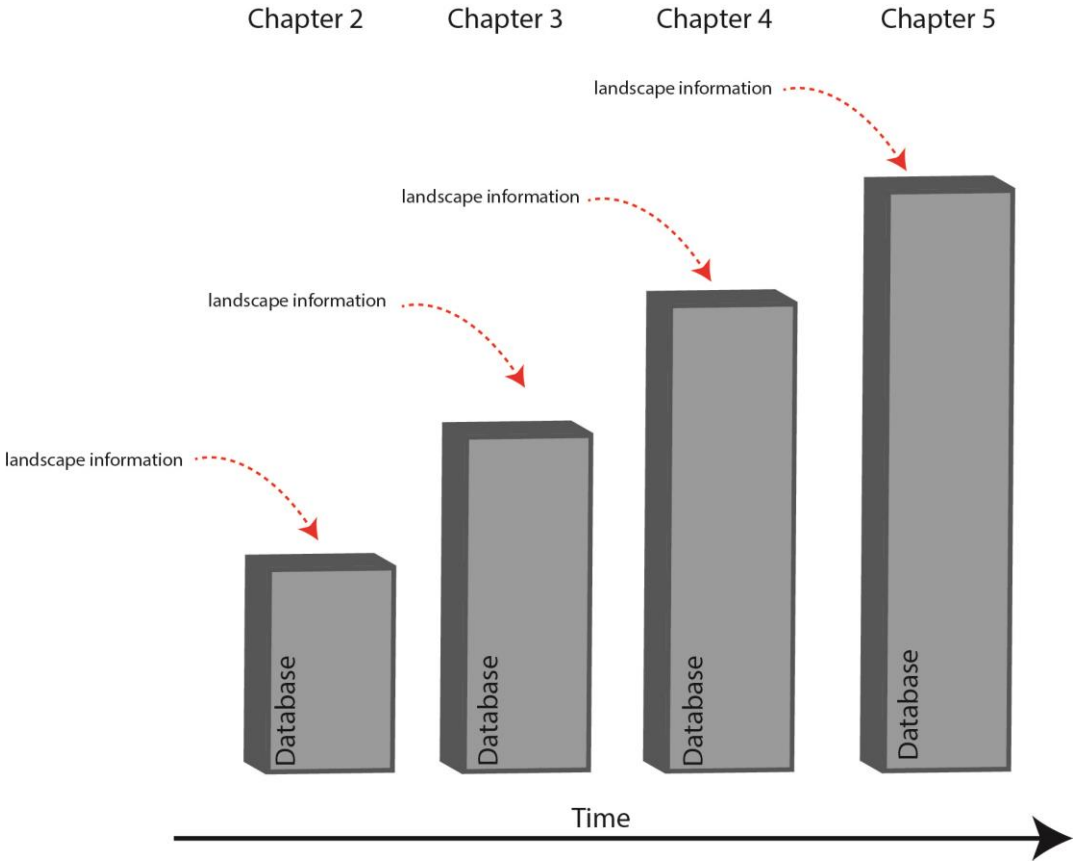

Figure 6-3 Developing GIS database in time by continuously adding and integrating landscape information

6.1.4 Study areas

In the beginning of this dissertation, three study areas (or transects) were selected. Each of them represented another area with different landscape features and experienced warfare during WWI. The selection of several study areas was called the 'multi-site case study approach' (Mills et al., 2009). The setup of three study areas in this dissertation proved to be useful in four ways. First, methodologies and the associated results could be compared in and between different areas, indicating that the methodology could be applied in landscapes with different landscape characteristics and with other warfare (Chapter 2). Second, another study area could be specifically used as a validation area (Chapter 3). Third, each analysis has its own criteria before the analysis can be performed. Because three study areas were available, the one that suited the best the criteria could be selected for analysis (Chapter 4). Last, the evolution of the militarised landscapes in different areas could be analysed (Chapter 4). Each of these will be briefly discussed in the following paragraphs.

In chapter 2, the use of three different areas proved the complementary relationship between the impact analysis and the trajectory analysis. This complementary relation could be statistically detected by calculating the Spearman correlation (Kutner et al., 2005) between both analyses in the three study regions. This correlation seemed to be rather low indicating that both are not correlated and provided other landscape information. The trajectory analysis evaluated the possible preservation of constructive WWI heritage and the impact analysis estimated the preservation of both constructive and destructive heritage. Because the relatonship between the two methodologies was proven in the three regions, one can conclude that this methodology can be applied in various regions.

In chapter 3, one (main) research area (study area 3, Kemmel area) was chosen to analyse the relationship between the preservation of shell holes in the microtopography today and the history of LULC. This was done by researching the relation between on the one hand the LULC changes, the associated intensification processes and their sequences (cf. trajectories) and, on the other hand, the exact location of preserved shell holes in the microtopography. A clear relation was found between specific trajectories and the presence or absence of shell holes today. To validate this proven association, another area was investigated (study area 3, Ypres and surroundings), this to confirm that this relationship was - besides the main study area - also generally recognisable in the wider landscape.

In chapter 4, three study areas were investigated to generally evaluate the dynamics of landscape patterns in the last century. Another aim was to investigate the relationship between the military impact and the influence on changing patterns in the post-WWI landscape. To do so, spatial variability had to be obtained by dividing the study areas into sample areas (1 km^2) with each a different average weighted military impact. Hence, the third study area (Kemmel region) provided the most 1 km^2 samples. Consequently, this area was used for this analysis because the more samples were available, the more the statistical results were reliable (Kutner et al., 2005).

Also in chapter 4, the results of the landscape pattern analysis could appoint clear differences in the changing post-WWI patterns of study area one (Nieuwpoort) versus study area two (Ypres) and three (Kemmel). This indicated that the reconstruction trends are not similar in each area and proved that the study of the war outcomes cannot be generalised by analysing only one study area.

6.1.5 Land use/land cover and linear structures database

In this dissertation, the landscape was particularly analysed by use of the spatio-temporal database which contained information of both land use/land cover and linear structures. Reflecting back on to what extent the database was used, one can conclude that the part of the database containing the historical land use/land cover information was the most important part of this research. In chapters 2, 3, 4 and 5, this specific landscape component was repeatedly analysed or processed in different analyses, each indicating different landscape information of interest. On the contrary, the part of the database that consisted of linear structures was less adressed for the predetermined research goals. In chapter 2, this linear information was analysed to examine the landscape one dealt with in the exploratory analysis and to define the historical characters. An overview was given of the abundance of types of linear structures and the way this changed in the past hundred years. Also in chapter 5, linear data was used to set up the conceptual framework by selecting the main landscape changes, patterns and trends in the last hundred years. However, despite the fact that less use was made of the linear structures in comparison with the land use/land cover data, the analysis of these at the beginning of this dissertation gave a more integrated view on the militarised landscape and made it possible to understand the militarised more profoundly in the further steps of this research.

One of the main consequences of the use of the spatio-temporal dataset is that this defined the format of spatial data for the following chapters. Land use/land cover data and linear structures were categorically defined by using the methods of the Historic Landscape Characterisation. With the introduction of these categorical data as the basis of this dissertation, designed tests, models or analyses relying on these data were also predestined to be categorical. Consequently, statistical analyses were limited to tests specifically designed for categorical data (Kutner et al., 2005). In chapter 2 for instance, results of the impact analysis and the landscape trajectory were both defined as categorical as they relied on the land use/land cover data. Consequently, only the categorical test could be used to define the correlation between the impact and the trajectories (cf. Spearman rank correlation test). The same occurred in the other chapters. On the contrary, this trend of designing

and creating categorical landscape information in the consecutive chapters was once 'broken' when landscape patterns were analysed with the software Fragstats in chapter 4. Results of landscape metrics were compared with the weighted average impact factor. The impact factor was before also only categorical (Chapter 2), but was transformed to continue data in order to compare this with the results of the landscape metrics. In this case, it was possible to perform a continuous statistical correlation test (cf. Pearson correlation test).

The spatio-temporal database was assembled with the predetermined aims of this dissertation in mind and was therefore based on three aspects: The Historical Landscape Characterisation, the selection of historical aerial photos as the main source and the decision to determine land use/land cover and linear structures as the main landscape elements for the landscape characters. This database was set up with the thought that it would be possible to conduct several archaeological, morphological and historical change analyses (Fairclough, 2003), that would contribute to the analysis of the dynamical militarised WWI landscape (section 1.2). By doing this research, we can confirm this thought as many different types of analyses in the three subjects were made. Historical analyses were made by analysing the evolution of the landscape in different ways. Chapter 2 analysed landscape changes with the LCTA methodology, chapter 3 studied the evolution of LULC in function of the preservation of shell hole landscapes, chapter 4 investigated the historical dimension of landscape patterns and last chapter 5 was specifically interested in the historical facts and interests of actors. Also morphological aspects were investigated by analysing the microtopography of shell hole landscape in chapter 3 and by analysing the landscape structure in chapter 4. Last, archaeological analyses and interests emerged by conducting research into the preservation of WWI relics. In chapter 2 the possible preservation was indicated, chapter 3 handled the specific preservation of WWI shell hole landscapes and chapter 5 researched the historical preservation of all WWI relics by investigating the responsible actors and actions.

At the beginning of this research four time periods (1915, 1918, 1940 and 2012) were selected to focus on. However, the hundred years' study in four time slices was not extensive. We argued that these were chosen because on the one hand the objectives of this paper focused on the landscape changes between the beginning, the end and after the war. On the other hand, choices had to made for the time phases analysed as the process of digitising was time consuming. Yet, qualitative landscape information was obtained between 1940 and 2012 by consulting abundant literature and historical maps in order to determine the main responsible actors for the preservation of WWI relics (Chapter 5). By doing so, the researched landscape changes between 1940 and 2012 (Chapters 2, 3 and 4) could be placed more into perspective and were better understood.

6.2 Reflection towards other conflicts and relevance of this approach

Military geographies "[…] are everywhere; every corner of every place in every land in every part of this world of ours […]'' (Woodward, 2005, p. 719). After analysing the historical dimension of the WWI militarised landscape in Flanders, one can easily confirm this statement. Hence, following Woodward (2005), military geographies are created by more than one occurred conflict in the area. This dissertation only investigated one conflict. If one would investigate also the other occurred conflicts in Flanders (going back in time or later then 1914-1918), it would be easy to confirm that the landscape is saturated with conflict footprints (both cultural and morphological), which form separate layers in the landscape (Woodward, 2010). This landscape can be compared with a 'palimpsest' whereby older layers of conflicts are erased, adapted or intensified by more recent conflicts (Antrop & Van Eetvelde, 2017; Mills et al., 2009; Palang & Fry, 2003). As Warf (1997) argued, military geographies are "multiple layers of base openings and closures reflecting the accumulation of strategic locational decisions over time" (p. 544).

This dissertation gave already small insights to this point of view of a 'palimpest', as also WWII relics and events were discussed besides these of WWI (Chapter 5). These can be considered as a new conflict-layer in the landscape of Flanders. If one would only pay attention to the traces of WWII in the landscape of Flanders of today, it is clear that WWII is another conflict-layer that left its traces and contributes to the military geographies of Flanders. Without executing any scientific research, this can be well illustrated by a recently published newspaper article in February 2019. The article argued that currently, eighteen Belgians civilians still receive a German war pension as a result of their collaboration with the Nazis during WWII (Figure 6-4). With this article, we can conclude that even a half of a century after WWII, WWII narratives still emerge today, reflecting back to the past and being a part of the military geographies of Flanders.

'Achttien mensen in België krijgen Duits oorlogspensioen, geen SS'ers'

21/02/2019 om 13:09 door evg | Bron: BELGA

Figure 6-4 Newspaper article "Eighteen people in Belgium still receive a German war pension, no SS'ers" (De Standaard, 21 February 2019)

This newspaper article in the context of WWII is only one example of the (unperceivable)[113] traces of other military geographies in Flanders of today; this besides WWI. Another conflict layer of a more recent conflict was perceived and discussed in the newspapers of January and February 2019. Recently, the United States of America imported hundreds of tanks, vehicles and helicopters in the ports of Antwerp and Zeebrugge, located on the North Sea. These were afterwards transported through The Netherlands and Germany to a final destination in East-Europe (Figure 6-5). The

[113] Military geographies can be visible or invisible (Russell, 2010).

transport was needed to support the operation 'Atlantic Resolve' that started in 2016. This operation has to prevent Russia from invading allied countries of the United States such as Ukraine (www.vrt.be/vrtnws, 26 January 2019). Because Belgium is one of the NAVO partners, the country supported and helped the import of military material from the United States of America to East-Europe. In cooperation with the head of the harbour of Antwerp, the military defence of Belgium established a private and protected 'support-zone' in the harbour of Antwerp (www.defensie.be, 30 January 2019). From this example, we can conclude that this event belongs also to the military geographies of Flanders as a 'support-zone' in the port of Antwerp was established. Hence, the uniqueness this time lies within the fact that the physically conducted conflict is located in East-Europe and not in Flanders, contrary to the cases of WWI and WWII.

Figure 6-5 Left: Imported tanks from America transported from the port of Antwerp (BE) (www.defensie.be, 30 January 2019); Right: Transport of tanks towards East-Europe, perceived in Roosendaal (NL) in 2019 (K. Van den Berghe, Roosendaal, 1 February 2019)

Information derived from the previous discussed newspaper articles contribute each to the fully understanding of all military geographies in Flanders, resulting from different conflicts. However, the context and the history behind the articles are lacking and are not known only from reading the newspapers. This brings us back to the discussed newspaper articles at the beginning of this dissertation (Chapter 1, p. 1). We started this dissertation with the following headline of a newspaper article:

> *"Those of Ypres think that all of World War I took place with them"*
>
> *(Sandy Ervard, 16 April 2014, p. 10).*

We discussed, in the same manner this newspaper article as the previous mentioned examples of WWII and the NAVO. Moreover, we tried to unravel why Sandy Ervard made this quote by analysing other newspaper articles published with the same topic. Hence, after researching many aspects of the militarised landscape of WWI from 1914 upon today, we are now able to interpret this newspaper headline in a different manner. The first reaction on this headline was – before researching the WWI militarised landscape in this dissertation - rather shocking and confronting towards the civilians and policy members of Ypres. However, the new insights in this dissertation put this quote into perspective as we now understand why remains in the region of Ypres are more abundantly present in the southern regions of the Westhoek and why this region obtains more (inter)national interest. We also now understand why other municipalities on the former front zone (such as Sandy Ervard) argued that they deserved the same 'attention' as Ypres and why exchange of finances between interacting stakeholders for the development, care or restorations of preserved

war monuments and heritage sites were unevenly distributed between municipalities in the Westhoek. Furthermore, we also know now where WWI remains are economically seen important in the Westhoek.

Previous 'why's' and 'where's' can all be answered by consulting the results of the analysis of the changing militarised landscape in the past century starting from 1914 upon today (Chapters 2, 3, 4 and 5). Indeed, Woodward (2004) argued that explanations can be formulated on the 'why's' and 'where's' by doing military geography. By looking to the developments of touristic activities for instance (cf. landscape changes and related patterns) and the relation of these towards WWI heritage policy (cf. responsible process of change), many answers can be formed. Or by analysing the economic interests of heritage policy (cf. process) and by consulting the related (unevenly distributed) developments for touristic purposes in the preparing years of the centenary (cf. the changes and patterns), causing each another impact of change, additional information can be delivered.

Basically, one is able to understand the newspaper articles[114] in a new manner after applying geographically conducted landscape research related to a conflict. Historical knowledge of the changing landscape brought new insights that placed quotations and newspaper articles in a new perspective. Therefore, we argue that the analysis of our study can also be applied to other conflicts of interest, such as the newspaper articles of WWII or the article about the import of military material from the United States of America. Therefore, this dissertation opens up directions for further research in relation to other conflicts.

6.3 Synthesis of Flanders Fields

In the beginning of this dissertation, the process of militarisation in the landscape was visualised according to the interpretation of multiple theoretical concepts (see Figure 1-3). The action and interaction between both human (socio-cultural) and natural factors (biophysical) stood central whereby the landscape was described as the scenery of the conflict. It was described that this reciprocal relationship between the natural and human factors alters the military landscape (Caldwell et al., 2004; Collins, 1998; Larsen, 2004; Pearson, 2012; Rech et al., 2015; Woodward, 2005). After conducting research in Flanders Fields, a reflection can now be given on the theory formulated in Chapter 1 and a general synthesis can now be made. The latter is based on the results and conclusions of the previous chapters.

This dissertation started with the history of WWI as main research subject and can be seen as a reality that happened during 1914-1918. Spatial patterns and landscape changes that occurred during the war were described into detail. Hence, afterwards (or already during WWI), this reality was transformed into heritage and was/is being used for several purposes. The conversion of history into heritage can be subdivided into positive, neutral and negative trends. For instance, a positive conversion is the one of a flourishing trend or can know a climax. A good example of a positive

[114] This example has to be seen amongst other present-day sources which tell also something about the WWI landscape such as photographs, landscape experiences of tourists of locals, touristic maps, archaeological excavations, museum expositions, etc.

evolving process are the conversions that happened during the commemoration of WWI that lasted from 2014-2018. During this period (and the years before and after), many initiatives occurred and transformed history into heritage whereby a climax of heritage protections and cultural events were reached. Additionally, the conversion of history into heritage can also know a neutral trend such as a standstill whereby no progress can be noticed. For instance, the will to transform history into heritage in the post-WWI landscape was suppressed by another historical fact (cf. another reality), such as the WWII. Contrary to the positive trend, the process can also be negative, whereby heritage can be progressive but limited by means. For instance, after WWI, a bad running economy occurred whereby heritage initiatives were limited because of a shortage of investments on the one hand and because this conversion is not the priority on the policy agenda during a crisis on the other hand. Another negative trend can be noticed when there is no conversion of history into heritage but an easement of history occurs instead. In this case, one did not longer want to have anything to do with the reality that happened and wanted to forget it. The years after WWI for example, people felt lost and angry and wanted to erase as fast as possible the remnants of the destructive war.

The previous described positive, neutral and negative conversion of history into heritage depends on the reciprocal relationship with the socio-cultural, economic and political actors involved in the landscape (Chapter 5). Thus, the creation of heritage from history depends on the needs and demands of a particular society which are embedded in the actors and their actions. These actions can have a direct impact on the landscape whereby the land cover (Chapters 2 and 4) and also the micro-topography (Chapter 3) changes. An indirect impact can also be noticed whereby the land use of the landscape changes (Chapters 2 and 4). In turn, the changes induced by (in)direct impact of the actors and their actions, have also an influence on the actors.

Notably, the conversion of history in heritage has three characteristics that have a defining role whether a positive, neutral and negative trend occurs, these are: time, space and scale[115]. Firstly, the conversion can change in time; thus also the actors and their actions vary in time. In other words, the value or importance of WWI heritage is dynamical by nature. After the war for instance, the historical value of WWI heritage was less important than during the commemoration of WWI. Secondly, the conversion of history into heritage also varies in space. On the frontline for instance, the WWI remnants have a different history and have therefore a different meaning when these are transformed into heritage. Lastly, the conversion differs also in scale. This scale can be noticed within the actors and their actions. For instance, several layers of heritage policy exist, going from local to international level. Each level considers the history and thus also the related heritage in another manner. The local governments saw the conversion of history into heritage as an opportunity to strengthen the local identity and to develop the local economy (cf. tourism). On an international level, Belgium wanted to profile Flanders Fields as a peaceful area within Europe whereby the intention to strengthen international relations by using the history of WWI.

In Figure 6-6, the previous described synthesis of Flanders Fields is visualised. This figure is differently than the figure represented in Chapter 1 (Figure 1-3), whereby the focus in this figure in this chapter is lain on the conversion of history into heritage as the results in this dissertation showed that this process was the leading thread in the history of Flanders Fields. Moreover, the action and interaction

[115] The three described components position this synthesis of Flanders Fields well within the geographical studies of heritage (Graham, 2002; Harvey, 2015; Wallis & Harvey, 2017).

between human and physical factors which was described in Chapter 1 is now more specified. The human factors are now labelled as socio-cultural, economic and social actors with associated actions. These have a direct and indirect influence on the previous described natural factors in Chapter 1, which is now labelled as land use/land cover and the micro-topography. These described elements[116] were chosen as these were investigated within this dissertation and proved to have a reciprocal relationship with the actors.

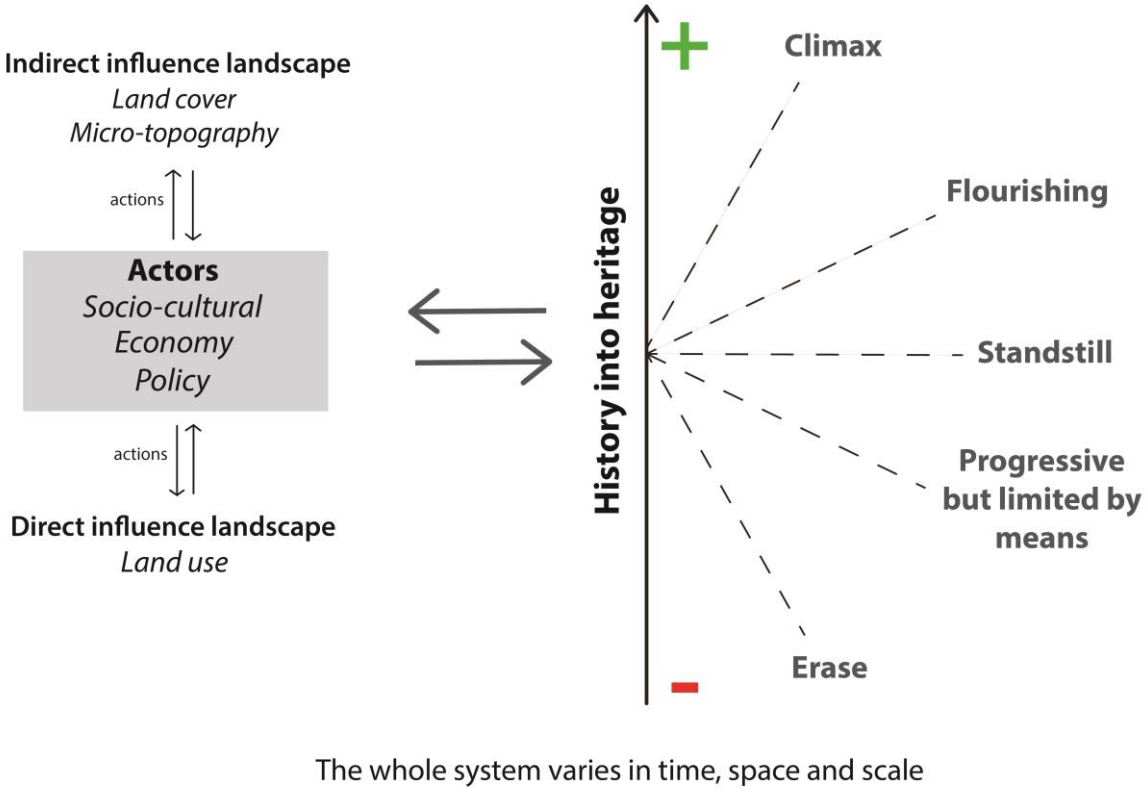

Figure 6-6 Synthesis of Flanders Fields with the conversion of history into heritage as the central role

[116] These described elements can always be more extended with other investigated elements in the biophysical landscape.

6.4 Directions for future research: Is there a future for the past?

Based on the main findings and experiences with methodologies, some directions for future research emerge:

- Several manners were conducted to obtain landscape information of the militarised landscape: landscape change information, location shell hole landscape, impact factor, etc. Therefore, it would be interesting to merge all the available landscape information (cf. landscape change information) to make a prediction model (e.g. multiple linear regression with 'Y' as the chance of preservation of WWI relics and the 'X's' would be the obtained landscape information). This model would give new insights into the prediction of the preservation of WWI relics in the present-day landscape and would help to make sustainable decisions in future landscape planning of the WWI heritage landscape in Flanders.

- Following on the above suggested prediction model, it would also be interesting to find a way to extrapolate the findings of the militarised landscape of WWI to the entire region. Can the derived information of the WWI landscape be generalized for the whole front zone in Flanders?

- The information 'gap' between 1940-2012 could be filled in by analysing other aerial photographs of Flanders. Hence, an automated way to digitise these studied areas which occupy an area of 208.6 km^2, would expedite the process of digitising landscape information.

- In this research, LULC information was particularly investigated. One way to make more use of linear structures in landscape change analyses would be to carry out a specific WWI network analysis that focuses on linear structures as the construction of military roads and railroads during WWI were mapped in detail in the spatio-temporal database. More roads and railways appeared in Flanders during the four years of the war, resulting in a dense military network towards the end of the war (1918). This network is also part of the militarised landscape and therefore it would be interesting to analyse how this network evolved in time. Many tools exist in GIS to analyse networks. For instance, the shortest distance from one point in the landscape to another can be calculated. This would give insights in how combatants and other stakeholders 'moved' in the militarised landscape from the frontline to the hinterland and in the other way around. By taking into account the topography and the military destruction (cf. the least expensive way) one could understand these 'movements' more specifically.

- Another manner to investigate the established military network would be achieved by performing a viewshed analysis. From any point in the military landscape, it can be shown which area was visible. The literature has already qualitatively described this in historical sources. For example, clear views of the enemy could be obtained from the Ridge of Westrozebeke. However, with the analysis of the viewshed, these views would be examined more quantitatively. Going one step further, these views could be investigated more profoundly by including existing historical panoramic photographs into the analysis (Barton, 2008). Afterwards, the visible area of the viewshed analysis can be determined on the photographs so that the situation during WWI can be better represented. However, previous ideas are rather 'superficial' as they only incorporate the military network of roads and railroads of two time phases (cf. 1914 and 1918). In between both years, many changes occurred in the landscape. Therefore, it would be interesting to connect the database of linear structures with another WWI network database of linear features that has spatial linear information of the years between 1914 and 1918 (Stichelbaut, 2011). By doing so, the results of the network analysis would be more reliable and realistic. The analysis of changing

linear structures of the First World War, however, remains a complex phenomenon to study. Each specific military 'line' could change from day to day because the warfare was very complex with many consecutive battles. Therefore, this proposed network analysis would be an abstraction of reality.

- The advantage of this database is that one is able to add an infinite number of additional referenced information layers to this database. This expanded set of landscape information layers would give the possibility to answer other and more research questions in the field of historical, archaeological and geographical interests. For instance, the soil types and the associated erosion factor can be added to this database which would give more information about the below-ground preservation of WWI remains (e.g. trenches, tunnels) by analysing this together with the above-ground changing LULC. Also, the location of toponyms derived from WWI maps can be linked with the spatio-temporal dataset. To unravel the real meaning of these toponyms given by the Allied or German forces, the location can be compared with the occurring LULC in that time. Another example of an extra information layer would be the location of WWI fallen of the Commonwealth during wartime. These locations were systematically written down by the Commonwealth War Graves Commission (Longworth, 2003). By analysing these locations for instance in relation to the landscape changes, the front movements (cf. how many times a specific area changed from hinterland to the front zone) and the location of trenches, one is able to understand the location of the fallen more into detail. Hence, previous examples can often only be realised by incorporating knowledge and insights of other disciplines (e.g. landscape archaeologists, geologists).

- In this dissertation, many spatial results were obtained that answered the predetermined research questions. These handled mainly the heritage of WWI and not the history. Hence, it would also be interesting to analyse the obtained in relation to military objectives. The following questions can be addressed: Which areas were the most shelled? Why were these most shelled? Has this something to do with a military strategy? Are the locations of the offensives and counter-offensives visible in the spatial results? Are there any variations in the military destruction along the frontline?

- Three different study areas were investigated with each different landscape characteristics. Three different fields of study were investigated with a different type of landscape. The focus in this dissertation was not specifically on the evolution of the characteristics but on the evolution of the entire militarised landscape. Therefore, it would be possible to perform an in-depth analysis of the evolution of these characteristics by analysing for instance the evolution of hedgerows in the typical Flemish *bocage* landscape (Antrop, 2006) in the past century and to understand these with the obtained knowledge of landscape changes.

- This dissertation mainly focussed on the preservation of WWI relics in the present-day landscape. Yet, it would also be interesting to address this focus in the other way around: How many of the WWI relics are already gone and are disappeared? How can we analyse the lost WWI heritage?

- As a final consideration in this enumeration, I focus on two future directions of this research in the context of contemporary and future policy which are within the scope of the second part of the title of this section: “is there a future for the past?” (section 6.4). Firstly, as I carried out a comprehensive analysis of the protection history of WWI heritage in Flanders (Chapter 5), I understand now why WWI heritage was (not) protected in the past century. I found more specifically that there were incentives that triggered the protections of WWI heritage. One of these was a comprehensive study conducted by scholars of the city of

Leuven (cf. Resurgam, 1985) that induced the protection of architectural heritage of the WWI reconstruction period. Moreover, the information found by scholars was added to the dossiers of the already protected reconstructed buildings and made these completer (Braeken, 2011; Duvosquel et al., 1985). It can be concluded from this example that the research carried out by these scholars was transformed into policy. In this context, the WWI landscape information derived from this dissertation can also be implemented into heritage policy or can also evoke a new phase of WWI protections. In other words, the knowledge obtained from this dissertation can be processed while preparing protection dossiers or can be added to already existing protection dossiers in order to make these completer with new scientifically based landscape information. Additionally, one of the new protection phases which would rely on this dissertation could be the protection of fields with a notable and outstanding micro topography derived from WWI shelling. Secondly, the spatio-temporal database that formed the basis of this dissertation was set up by combining landscape information into landscape characters (HLC) types (Chapter 1). As mentioned before, HLC types offer the understanding of the time depth of a landscape which is useful for planning processes or spatial development (Fairclough, 1999, 2003). Consequently, the landscape information that can be identified from the landscape characters in this dissertation (cf. time depth), can also be used for planning purposes as a supplementary planning guidance in the Westhoek region. Hence, for spatial planning purposes, the HLC methodology needs to be taken one step further by incorporating the knowledge and ideas of planners and other stakeholders as well. By doing so, the sense of place in respect to the local character would be maintained.

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CHAPTER 7 – CONCLUSIONS

The WWI militarised landscape proved to be much more than only the obvious WWI remains in the present-day landscape and narratives from literature and newspaper articles. In section 7.1 the main results are presented, focusing on the questions defined in the introduction (section 1.5). These research questoins were investigated per chapter. Afterwards, the main research question of this dissertation is answered (section 7.2).

7.1 Research questions

A. What military landscape characters does the current cultural landscape in Flanders Fields has today? (Chapter 2)

In order to determine the military landscape characters, landscape information visible on historical aerial photos needed to be determined following the methodology of the Historical Landscape Characterisation. In total, eleven historical landscape characters were defined (e.g. arable land, pasture, castle park, etc.) that were based on land use/land cover and military influence. The landscape characters could be divided in the original state 'o' and the military influenced state 'i'. With this information a spatio-temporal database was composed which spatially located the landscape characters; this for three study areas with different landscape features and different associated WWI military activities, covering in total 208.6 km^2 (Chapter 2). The spatio-temporal database was also based on concepts from the Landscape Change Trajectory Analysis. The resulting spatio-temporal database became the basis of this dissertation, because various analyses in the other chapters were based on this spatial information (Chapters 3, 4 and 5).

B. How high is (the degree) of preservation of WWI relics in the present-day landscape based on landscape changes in the past century? (Chapter 2)

To determine the possible preservation of WWI relics, an initial exploratory overview of the landscape changes in the spatial temporal database was necessary in order to obtain general knowledge of the landscape. This overview indicated that the pre-war '*polder*' and '*bocage'* landscape (hedgerow landscape) in Flanders rapidly changed during wartime (1914-1918) into a militarised landscape due to added military constructions and destructions. Inundations, shell holes, military roads, trenches, railroads and bunkers are some examples of military disturbances observed on valuable historic aerial photographs. This military impact in the southern part of the front (region of Ypres and Kemmel) was heavier than the northern part (region Nieuwpoort), in the sense of military destruction and not saline water damage as a result of inundation. More than the half of the area on the southern frontline was wiped away into craterland with only a few recognisable military features. The heavily fought higher parts of the landscape ('Westrozebeke Ridge' and Flemish Hills) mainly marked the zone full of craters. This zone was connected with a dense network of military roads and railroads, which reached far into the hinterland. After the Armistice, the landscape had been completely transformed into a habitable area with more houses than before the war. This latter trend was together with the increase of industry and roads, noticeable until 2012.

After exploring the changing landscape, the possible preservation of military destruction (e.g. shell holes) and construction (e.g. shelters, trenches) relics could be determined in the front region (cf. frontline and hinterland) by applying two different analyses: The Landscape Change Trajectory Analysis (LCTA) and Impact Analysis (IA). Both analyses indicated an estimation of the preservation of WWI relics today, this for both constructive (LCTA and IA) and destructive WWI relics (IA). According to the LCTA, the northern part of the front region or the '*polder*' area has the highest possible preservation rate of remains of military constructions. This because 43.9 % of fields in the analysed

region did not show any change in the land use/land cover in the past century which increased the number of parcels with a possible preservation; this seen from 1915 upon 2012. These valuable territories are scattered in the area. In the southern part of the front zone (region of Ypres and Kemmel), the estimation of the preservation of relics of military constructions is lower. Only 10.8 % to 14.8 % of the studied areas marked a possible preservation which was also indicated by no changes in the land use/land cover in the past century. These valuable fields are mainly located in the hinterland. When focusing on the preservation of both the remains of military constructions and destructions (IA), the chances of locating WWI relics today are the highest in the southern part of the front region (Ypres and Kemmel region) as this region was the one with the most military disturbances. This region knew a high military impact by which 34.1 % of the area was disturbed. These territories are principally located along the front line.

C. Why are WWI shell hole landscapes (not) visible in the landscape of Flanders Fields? (Chapter 3)

During WWI, the frontline in Flanders was one of the most shelled areas. The landscape was completely wiped away by continuous artillery shelling. The half of the studied area knew heavily destructions with recorded shell hole densities of more than 480 shell holes/ha. In most of the other half of the studied area, shell hole densities were recorded of 200-480 shell holes/ha, which is still dense. Today, traces of these shell holes are still (scattered) visible in the microtopography of today. 19.49% of the studied area on the former front line still contains traces of shell holes in the microtopography whereof traces are approximately 25 % clearly visible, 50 % moderately visible and 25 % poorly visible. Fields with clearly visible traces of shell holes are logically associated with a high density of shell holes in 1918 (> 480 shell holes/ha). However, not all the fields with a high density of shell holes during the war still contain traces in the microtopography.

To explain the preservation or disappearance of traces of shell holes in the microtopography of the present-day landscape, the dynamics of land use/land cover changes were studied between the end of the war (the 'start'-situation of analysis with severe shelled areas) and today (the 'end'-situation of analysis with the recovered landscape). The assumption was that these land use/land cover changes had an influence on the changing microtopography of the past century. I could conclude that a history of arable land (hay land and crops) had a destructive effect on the preservation of shell hole traces. On the contrary, a history of grassland (pasture) and woodland is beneficial for the preservation of clearly visible shell holes today.

When the intensification processes – this approached as human inputs in fields (e.g. ploughing) to improve the output - are linked with each land use, new insights are obtained towards the preservation of shell holes. I concluded that the higher the intensity in the last century, the fewer shell hole traces are found in today's microtopography. Additionally, as the intensity increases, the visibility of the shell holes also decreases. From the latter, I conclude that a history of high intensity does not exclude the preservation of shell holes today. It has also been shown that only the study of the intensification processes that have taken place between the post-WWI period until today are the most important for the preservation of shell holes.

D. How can a landscape pattern analysis bring us additional knowledge of the post-WWI militarised landscape? (Chapter 4)

The spectacular reconstruction of the landscape after WWI with traditional influences was a complex and outstanding event in history and was, therefore, an interesting case to study. After the reconstruction period, this WWI militarised landscape continues to change upon today. When generally studying the changing land use/land cover in the landscape between the pre-war and post-WWI situation, it was noticeable that the reconstruction especially changed the militarised landscape in the cities and villages compared to the pre-war situation. This change was clarified by the

reconstruction of ruins into build up land (housing). After 1940, changes were particularly noticeable in the countryside due to the replacement of pasture and arable land into extra build up land (housing).

However, these described landscape changes of land use/land cover and other previous conducted landscape change studies (Chapters 2 and 3) did not indicated specific information of the changing spatial patterns in the militarised landscape. Compared to other dynamic landscape analyses, the study of dynamic patterns revealed additional knowledge of the occurred processes in the landscape (e.g. land use policy in the reconstruction period after WWI). The properties of these changing patterns could be studied with a wide range of landscape metrics and delivered insights in these processes.

The applied landscape metrics to the WWI militarised landscape of 1915 and 2012 showed that in the northern part of the former front area (region Nieuwpoort) properties of land use/land cover patterns are different than in the southern part of the area (region Ypres and Kemmel). The metrics indicated that the diversity and aggregation of the militarised landscape in the past hundred years decreased in the north while the opposite occurred in the south. This indicates that in these two regions opposing processes and related impacts have taken place.

When comparing specifically the patterns of the pre-war landscape with the post-WWI militarised landscape, it was clear that the reconstruction – which should be traditionally oriented following historical and contemporary literature (e.g. same location roads and the same land use) – was not identical compared to the pre-war landscape. This post-WWI landscape is generally less diverse, more fragmented and more aggregated compared to the pre-war situation. When the landscape was divided into different regions depending on the degree of military impact (constructive and destructive) during 1914-1918, the patterns in these regions indicated that this military impact (or the responsible process) had a notable influence on the resulting landscape patterns after the war. The higher the military impact in 1914-1918, the more diverse the land use/land cover in the landscape is and the less complex the fields are in shape.

I can conclude that a landscape pattern analysis brings innovative information of the changing WWI militarised landscape. Previous knowledge of the changing spatial patterns can help to control the processes that have set these changes in motion. When controlling these, these spatial patterns of the militarised landscape can be conserved or adapted.

E. Which (human) actors caused that the WWI militarised landscape still persists today, 100 years later? (Chapter 5)

It is undeniable that the role of humans and their actions in the WWI militarised landscape was enormous. Consequently, the landscape 'consumed' these actions. Humans abruptly altered the landscape during wartime by adding both military destructive and constructive elements. Afterwards, they changed the landscape again and completely reconstructed it. Today, remains of these historical human actions in the context of WWI are still preserved, disappeared or were demolished in the landscape of the past century by a path-dependent network of actors, their actions and mutual interactions, which is also called the 'warscape'.

When the war was still in progress, conflicting ideas and discourses had already arisen in the context of the planning of a traditional or modern reconstruction of the landscape. Traditionalists argued that not only the patrimony but also the entire Belgian pre-war landscape should be rebuilt according to the pre-war situation. Modernists supported innovative spatial plans and the use of modern materials. After the war, especially the progressive traditional - but limited by means – rebuilding occurred. However, a new 'kind' of actors arose, namely the 'preservers'. This group wanted to

preserve the ruins of WWI. Hence, they did not succeed because the protection of WWI remains was not seen as important in times of economic and financial crisis. Consequently, the focus of the 'preservers' changed from the preservation of ruins and destroyed landscapes to the construction of monuments. In Interbellum, these monuments were massively visited and improved the local economic opportunities. During WWI, the first protection of the WWI heritage was carried out, but the number of tourists also decreased. This period is marked by a standstill, from political, economic and cultural point of view. The first decades after WWII brought another economic and financial crisis. For some time, this 'blocked' the government's attention for the protection of WWI heritage. Starting from the sixties, WWI protections and tourism increased again which brought heritage policy into being again. Additionally, a new wave of WWII remains was introduced. To prepare the centenary peak (2014-2018) actors launched plans to sustain and/or increase tourism in the region, which also increased the number of heritage protections. The better accessible landscape and sites became a touristic and economic success.

The connecting thread in the past century, is in one way or another 'heritage' and how one dealt with it, cf. heritage policy. This reflects well the social, economic, political and cultural circumstances and actors that are also partly responsible for the preservation of WWI remains towards today.

7.2 Take-home message

Hence, what remains is to answer the general research question: 'How does the landscape tell the story of the First World War?'. Based on the empirical results, I argue that there is no clear answer to this question. Telling the story of WWI with the landscape as the 'lens' of research indeed depends in a reciprocal way on how one choses to look or to analyse this particular landscape. In other words, the starting point or used perspective determines for an important part the results. It is not "about what we see but about how we look" to the landscape (Wylie, 2007, p. 7) (see section 1.6.1). Such perspective is for example the terrestrial perspective of a painter which analyses the landscape while painting the destruction of the landscape, the terrestrial perspective of a photographer taking a photo of the painter and the surroundings (Figure 7-1), or by a bird's eye perspective from aerial photographs (Figure 7-2).

Each perspective offers us another possible understanding of the militarised landscape where 'possible' is meant in the broadest sense of the word. Everyone understands the military landscape in its own way, whether the observer is a scientist or a layman. The analysis of a landscape is always a social construct, depending on the characteristics of the viewer (e.g. background, expert, layman, …). It always starts with a particular person that looks to the landscape, or hears, feels or smells it.In general, first, a (terrestrial perspective) of a painter is on the one hand the most subjective, but on the other hand the most emotional. It positions the viewer right in the landscape. Nevertheless, the painting style is realistic or surrealist for example and raises a feeling and stirrers emotions, at least for some. Second, a photo is more objective – although one can choose its framing – and stands emotionally a bit 'further' of the studied landscape compared to the painter. The photographer (let's not use 'shot' here) photographed firstly the landscape by use of a device, and only secondary by a person. Hence, the photo as such captures the state of the landscape as it is in reality, without adding any personal feelings to this perspective. However, again the framing effect and the limits of the device cannot be ignored. Thirdly, the aerial photo stands – at least literally – the furthest away from the landscape. The used bird's eye perspective gives us an overview of the landscape. It provides a (momentous) structural overview of the landscape (e.g. the relief, networks or troops). Other possible perspectives derive from video's or texts, but these are less relevant (due to the absent of technology in that period) or are used within this dissertation as a secondary perspective (e.g. propaganda, policy), respectively. To conclude, each perspective delivers other and complimentary information of the landscape. However, this raises the question why one perspective

is more accepted than the other? I believe this relies on the policy agendas on a certain moment in time and on the associated funds at that moment in time.

Figure 7-1 Observation post painted by Achiel Van Sassenbrouck (1918). This photo was made by Arthur Bruselle from Bruges (source: City Archive Diksmuide)

Figure 7-2 American reconnaissance aircraft with aerial camera being unloaded (source: US National Archives)

This dissertation told the story of WWI by using or researching the bird's eye perspective with historical and contemporary aerial photographs in the first place. Two observers of the landscape are thus recognised: the photographer and the researcher which is looking to the photos. Subsequently, these were combined with a diverse set of research methodologies and research focusses such as landscape changes, land use intensifications, linear structures, constructive and destructive military elements, literature, visible and invisible military remains, the microtopography, landscape patterns and stakeholders. Separately and combined, these provided significant information and helped to enrich and nuance the story of the WWI through the 'lens' of the landscape. As such, this dissertation achieved to connect the 'technocratic' landscape of WWI (cf. from a bird's eye perspective) with more qualitative information coming from several perspectives. In other words, the objective has been enriched with the subjective, and vice versa. In this sense, arguably, this dissertation could be labelled as a rather 'traditional' geographic research. Traditional understood here as methodological pluralistic; in my opinion what landscape research is about.

APPENDICES

The appendices are numbered according to the chapters.

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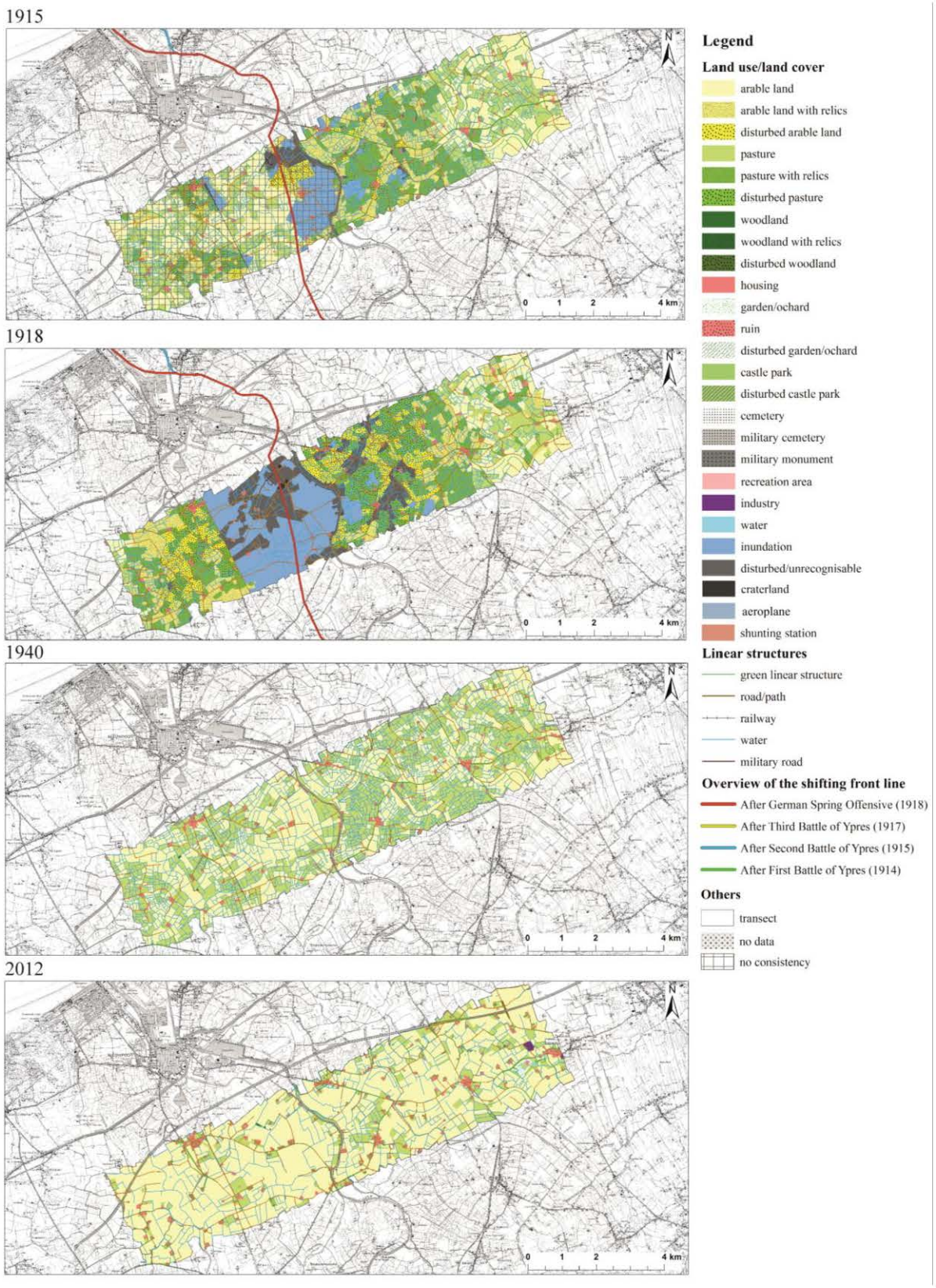
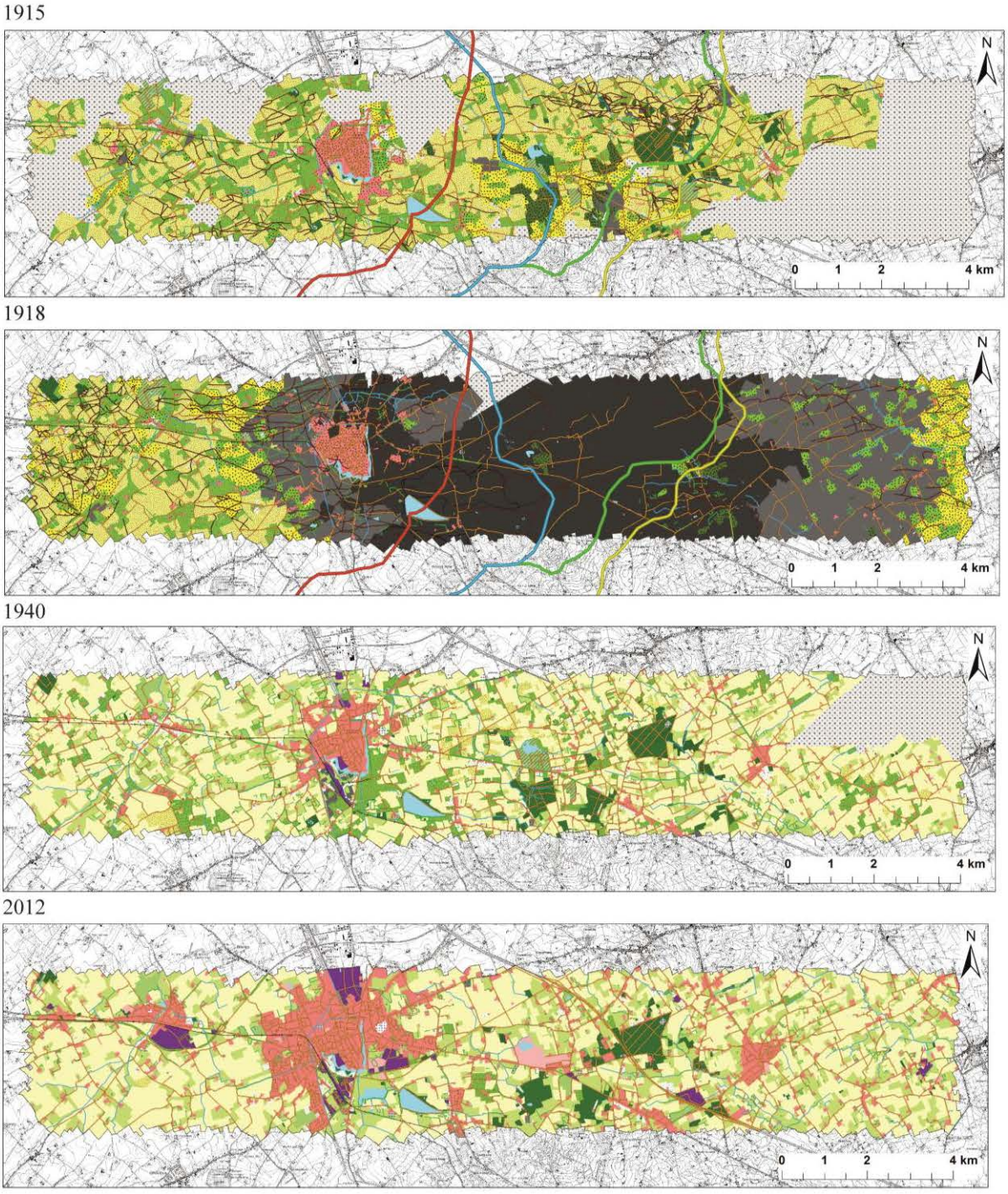
Appendix 2A LULC transect Nieuwpoort

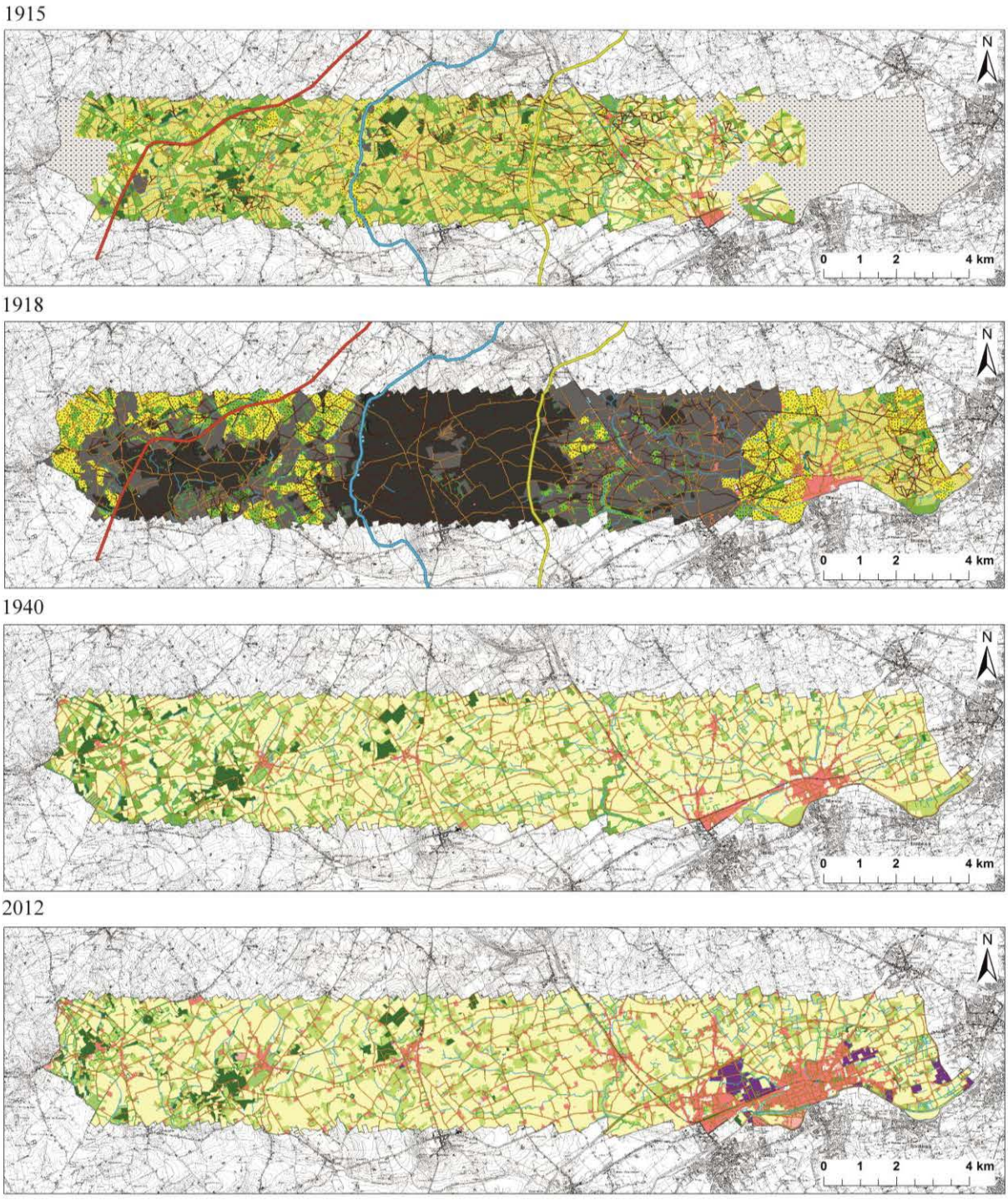
In order to be able to analyse the LULC maps per study area more into detail, see https://www.dropbox.com/sh/mxnxfj795m83bpz/AABuAlt9zPypqHP_F22ggoaya?dl=0.



Appendix 2B LULC transect Ypres



Appendix 2C LULC transect Kemmel



Appendix 3 Intensity values

Similar as arable land (hay land and crops) and grassland (pasture), intensity values were given to the other land use/land cover types for each studied time phase that were based besides on the visible information on the historical aerial photographs, also based on the four predetermined assumptions in chapter 3, section 3.3.3. First, the intensity values for the other types in 1915 were also based on the assumption that despite the different levels of disturbance (level 2.d), an equal intensity value can be given for the specific LULC under study in the understanding that every parcel was useful during wartime. Second, we are also assuming that the values for 1918 are zero for all the other LULC types since domestic and economic activities were considered as stopped. This because the LULC were transformed between 1914 and 1918 into a militarised landscape (Van den Berghe et al., 2018). Third, in contrast to the year 1915, a still visible military influence in 1940 does mean a decrease in intensity. Fourth, also in the year 1940, we consider the intensity values given to this period higher than 1915 because an intensive recovery of the landscape had been occurring and modern developments have taken place (De Vos, Simoens, Warnier, & Bostyn, 2014).

1. Arable land and pasture

(See chapter 3, section 3.3.3)

2. Woodland

In 1915, woodland was visible on historical aerial photographs (Van den Berghe et al., 2018a). The pre-war established '*Boswetboek'* (forest code) assumed that the term 'woodland' meant an area with a large number of trees. For this defined 'woodland' the code prepared rules concerning the monitoring, conservation, management and exploitation of forests, as well as the identification, prosecution and punishment of forest offences. Punishments were imposed for logging and forest destruction; this only for forests owned by the State (Belgisch Staatsblad, 1854). Hence, during wartime, woodlands on the front line were heavily fought (e.g. Sanctuary wood, Railway Wood[1]) (Agentschap Onroerend Erfgoed, 2019j; Cave, 2013) or were more to the hinterland often in secret cut down by locals (Heyde et al., 2015). Consequently, a low intensity value was given to this time period. In 1918, most of the trees were destroyed which resulted in an intensity value of zero (Van den Berghe et al., 2018). Afterwards, as forest resources have been traumatised, high intensities were obtained because on had to replant trees and an intensive management occurred. The regrowth of the trees depended on the type of tree. Beech recovered quickly while poplars and oak struggled growing (Wearn et al., 2017). To conclude, the recovery of woodland was an intensive long-term work. Therefore, a high intensity value was given to 1940. In 2012, a lower intensity was given compared to 1940 as the 'woodland' became more regulated and protected by several initiatives between 1940 and 2012. The most important initiative was the '*Bosdecreet*' (Forest Decree). The content drawn up in the pre-war established '*Boswetboe*k' that was established for Belgium, was partly taken over in the Flemish '*Bosdecreet*'. This Decree has the objective to regulate the conservation, protection, management and restoration of forests. It states that the forest can has various functions such as economic, social, educational, scientific and ecological functions. Particularly, attention is paid to forest management plans for all public forests and also for private forests as well which extent over at least 5 ha. In addition, the Decree aims to protect forests by stating that work leading to changes in physical conditions of the forests can only be carried out with

[1] 'Railway Wood' was the name given by the British forces to a small forest located nearby the railway Ypres-Roeselare. 'Sanctuary Wood' was also the name given by the British forces to a forest where one could rest for a moment and escape from the violence as this woodland was located behind the frontline (Agentschap Onroerend Erfgoed, 2019j; Cave, 2013).

the approval of the authorities. For instance, deforestation is forbidden unless one follows the legal procedure (Vlaamse Codex, 1990).

3. Build up land (housing and garden)

During 1915, construction activity in Belgium came to a standstill in Belgium (Agentschap Onroerend Erfgoed, 2019a). Reconstruction plans were made by the Belgian government in hostile to prepare the post-war reconstruction by establishing funds and by recruiting (international) ideas (Duvosquel et al., 1985). However, on the occupied area, reconstruction plans sometimes already started under lead of the German occupier (Cortjaens, 2011; Ernst, 1915; Schüller, 1918). Consequently, an input factor of one is given to this time period. Later, in the last months of the war, no reconstruction plans had been carried out due to the heavy destructions (Van den Berghe et al., 2018a). Therefore, the intensity value became zero. The reconstruction during Interbellum was subsequently a work that took decades to complete with the help of (inter)national stakeholders (Duvosquel et al., 1985; Floré, 2011; Hortensius, 1989). Technical and theoretical knowledge of building materials developed during this period (e.g. material research of reinforced concrete). Bridges, houses, large complex buildings, roads, churches (e.g. Zonnebeke Church), walls (e.g. wooden barracks), fundaments of houses all became stronger and better developed (Van de Voorde, 2011). Therefore, this time period was given an intensity value two. This is more compared to 1915 because of the intensive altered reconstructions[2] that occurred. Between 1940 and 2012, two phases can be described. On the one hand occurred another reconstruction period after WWII (Floré, 2011) and on the other hand emerged new building techniques, town planning ideas and architectural designs in the light of modern needs (Braeken, 2011; Van de Voorde, 2011). Hence, a similar intensity value was given to 2012 as in 1940 which is based on the assumption that the stronger the buildings were built, the longer they lasted. As a result, the human input is not higher, because build up land did not need to be replaced so rapidly. Because the gardens are seen a part of the houses they were given the same intensity values as the buildings.

4. Ruin

It is clear that a destroyed house or other building cannot be used anymore. Therefore, these ruins obtained an intensity value of zero. In general, these did not occur anymore after the reconstruction period besides few examples.

5. Castle park

In the beginning of the war, wood was often chopped in secret by locals. Therefore, an intensity value of one was given. These castle domains were often used by troops as strategic observations points or they were the theatre of the battle. These battles completely destroyed the castle domains that were located in the front zone. Other castle parks in the hinterland served as the perfect location for headquarters or hospitals (Heyde et al., 2015). Consequently, as these parks were particularly military orientated, no intensity value was given to the destroyed parks in 1918. Later, the recovery of these parks took a lot of effort whereby the majority of the pre-war established castles domains were reconstructed. Hence, these parks were after they were reconstructed not that intensively maintained anymore and therefore obtained an intensity value of one in 1940. Between 1940 and 2012, these castle parks were still not intensively maintained and were sometimes abandoned due to the high maintenance costs that occurred (Heyde et al., 2015). Consequently, in 2012, these also obtained an intensity value of one.

[2] For an extensive overview of the studies that dealt with this subject see Agentschap Onroerend Erfgoed (2019a) or Appendix 5E.

6. Cemetery and monuments

Military cemeteries and monuments were established by diverse stakeholders (e.g. Commonwealth War Graves Commission, Flemish soldiers) and were maintained during and after the war (Longworth, 2003; Shelby, 2014). Therefore, these obtained an intensity value of one for 1915, 1940 and 2012. In 1918, no cemeteries could be distinguished on the aerial photographs in the studied area. Consequently, no intensity value was given for this year.

7. Recreation area

In the region, golf parks were the only recreational parks visible on the aerial photographs from before WWI (Van den Berghe et al., 2018a). Hence, no specific literature was found giving the information about the role and function of these golf parks during 1915. As these are located far into the hinterland in 1915, we suspect that they were still in use. The maintenance of a golf course is labour intensive. Therefore, these were given an intensity value of four. Later on, no recreation areas were observed in 1940. Later, a well-known recreation park was added to the region in 1954, namely the amusement park 'Bellewaerde' which was established in the pre-war constructed castle park Bellewaerde (Bellewaerde, 2019). Both the golf parks and amusement park obtained an intensity value of four in 2012 as these need a lot of maintenance.

8. Industry

In the beginning of the war, the Allies blocked the industry in the by the German occupied areas (Van den Wijngaert et al., 2006). The economic blockage resulted in a shutdown of many commercial activities (Demasure, 2014). However, the industry was partly dismantled in occupied Belgium and partly used for warfare. Therefore, an intensity value of four was given to 1915 as the still working industry had to operate at full capacity in function of the war. Later, problems increased in occupied Belgium as the German claimed on the on hand food (e.g. wheat, barley and potatoes) and on the other hand also cattle (e.g. dairy cows and horses). The production in the industry was no longer possible because goods could not be transported anymore without the horses. Also wagons, carriages and cars were claimed and hampered even more the transport of goods. Therefore, industry was forced to close down (Demasure, 2017). On the Allied side of the front, the industry in the cities was already bombed in the beginning of the war (e.g. Ypres during First Battle of Ypres, 1914) (Banks, 2001), resulting in non-active industry which lasted until after the war. However, further in the hinterland, exceptions were found in the brewery industry. Due to refugees and allied soldiers, the demand for beer increased rapidly. Hence, the supply of barley and malt declined, causing many breweries to close (Demasure, 2017). Consequently, an intensity value of zero was given to 1918. Later in 1940, the industry recovered and imported massively raw materials and machinery. Already in 1920, the production of steal and metal reached 80 % of the pre-war situation (Van den Wijngaert et al., 2006). However, no industrial areas were mapped in the year 1940. Consequently, no associated intensity value is given to this time period. Between 1940 and 2012, the economy grew because foreign capital was attracted from multinationals. Also the agro-industry came up and processed various products (Gaus, 1992). Because these evolutions took place, a high input value was given to the year 2012.

9. Pool

Drinking ponds provided water for livestock and are often used for fishing. That is why this LULC has been given an intensity value of one in 1915, 1940 and 2012. In the year 1918 it is assumed that these functions came to a standstill and therefore obtained an intensity value of zero.

10. Militarised landscape

The militarised landscape elements obtained an intensity value of zero for all the time phases. This because the intensity values that were previously defined by the human input, included only the inputs given by stakeholders for economic, social or cultural purposes and not the inputs given for military purposes.

Appendix 4A Results landscape metrics in the three study areas calculated on class level

Note: '/' means that no value could be calculated as only one patch was available in the particular LULC type

	LULC TYPE	CA	PLAND	NP	PD	TE	ED	AREA_MN	AREA_SD	GYRATE_MN	SHAPE_MN	IJI	ENN_MN
Units	-	*ha*	*%*	-	*NP/100 ha*	*Meters (m)*	*Meters/ha*	*ha*	*ha*	*m*	-	*%*	*m*
Study area one (Nieuwpoort)													
1915	1	1134.4	47.8	61	2.6	150.390	63.4	18.6	112.8	92.5	1.6	40.2	46.9
	2	1074.4	45.3	58	2.4	172.120	72.6	18.5	54.5	110.8	1.8	46.0	41.9
	4	48.2	2.0	77	3.2	30.540	12.9	0.6	0.9	28.8	1.3	54.3	213.6
	5	13.8	0.6	24	1.0	8.860	3.7	0.6	0.9	27.6	1.3	71.3	287.0
	10	66.1	2.8	38	1.6	19.620	8.3	1.7	4.9	32.3	1.2	71.9	222.5
	11	34.7	1.5	11	0.5	16.070	6.8	3.2	7.0	116.9	1.8	63.5	388.8
1918	1	1032.2	43.5	54	2.3	146.190	61.6	19.1	94.9	107.7	1.7	51.5	64.9
	2	1004.4	42.4	60	2.5	151.130	63.7	16.7	49.3	109.6	1.7	57.8	55.3
	4	28.0	1.2	49	2.1	19.420	8.2	0.6	0.7	28.8	1.4	45.5	236.8
	5	36.2	1.5	54	2.3	20.810	8.8	0.7	1.1	28.5	1.3	69.0	206.3
	10	62.8	2.6	21	0.9	10.900	4.6	3.0	8.1	36.2	1.2	59.8	417.1
	11	207.8	8.8	34	1.4	35.530	15.0	6.1	18.2	71.7	1.4	69.1	49.0
1940	1	1150.1	48.5	59	2.5	158.600	66.9	19.5	126.4	91.1	1.6	35.6	53.6
	2	1141.6	48.1	62	2.6	188.170	79.3	18.4	61.0	106.6	1.8	46.4	39.7
	4	78.0	3.3	115	4.8	49.440	20.8	0.7	1.2	31.0	1.4	63.4	149.0
	10	1.9	0.1	49	2.1	4.000	1.7	0.0	0.0	7.0	1.0	24.0	311.1
2012	1	1867.1	78.7	38	1.6	130.330	55.0	49.1	295.3	70.3	1.4	53.3	29.9
	2	340.4	14.4	92	3.9	114.420	48.2	3.7	7.4	74.9	1.7	41.9	96.4
	3	3.0	0.1	6	0.3	2.240	0.9	0.5	0.5	31.6	1.3	30.1	902.6
	4	145.2	6.1	123	5.2	72.800	30.7	1.2	2.3	38.7	1.5	51.0	115.6
	9	6.7	0.3	2	0.1	1.720	0.7	3.3	2.6	65.1	1.3	50.6	832.0
	10	9.2	0.4	72	3.0	12.480	5.3	0.1	0.3	13.2	1.2	67.5	218.2
Study area two (Ypres)													
1915	1	3159.3	58.7	59	1.1	422.310	78.4	53.5	251.2	163.9	2.1	47.1	56.1
	2	1317.6	24.5	240	4.5	370.760	68.8	5.5	12.4	91.6	1.8	37.3	87.3
	3	319.6	5.9	48	0.9	67.370	12.5	6.7	16.5	85.2	1.7	53.4	292.1
	4	16.1	0.3	52	1.0	12.110	2.2	0.3	0.8	18.5	1.2	55.3	212.2

	5	347.5	6.5	562	10.4	151.090	28.1	0.6	6.2	19.0	1.3	47.8	104.6
	6	71.0	1.3	6	0.1	11.320	2.1	11.8	8.1	132.9	1.6	58.8	1749.6
	7	5.7	0.1	4	0.1	2.840	0.5	1.4	0.7	50.4	1.6	55.1	2610.3
	8	1.1	0.0	1	0.0	540	0.1	1.1	0.0	40.8	1.3	33.9	/
	9	2.1	0.0	2	0.0	1.340	0.2	1.0	0.6	49.5	1.6	45.3	28.3
	10	58.6	1.1	98	1.8	28.330	5.3	0.6	3.1	19.8	1.3	64.6	258.9
	11	86.9	1.6	11	0.2	18.590	3.5	7.9	11.4	101.7	1.6	52.6	548.2
1918	1	891.2	16.5	30	0.6	102.990	19.1	29.7	121.7	136.6	1.9	42.2	240.4
	2	497.9	9.3	61	1.1	135.720	25.2	8.2	14.5	106.9	1.9	48.7	171.3
	3	47.5	0.9	13	0.2	14.480	2.7	3.7	5.9	67.2	1.6	34.1	862.1
	4	3.7	0.1	35	0.6	5.480	1.0	0.1	0.1	12.3	1.2	55.1	379.3
	5	220.0	4.1	261	4.8	89.460	16.6	0.8	7.7	23.4	1.3	60.0	135.0
	6	24.7	0.5	2	0.0	4.940	0.9	12.3	12.0	118.5	1.8	52.6	2308.9
	7	1.6	0.0	4	0.1	1.600	0.3	0.4	0.1	26.7	1.5	46.5	129.9
	10	51.9	1.0	93	1.7	26.140	4.9	0.6	3.0	19.5	1.3	57.7	265.2
	11	3647.0	67.7	15	0.2	172.160	32.0	280.2	962.8	298.9	2.0	63.1	58.9
1940	1	3010.5	55.9	124	2.3	471.590	87.6	24.3	146.7	112.7	1.8	44.8	51.0
	2	1297.7	24.1	273	5.1	449.320	83.4	4.8	11.9	85.5	1.9	41.3	171.3
	3	255.4	4.7	60	1.1	60.360	11.2	4.3	14.3	57.2	1.6	58.9	268.7
	4	625.9	11.6	604	11.2	262.780	48.8	1.0	9.3	28.1	1.3	49.2	88.9
	6	73.4	1.4	9	0.2	14.680	2.7	8.2	10.9	91.1	1.5	54.9	860.6
	7	16.4	0.3	21	0.4	9.340	1.7	0.8	0.8	32.9	1.3	63.2	675.2
	9	20.7	0.4	7	0.1	7.020	1.3	3.0	3.7	76.5	1.5	71.9	59.0
	10	59.2	1.1	216	4.0	35.080	6.5	0.3	2.0	12.0	1.1	69.3	194.5
	11	26.1	0.5	10	0.1	10.900	2.0	3.0	3.8	72.2	1.9	67.9	1250.0
2012	1	2313.1	50.0	114	2.1	345.000	64.1	20.3	78.8	132.7	1.9	49.7	82.3
	2	1238.3	23.0	221	4.1	410.680	76.3	5.6	11.7	94.0	2.0	56.8	87.5
	3	264.5	4.9	53	1.0	63.820	11.9	5.0	16.9	66.2	1.6	68.4	285.7
	4	1177.4	21.9	432	8.0	311.180	57.8	2.7	25.1	42.0	1.5	61.7	81.7
	6	62.8	1.2	10	0.2	15.740	2.9	6.3	7.1	87.7	1.7	64.6	1319.6
	7	22.6	0.4	25	0.5	11.660	2.2	0.9	1.1	35.1	1.3	62.1	660.6
	8	71.0	1.3	7	0.1	13.480	2.5	10.1	15.6	116.8	1.7	76.2	2172.0
	9	155.1	2.9	18	0.3	27.820	5.2	8.6	12.1	101.9	1.5	74.6	696.4
	10	80.4	1.5	263	4.9	45.160	8.4	0.3	2.1	13.0	1.2	73.6	185.9

Study area three (Kemmel)													
1915	1	4641.5	70.2	45	0.7	558.590	84.5	103.1	531.5	167.5	2.0	52.8	49.4
	2	1384.4	20.9	336	5.1	487.690	73.7	4.1	7.2	83.3	1.8	36.6	81.9
	3	243.3	3.7	77	1.2	78.380	11.9	3.2	5.7	65.5	1.6	32.6	157.6
	4	163.9	2.5	528	8.0	128.840	19.5	0.3	1.3	17.9	1.3	41.3	109.2
	5	98.9	1.5	354	5.4	90.340	13.7	0.3	0.7	18.8	1.3	47.1	149.2
	6	17.4	0.3	3	0.0	4.200	0.6	5.8	3.7	87.8	1.5	36.4	1622.1
	7	1.4	0.0	3	0.0	1.380	0.2	0.5	0.1	30.2	1.7	49.9	5724.6
	8	0.6	0.0	1	0.0	440	0.1	0.6	0.0	31.2	1.4	0.0	/
	10	8.4	0.1	177	2.7	18.480	2.8	0.0	0.2	9.3	1.1	43.3	259.7
	11	53.2	0.8	15	0.2	14.460	2.2	3.5	5.9	64.3	1.5	44.2	206.2
1918	1	880.0	13.3	58	0.9	127.600	19.3	15.2	30.7	116.1	1.8	64.0	109.1
	2	393.1	5.9	118	1.8	136.590	20.7	3.3	6.4	72.4	1.6	53.2	136.5
	3	56.6	0.9	29	0.4	24.880	3.8	2.0	2.2	60.1	1.6	55.1	389.7
	4	5.3	0.1	23	0.3	5.020	0.8	0.2	0.5	16.4	1.2	52.3	421.4
	5	85.4	1.3	389	5.9	88.080	13.3	0.2	0.5	17.1	1.3	43.2	129.3
	7	0.1	0.0	1	0.0	120	0.0	0.1	0.0	10.0	1.2	0.0	/
	10	14.8	0.2	100	1.5	24.740	3.7	0.1	z0.6	21.1	1.3	17.8	318.3
	11	5177.7	78.3	16	0.2	268.520	40.6	369.5	1315.9	378.8	2.1	66.3	53.5
1940	1	4416.4	66.8	83	1.3	592.060	89.5	53.2	391.2	121.1	1.8	49.5	46.3
	2	1510.7	22.8	304	4.6	540.990	81.8	5.0	9.2	93.1	1.9	40.0	78.9
	3	230.4	3.5	68	1.0	71.880	10.9	3.4	8.0	68.6	1.6	42.5	234.2
	4	399.3	6.0	786	11.9	253.780	38.4	0.5	2.5	23.1	1.3	41.6	92.8
	5	0.1	0.0	1	0.0	220	0.0	0.1	0.0	19.0	1.4	47.1	/
	6	31.6	0.5	5	0.1	7.840	1.2	6.3	5.8	85.7	1.6	67.0	930.2
	7	4.3	0.1	22	0.3	5.020	0.8	0.2	0.2	18.0	1.3	62.9	961.7
	10	19.9	0.3	277	4.2	36.160	5.5	0.1	0.3	11.4	1.1	55.3	211.3
2012	1	4162.9	63.0	109	1.6	547.950	82.9	38.2	301.9	100.4	1.7	46.3	49.0
	2	1361.6	20.6	311	4.7	516.580	78.1	4.4	9.2	81.5	1.9	44.7	83.9
	3	227.1	3.4	98	1.5	82.000	12.4	2.3	7.1	51.1	1.6	50.1	226.6
	4	711.7	10.8	647	9.8	339.940	51.4	1.1	6.1	33.2	1.4	44.6	86.7
	5	8.9	0.1	2	0.0	2.080	0.3	4.4	3.6	75.9	1.4	44.7	7931.4
	6	32.9	0.5	4	0.1	9.180	1.4	8.2	4.9	117.6	2.2	61.9	991.4

	7	14.4	0.2	28	0.4	8.060	1.2	0.5	1.5	22.5	1.3	58.5	803.0
	8	23.8	0.4	9	0.1	6.340	1.0	2.6	4.6	49.3	1.4	54.6	1621.7
	9	52.3	0.8	9	0.1	11.080	1.7	5.8	9.1	83.3	1.6	59.5	253.2
	10	17.3	0.3	394	6.0	33.800	5.1	0.0	0.1	7.6	1.1	54.1	182.2

Appendix 4B Results landscape metrics in the three study areas calculated on landscape level

	TA	NP	PD	TE	ED	AREA_MN	AREA_SD	GYRATE_MN	SHAPE_MN	IJI	PR	PRD	SHDI	SHEI
units	*ha*	*-*	*NP/100 ha*	*m*	*m/ha*	*ha*	*ha*	*m*	*-*	*%*	*-*	*-*	*-*	*-*
Study area one														
1915	2371.5	269	11.3	209.200	88.2	8.8	60.1	64.9	1.5	50.4	6	0.3	1.0	0.5
1918	2371.3	272	11.5	191.990	81.0	8.7	49.4	68.2	1.5	58.4	6	0.3	1.2	0.6
1940	2371.5	285	12.0	210.430	88.7	8.3	64.8	55.7	1.4	44.7	4	0.2	0.8	0.6
2012	2371.5	333	14.0	173.110	73.0	7.1	101.0	46.8	1.5	49.3	6	0.3	0.7	0.4
Study area two														
1915	5385.3	1083	20.1	543.300	100.9	5.0	60.4	47.6	1.5	45.3	11	0.2	1.2	0.5
1918	5385.3	514	9.5	323.780	60.1	10.5	162.2	47.1	1.4	56.6	10	0.2	1.0	0.5
1940	5385.3	1324	24.6	683.860	127.0	4.1	46.3	47.6	1.5	46.4	10	0.2	1.2	0.5
2012	5385.3	1143	21.2	651.840	121.0	4.7	30.5	57.2	1.5	57.9	9	0.2	1.5	0.7
Study area three														
1915	6612.9	1539	23.3	710.000	107.4	4.3	92.6	38.8	1.4	44.4	10	0.2	0.9	0.4
1918	6612.9	734	11.1	378.760	57.3	9.0	188.8	43.1	1.4	56.7	9	0.1	0.7	0.3
1940	6612.9	1546	23.4	773.460	117.0	4.3	91.5	42.2	1.4	44.5	8	0.1	0.9	0.5
2012	6612.9	1611	24.4	797.570	120.6	4.1	79.3	42.3	1.5	46.0	10	0.2	1.1	0.5

Appendix 4C Selection FRAGSTATS metrics

This appendix provides an overview of the selected metrics. For each metric, it was determined which selected metric is arguably related to another metric (column 'related to') and which metric should be analysed together with other metrics (column 'together with'). The second column provides a hyperlink to the formula of the discussed metric. In case of the printed version of this dissertation, see also McGarigal (2019). Finally, the last column provides comments. The information in this table is based on McGarigal et al. (2012) and McGarigal & Marks (1995).

			Related with	Together with	Comments
Area, density and edge metrics					
Class level					
Total Class Area	CA (or CAP = Class Area Proportion)	**Composition**: How is the composition of the class? How diverse is the class? Which class is dominant or is there evenness in the classes?	PLAND	PLAND, AREA_MN, PD to provide basic insights in each class	- The proportion of each class in the landscape in hectare - CA = PLAND/100 - CA and PLAND give the same information
Percentage of Landscape	PLAND	**Composition**: How is the composition of the class? How diverse is the class?	CA	CA, AREA_MN, PD to provide basic insights in each class	- The proportion of each class in the landscape in percent - CA and PLAND give the same information - PLAND = CA * 100
Number of Patches	NP (or PN = Patch Number)	**Configuration**: How much is each class fragmented?	PD	CA, SHAPE, GYRATE and ENN_MN to provide extra information about the fragmentation in the classes	- If the total area is held constant, then NP and PD represent the same information
Patch Density	PD	**Configuration**: How much is the class fragmented?	NP	NP	- PD standardizes the NP by dividing NP with the total area. In this manner, the outcome can be compared within different extents
Total Edge	TE	**Configuration**:	ED	AREA_MN and CA to understand the area	- If the total area is held constant, then ED and

		What is the sum of all the edges in the landscape per class?		and edge relationship	TE represent the same information
Edge Density	ED	**Configuration**: Which class types are aggregated and why?	TE, CLUMPY	TE	- ED standardizes TE by dividing TE by the total area facilitating comparisons amongst landscapes of various sizes - Amount of border between patches based on edge length
Patch Area Distribution	AREA_MN, SD	**Configuration**: AREA_MN: How much is each class subdivided or fragmented? AREA_SD: Have the patches of each class the same size or is it diverse?		With NP because the smaller the AREA_MN the higher the NP	- Difference between AREA_MN and CA: CA divides the total area of patches by total landscape area, AREA_MN divides the total area of the patches by number of patches in landscape. Therefore, AREA_MN provides information of the configuration and CA of the composition. - AREA_SD: patch size standard deviation is a measure of absolute variation of patch sizes. For instance, if each patch has the same in size, then AREA_SD will be small to zero.
Radius of Gyration Distribution	GYRATE_MN	**Configuration:** Is there patch extensiveness per class? Is there ribbon development?		AREA_MN to understand how far the patch across the landscape extends, the longer GYRATE_MN, the bigger the patch	- Measures the mean distance between the cells of the patch and the centroid of the patch
Landscape level					
Total Area	TA	**Composition**: What is the area of each extent?			- Useless for Q3 because all the extents are already known (1 km^2)
Number of Patches	NP	**Configuration**: How much is the landscape fragmented? Is this making it a complex landscape?	PD	CA, SHAPE, GYRATE and ENN_MN to provide extra information about	- If the total area is held constant, then NP and PD represent the same information

				the fragmentation in the classes	
Patch Density	PD	**Configuration**: How much is the landscape fragmented?	NP	NP	- PD standardizes the NP by dividing NP with the total area. In this manner, the outcome can be compared within different extents
Total Edge	TE	**Configuration:** What is the sum of all the edges in the landscape?		ED	- Also possible for Q2, hence, the bigger the extent, the more chance on a bigger TE (Turner et al, 1998)
Edge Density	ED	**Configuration:** How aggregated is the landscape?	TE; ED on landscape level is related with AI and IJI as these measure also the aggregation	TE	- ED standardizes TE by dividing TE by the total area facilitating comparisons amongst landscapes of various sizes - Amount of border between patches based on edge length
Patch Area Distribution	AREA_MN, SD	**Configuration:** AREA_MN: How much is the landscape subdivided or fragmented? AREA_SD: have the patches in the landscape class the same size or is it diverse?		With NP because the smaller the AREA_MN the higher the NP	- Difference between AREA_MN and CA: CA divides the total area of patches by total landscape area, AREA_MN divides the total area of the patches by number of patches in landscape. Therefore, AREA_MN provides information of the configuration and CA of the composition. - AREA_SD: patch size standard deviation is a measure of absolute variation of patch sizes. For instance, if each patch has the same in size, then AREA_SD will be small to zero.
Radius of Gyration Distribution	GYRATE_MN	**Configuration:** Is there patch extensiveness? Is there ribbon development?		AREA_MN to understand how far the patch across the landscape extends, the longer GYRATE_MN, the bigger the patch	- Measures the mean distance between the cells of the patch and the centroids of the cells in the patch

Shape metrics					
Class level					
Shape Index Distribution	SHAPE_MN, SD	**Configuration:** SHAPE_MN: How complex are the patches of the classes? Are they compact and simple? SHAPE_SD: Are the shapes of the patches very differently in each class?		AREA_MN gives an idea of how large the corresponding surface area is for a certain calculated shape.	- The smaller the SHAPE, the more compact and simple the patch - Measures the shape of the patches of a class by analysing the perimeter of the patches (in grid cells)
Landscape level					
Shape Index Distribution	SHAPE_MN, SD	**Configuration:** SHAPE_MN: How complex are the patches of the landscape? Are they compact and simple? SHAPE_SD: Are the shapes of the patches very differently in the landscape?		AREA_MN gives an idea of how large the corresponding surface area is for a certain calculated shape.	- The smaller the SHAPE, the more compact and simple the patch - Measures the shape of the patches of the landscape by analysing the perimeter of the patches (in grid cells)
Isolation/proximity metrics					
Class level					
Euclidean Nearest Neighbour Distance Distribution	ENN_MN (or MNN = mean nearest neighbour)	**Configuration:** Are the patches of different classes scattered? Are they accessible or isolated?			- Shortest Euclidean distances based on edge-to-edge distance between patches of the same class - At least two patches of the corresponding type occur to calculate ENN_MN - The lower ENN_MN, the higher the accessibility between classes

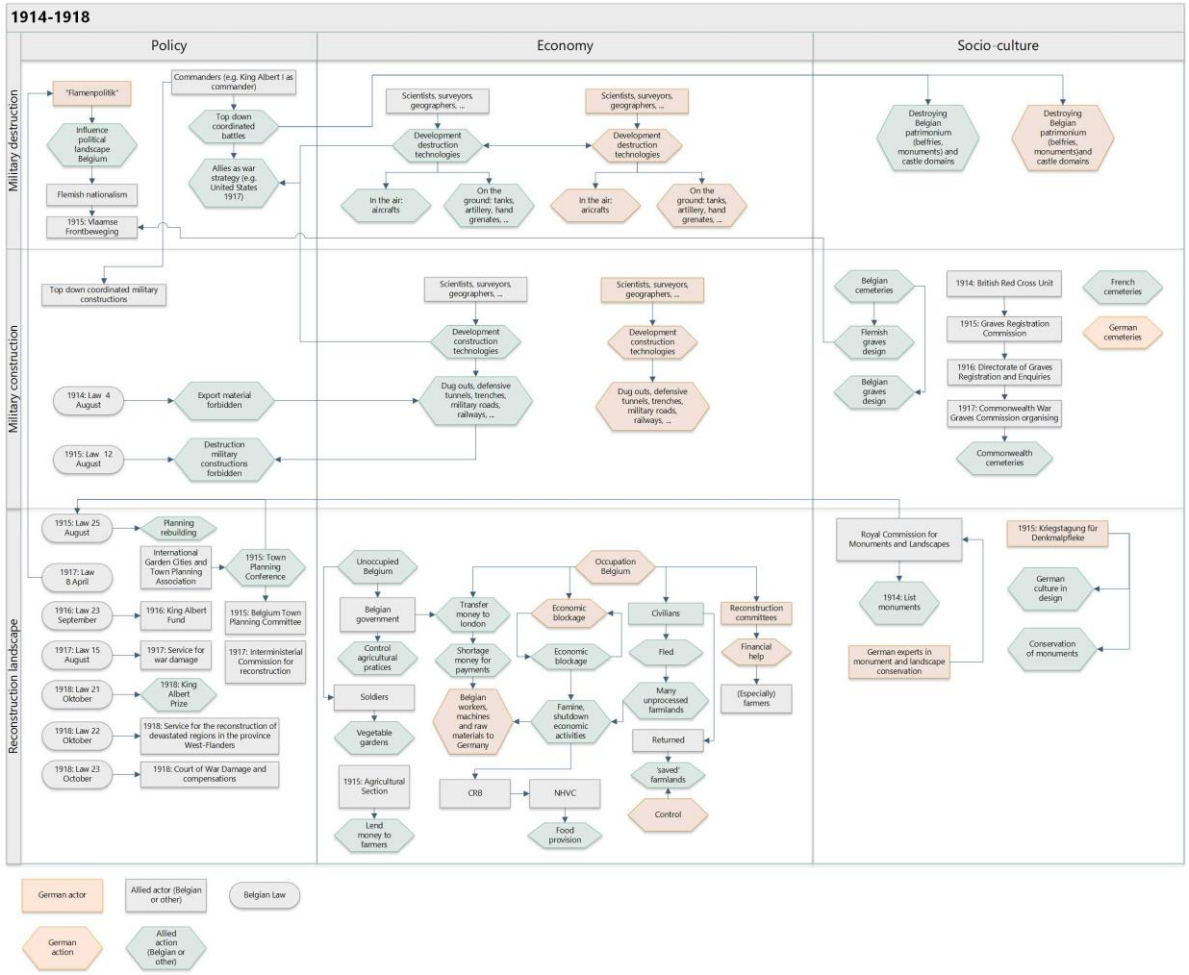
Contagion/interspersion metrics					
Class level					
Aggregation Index	AI	**Configuration:** What types of land cover of the same class are aggregated?	ED	CA	- Measures the aggregation with dispersion (between same class with like cell adjacencies or joins) - Reason AI: Other aggregations indices (e.g. CONTAG) measure both dispersion and interspersion, making it hard to interpret - Reason AI: LSI is also an aggregation index that uses the edges, but measures dispersion. This metric was dropped because it was nonlinear and therefore is hard to interpret. IJI is defined between zero and hundred making it interpretable.
Interspersion & Juxtaposition Index	IJI	**Configuration:** What types of land cover of different classes are aggregated? How evenly distributed are the edges amongst the available patch types?	ED		- Measures the aggregation with interspersion (between different classes with the edges) - IJI works with edges and not with unlike cell adjacencies, so it is not sensitive for the resolution (cell size), other aggregation indices are sensitive for the size of the cell - Reason IJI: Other aggregations indices (e.g. CONTAG) measure both dispersion and interspersion, making it hard to interpret - Reason IJI: LSI is also an aggregation index that uses the edges, but measures dispersion. This metric was dropped because it was nonlinear and therefore is hard to interpret. IJI is defined between zero and hundred making it interpretable.
Landscape level					
Aggregation Index	AI	**Configuration:** Is the landscape aggregated based on patches of the same	ED		- Measures the aggregation with dispersion (between same class with like cell adjacencies or joins) - Reason AI: Other aggregations indices (e.g.

		classes?			CONTAG) measure both dispersion and interspersion, making it hard to interpret - Reason AI: LSI is also an aggregation index that uses the edges, but measures dispersion. This metric was dropped because it was nonlinear and therefore is hard to interpret. AI is defined between zero and hundred making it interpretable.
Interspersion & Juxtaposition Index	IJI	**Configuration:** Is the landscape aggregated based on patches of different classes?	ED		- Measures the aggregation with interspersion (between different classes with the edges) - IJI works with edges and not with unlike cell adjacencies, so it is not sensitive for the resolution (cell size), other aggregation indices are sensitive for the size of the cell - Reason IJI: Other aggregations indices (e.g. CONTAG) measure both dispersion and interspersion, making it hard to interpret - Reason IJI: LSI is also an aggregation index that uses the edges, but measures dispersion. This metric was dropped because it was nonlinear and therefore is hard to interpret. IJI is defined between zero and hundred making it interpretable.
Diversity metrics					
Landscape level					
Patch Richness	PR	**Composition**: How diverse is the landscape?	PRD	With composition metrics because PR ignores the configuration	- Richness = refers to the number or variety of patch types present in a landscape
Patch Richness Density	PRD	**Composition**: How diverse is the landscape?	PR	PR	- Standardizes richness per area and facilitates comparison amongst different landscape extents
Shannon's Evenness Index	SHEI	**Composition**: How evenly distributed are	SHDI	SHDI	- Evenness = even distribution of area amongst patch types

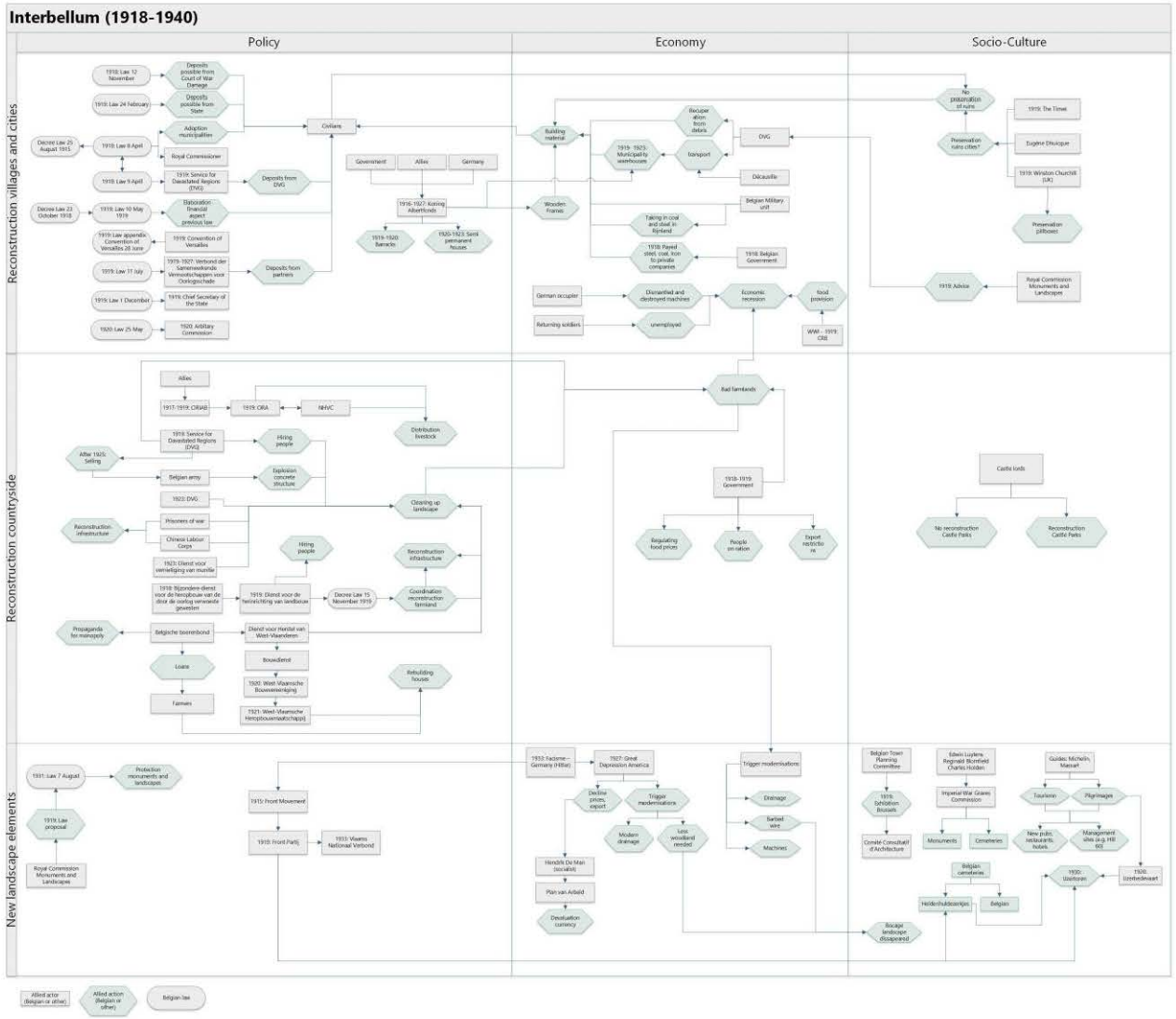
		the patch types in the landscape?			
Shannon's Diversity Index	SHDI	**Composition**: How diverse is the landscape in terms of representative patch types and the even distribution of these patches types in the area?	SHEI	PR and PRD (richness) SHEI (evenness)	- Diversity = measures the landscape diversity based on the richness and evenness of patch types - Leans on information theory - A maximum diversity is reached when each type occurs in the same amount and is evenly distributed

Appendix 5A Cross-functional flowchart 1914-1918

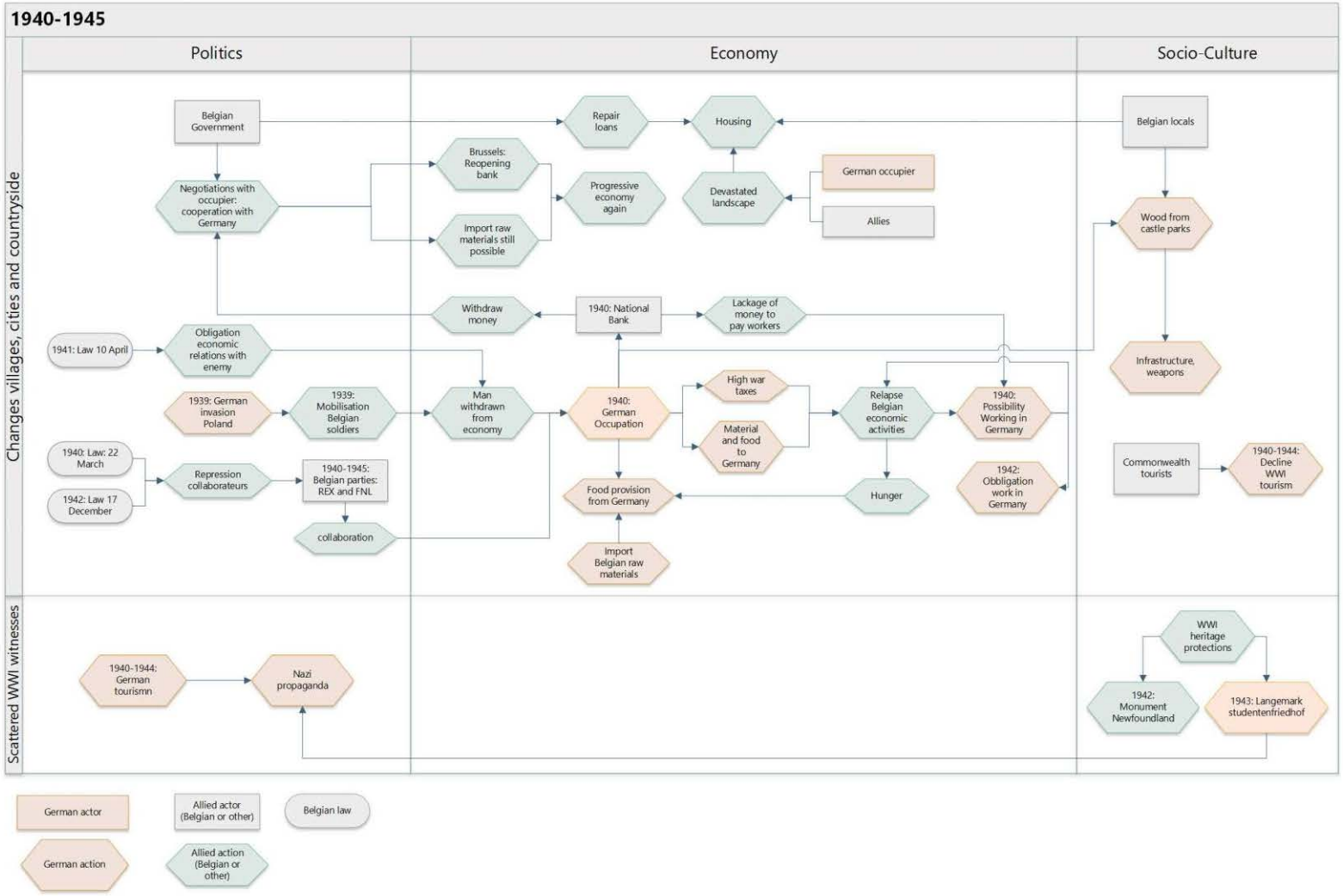
In order to be able to analyse the cross-functional flowcharts 1914-1918, 1918-1940, 1940-1944 and 1944-today in full quality, see https://www.dropbox.com/sh/mxnxfj795m83bpz/AABuAlt9zPypqHP_F22ggoaya?dl=0.



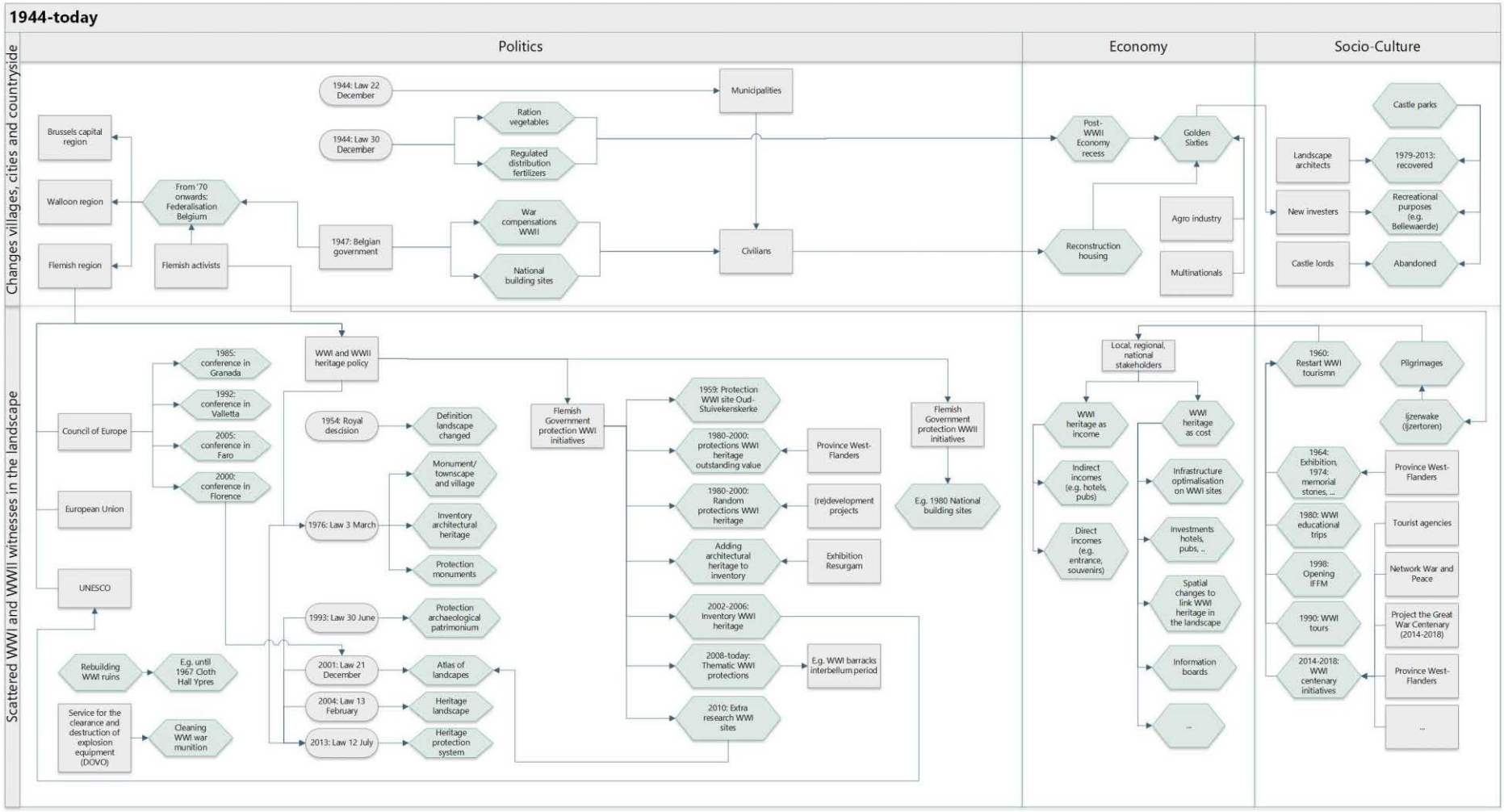
Appendix 5B Cross-functional flowchart 1918-1940



Appendix 5C Cross-functional flowchart 1940-1945



Appendix 5D Cross-functional flowchart 1944-today



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Curriculum vitae Hanne Van den Berghe

Hanne Van den Berghe (°1991) was born in Torhout and originates from Diksmuide. Today, she is living in Ghent. She completed her secondary education in sciences and maths at the Sint-Aloysiuscollege in Diksmuide (recently called 'T Saam), after which she started her studies at Ghent University. In June 2015, she graduated as a master in Geography. In September 2015, she began with her PhD in Geography within the BOF GOA project 'Non-Invasive Landscape Archaeology of the Great War' (funded by UGent) at the department of Geography, Landscape Research Unit. In the first year of her PhD, Hanne travelled to Edinburgh (UK) to collect data in the National Collection of Aerial Photography. Later, during her four years as a PhD student, she also spent time in other European countries to participate in international conferences. She attended conferences in Innsbruck and Seefeld (Austria), Canterbury (UK) and Prague (Czech Republic) and twice in Ghent, this to present and discuss her work. On the conference in Prague, she chaired one of the sessions and on the conference in Ghent, she helped to organize an excursion trip to the Westhoek. Following from these five conferences, four C3 publications and one C1 publication were written. In addition to presenting her work to the international public, she also spent time on writing several academic papers. In total, she wrote four international peer reviewed A1 publications as a first author. Besides these publications, she also participated in eight other A1 publications within an interdisciplinary team as co-author. Furthermore, she took part in writing a book in which two B2 publications were written as a co-author.

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