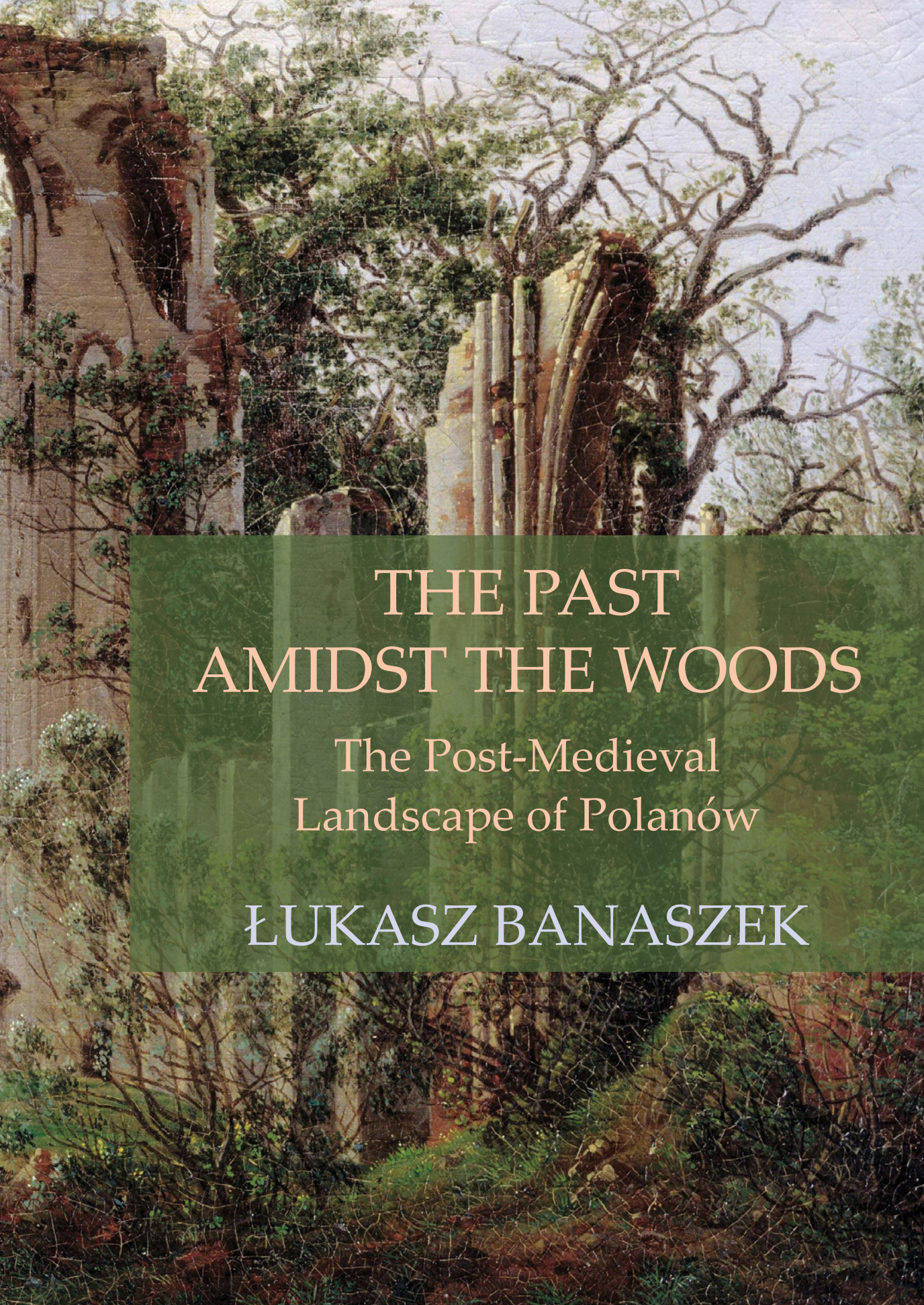

THE PAST AMIDST THE WOODS

The Post-Medieval Landscape of Polanów

ŁUKASZ BANASZEK

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Cover illustration: A fragment of *Ruins of Eldena* by Caspar David Friedrich. Public domain.

Abstract: This publication explores a complex landscape south of Polanów, and its transformations over the last few centuries. The area is rich in early and late modern earthworks which have been investigated through various archaeological prospection methods. Recognising that the forest is a dynamic and complex entity, the impacts on archaeological discovery strategies are discussed. Thus, while the work identifies the role that the longevity of forest has had on the survival of archaeological monuments, at the same time, this volume aims to demystify the omnipresent woodland of West Pomerania. While increasing awareness of earthworks in the forest, that otherwise have rarely attracted the attention of inhabitants of the area, this volume also draws attention to other actors in the landscape, including archaeologists.

Keywords: archaeological prospection; Polanów; West Pomerania; airborne laser scanning; landscape survey

Abstrakt: Publikacja prezentuje wielowarstwowy krajobraz okolic Polanowa, a także jego przekształcenia na przestrzeni kilku ostatnich stuleci. Ukazana zostaje wielość i rozmaitość wczesno- i późnonowożytnych obiektów archeologicznych o zachowanej formie terenowej. Jednocześnie analizie poddana zostaje efektywność różnorodnych metod prospekcji archeologicznej. Las rozumiany jest jako dynamiczny i niejednorodny fenomen, który wpływa na strategie prowadzenia badań archeologicznych oraz do pewnego stopnia definiuje odkrycia będące rezultatem tych badań. Publikacja omawia związek pomiędzy długotrwałym zalesieniem a stanem zachowania obiektów archeologicznych. Jednocześnie jej celem jest demistyfikacja powszechności lasów na Pomorzu Zachodnim. Opracowanie dąży do zwiększenia świadomości odnośnie obiektów archeologicznych o własnej formie terenowej, które zazwyczaj pozostają na marginesie zainteresowania lokalnej ludności, a także innych uczestników omawianego krajobrazu, w tym archeologów.

Słowa kluczowe: prospekcja archeologiczna; Polanów; Pomorze Zachodnie; lotnicze skanowanie laserowe; badania krajobrazowe

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For my grandparents

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I

INTRODUCTION

For myself early (roughly late 15th to the late 18th century) and late (roughly late 18th century to 1945) modern heritage is as important as earlier, prehistoric and medieval, remains, and I argue that it deserves understanding and protection as much as 'traditional' archaeological remains. Although the genetic connection of the local population of my study area with the ancient past of the region was irreversibly lost in the aftermath of World War II, new relations, between the land and descendants of the post-war pioneers, have gradually emerged. Today, new ideas and attitudes towards the West Pomeranian landscape are born and the bonds get stronger every year – indeed, this volume is in part a response to, and a part, of this movement. The main aim of this volume is to improve the understanding of the early and late modern layers of the landscape.

1.1. Recovered Territories. Unrecovered landscape?

Until 1945 the area of present-day Polish West Pomerania was part of the Prussian, and German (after the unification of Germany in 1871), province of Pomerania (German *Pommern*), with Farther Pomerania (*Hinterpommern*) east of the Odra River, and Cispomerania (*Vorpommern*) on the other bank. Prussian (after the establishment of the Kingdom of Prussia in 1701), and before that Brandenburg-Prussian, rule over these lands begun as a result of the Thirty Years' War. Swedish control over Stettin, along the Odra estuary, and the coastal region between the river and Mecklenburg, started during the war and ended with the Treaty of Stockholm (1720), although parts of Cispomerania were under Swedish rule until the Congress of Vienna (1815).

The Peace of Westphalia (1648), which ended the war, officially dissolved the Duchy of Pomerania, a West Slavic state ruled by Dukes of the House of Griffins since the 12th century (Piskorski, 1999). Polish authority over the southern Baltic coastland was episodic and resulted from several military campaigns between the 10th and 12th century. Although Wartislaw I, the founder of the House of Griffins accepted Polish sovereignty, his

descendants were vassals also to other, non-Slavic, rulers, including the emperors of the Holy Roman Empire (Labuda, 1972). In other words, the construct of 'Polish West Pomerania' is relatively recent and thus, the context in which it was coined requires brief explanation.

As a result of World War II and the political decisions made during the Yalta and Potsdam conferences, the borders of the newly established two German states, the Polish People's Republic, and other Central and East European countries were significantly modified. Leaving behind the lands of present-day western Ukraine, Belarus and Lithuania, the western borders of Poland were established on the Odra-Neisse line. In addition, the splitting of East Prussia between the Soviet Union and communist Poland led to territorial changes in the north (Davies, 2013). These extensive lands, a third of the Republic of Poland, have been called the 'Recovered Territories', although the literal translation from Polish, the 'Regained Lands', better reflects the ideology that was coined immediately after the war. However, a more neutral term, Western and Northern Territories, is commonly used today. These vast lands, together with Polish provinces in the east, which were incorporated by the Soviet Union in 1945, the borderland of former Czechoslovakia, and other regions of Central and Eastern Europe, were the arena of massive post-war population displacement (Polian, 2004; Ther & Siljak, 2001). This migration was not limited to the newly joined territories and lasted for a few decades (Curp, 2012).

Historically, some of the Recovered Territories were in closer relations with Poland than West Pomerania. These areas were settled by several Slavic groups that were Germanized to a varied degree. Masurians, Warmians, Kashubians, Slovincians, and Silesians lived next to the German population (Blanke, 1999; Jankowiak, 2001; Linek, 2001). Initially, these descendants of West Slavic peoples were granted permission to stay in their native territory by the communist government after the rearrangement of state borders. However, over time these communities disintegrated due to poor and often discriminatory treatment by the authorities, and not always friendly relations with the newcomers (Eberhardt, 2011). Significant numbers of these people left the Recovered Territories within a few decades of the end of the war (Sakson, 1990).

As a result, the Western and Northern Territories were depopulated in the immediate post-war period. The refugees from lands incorporated by the Soviet Union (Kochanowski, 2001) had not fulfilled the gap (Eberhardt, 2011), and neither had the migrants from central Poland, and other settlers, including Ukrainians relocated from Eastern Galicia (Subtelny, 2001). Although the increase in birth rate after the war (the post-war 'baby-boomer' generation) soon compensated for the losses, the newly established settlement pattern significantly differed from the pre-war era. In addition, a dramatic cut was made between the landscape and its inhabitants (Rączkowski & Sroka, 2017). The newcomers did not have anything in common with the area, while

other migrants, the forced repatriates in particular, assumed that their stay in the west was temporary. This belief was initially encouraged by splinter groups of the Wehrmacht, marauders, guerrilla movement, and propaganda (Biddiscombe, 2016), as well as iniquity of the Red Army soldiers (Piskorski, 1999), and, later, by general insecurity about the future. In fact, the western borders of Poland on the Odra-Neisse line were acknowledged by the West German state as late as 1970 (Gelberg, 1982).

The removal of German dwellers and gradual emigration of the Germanized native inhabitants from the Recovered Territories, and, to a great extent, involuntary immigration, caused a loose relationship between the inhabited land and the insecure (about the future) newcomers. The communist government coined several national myths in an attempt to strengthen this relationship, and simultaneously to mask the annexation of the eastern Polish provinces by the Soviet Union. These myths were extensively used to demonstrate the bonds between the Recovered Territories and 'core' Poland, and to exploit their Slavic heritage (Demshuk, 2012; Domke, 2010; Grzechnik, 2017; Polak-Springer, 2015).

Archaeology and history were perfect tools for justifying Polish sovereignty over the Western and Northern Territories (Kobyliński & Rutkowska, 2005). Indeed, there was significant convergence of national traditions in archaeological research with the political expectations of the communist party, which resulted from ideas that pleased comrades in Moscow (Lozny, 2011; Urbańczyk, 2000). As a result, the distant, prehistoric and medieval, past of the joined lands was studied, often within the framework of large state-funded programmes (e.g. Gediga 2017). However, more recent and predominantly Prussian/German heritage was in broad terms neglected and often deliberately destroyed (Chylińska, 2007; Kiarszys, 2016; Mazur, 2000; Radziszewska, 2016). These actions aimed to lessen the connection between the Germans and the Recovered Territories, and to construct a new identity for the post-war settlers.

Given the political instability, the generations of pioneers of the Western and Northern Territories, and in particular the forcibly relocated settlers, have not developed deep relations with the inhabited land. This discontinuity had serious impacts on the understanding and perception of the landscape. In fact, it is disputed as to whether any local identity has developed amongst the Poles living in the Recovered Territories (Migdalski, 2014). Nevertheless, a gradual shift in attitude towards early and late modern heritage and history of the territories has been taking place since the fall of communism. In this new reality, the construction of local identities has gained momentum and now, it includes the German(ized) part of the history of these lands (Bialasiewicz, 2002; Grzechnik, 2012; Lewandowska, 2007). It is notable that, to a great extent this is a bottom-up movement that involves many local communities, rather than a planned governmental programme (Skórzyńska & Wachowiak, 2017).

1.2. Aims, origins, and structure of this volume

This publication presents the complexity of the observed landscape, and its transformations over the last few hundred years. There is abundance of early and late modern earthworks, some of which are previously known, which are discussed with recently identified archaeological features in their landscape and land-use context. The effectiveness of various archaeological prospection methods used within the study area is explored. Together with the analysis of historic maps, the methods are also applied to understand the conditions offered by the deserted land to the post-war newcomers, and whether they have taken advantage of what was made available.

By treating the forest as a dynamic and complex entity, its impact on archaeological discovery strategies is recognized. While the longevity of forest has a notable impact on the survival of archaeological monuments, at the same time, this volume aims to demystify the omnipresent woodland of West Pomerania. Changes in the extent and character of afforestation is used to understand how extensive planting over the last few centuries enclosed once open land. This volume exposes the myth of an unchanged and 'natural' woodland. The study of the landscape demonstrates that under the canopy there are the remains of a world, which underwent a massive dislocation in 1945, restarting thereafter with different population of actors. The ambition of this volume is to increase awareness of the features, by and large hidden in the forest, that rarely attract the attention of present-day inhabitants of the area, as well as other participants in the exploited landscape.

This volume is in parts personal. I am a third generation of Polish inhabitants of West Pomerania, with family roots in different parts of present-day Belarus, Lithuania, Poland and Ukraine. However, I see this region as my homeland. I keep in mind my grandparents' stories from their pre-relocation years, and I understand the sentiments towards 'the East', which are common amongst their generation, as well as their German counterparts. However, the memories of my parents relate to West Pomerania. They accepted that the lands forcibly abandoned by their parents were lost and that they have had to build their life in a new reality. In this sense, being born and raised in the land where my parents spent most of their life makes the relations between my generation and the landscape different from how it was perceived by our elders. For me, the pre-war German(ized) settlement is in a sense a distant past.

The origins of this volume lie in research that formed a part of my PhD thesis (Banaszek, 2015a). It has drifted away from the theory-oriented investigations which characterized previous works, towards archaeological landscape survey. In this, I examine the area south of Polanów. It constitutes one of three West Pomeranian areas that were documented by airborne laser scanning (ALS) commissioned by the Institute of Archaeology (former Institute of Prehistory), Adam Mickiewicz University (IA AMU) in Poznań (Banaszek, 2015a). Hence, this volume demonstrates in greater detail

the archaeological character of the extensively afforested area. This type of landscape is one of the most common in Pomerania, and, in broad terms, of Poland, where almost a third of the land mass is covered with forest (Milewski, 2017), while earthworks enclosed within woodland have been little studied and poorly understood.

The volume begins by describing the case study area and explaining why it was surveyed by means of ALS (section 1.3). This is followed by a discussion of the available source materials, and the remote sensing methods and datasets that have been used. Desk-based and field survey methodologies are presented together with the results of previous archaeological surveys (section 2). Thereafter, the modern history of woodland is analysed through historic maps, presented alongside the settlement pattern (section 3.1). The relationship and balance between afforestation and the extent of cultivation over the last few centuries has been unstable. In this context, the outcomes of interpretative mapping from ALS derivatives and field observation are presented against the impact of forest on the survival of recorded archaeological monuments. The results (section 3.2), which build on an integrated approach to the available resources and data, comprise several classes of archaeological earthworks, some of which have attracted little attention within Polish archaeology. Together these demonstrate the scale of the modern transformation of the landscape. Thereafter, the newly identified monuments and settlement pattern are integrated with the limited results of traditional prospection to produce a complex picture of the modern landscape (section 3.3). The volume concludes with a discussion of the utility of integrated approaches to the archaeological landscape (section 4).

1.3. Case study area

The study area, of about 64.5km^2 is located in the heart of Polish share of the region of Pomerania (Figure 1), which, together with its German counterpart, constitute most of the Southern Baltic Coastlands. Polish Pomerania includes the Lakeland, located between the coast and the Toruń-Eberswalde Urstromtal in the south, and the Lower Vistula River Valley in the southeast and east (Kondracki, 2000; Solon *et al.*, 2018). The landscape of Pomerania is geologically young and was formed by the last, Vistulian, glaciation, which came to an end ca. 11 700 BP. Thus, the area is characterised by slightly different topographic and geomorphologic forms when compared to other Polish Lakelands, which together fall into the North European Plain[1]. A belt of terminal moraine uplands separates the northern, predominantly coastal, lowlands from the Pomeranian Lakeland extending to the south of the hills. As a result, short rivers flow directly into the sea on north facing slopes, while southern slopes lie within the catchments of Odra in the west,

[1] The North European Plain is often referred to as the Central European Plain in particular by geographers from former Eastern Bloc Countries (e.g. Kondracki, 2000; Solon *et al.*, 2018).

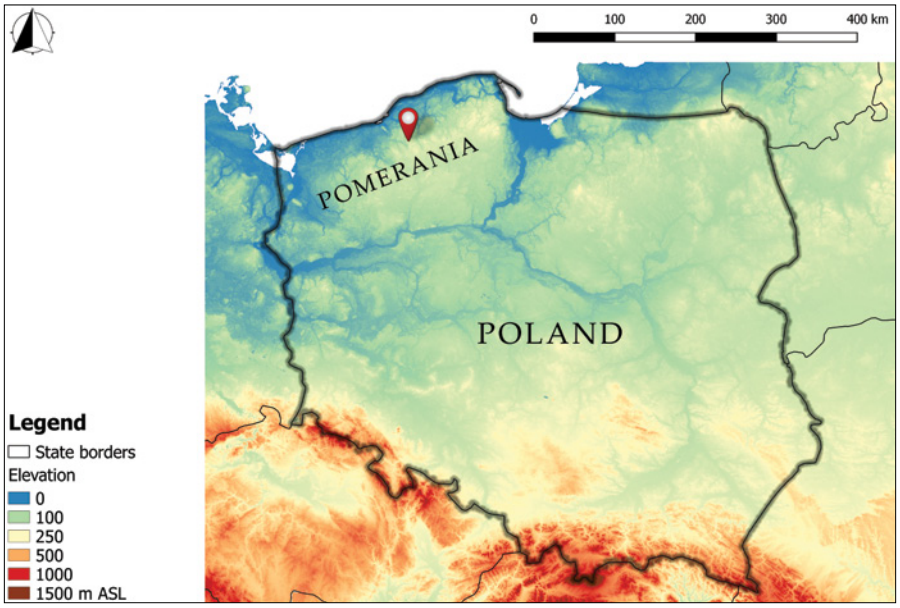

Figure 1. Location of the study area against Digital Elevation Model of Poland. NASA SRTM 1 arc second data available from the U.S. Geological Survey.

Table 1. Polish place names of important townships, within and outside the study area, and their alternative versions as recorded on historic maps (cf. section 2.5).

Polish	**Lubinus' map**	**Schmettau & Schulenburg's map**	***Urmesstischblatt* map**	***Messtischblatt* map**
X[1]	*Goien*[2]	X	X	X
X	*Rederang*[3]	*Raderang*	*Raderangskath*	*Raderang*
Bartlewo	X	X	X	*Bartelow*
Biała	*Bial*	*Bial*	*Bial*	*Bial*
Biała	X	*Bijaller Katen*	*Vw. zu Bial*	*Vw. Bial*
Biały Bór	*De Ball de Olde*	?[4]	?	*Baldenburg*
Bobięcino	*Papentzin*	*Papenzin*	*Papenzien*	*Gut Papenzin*
Chocimino	*Gutzmin*	*Gudzmin*	*Gutzmin*	*Gutzmin*
Czyżewo	*Glowitz*	*Globnitz?*	*Alt Glomnitz*	*Globnitz*
Drzewiany	*Darvene*	*Dravaene*	*Drawehne*	*Drawehn*
Gatka	*Thom Gande*	*Gadjen*	?	*Gut Gadgen*
Gołogóra	*Bredenberg*	*Breitenberg*	*Breitenberg*	*Breitenberg*
Górawino	*Gervin*	*Gervin*	*Gerfin*	*Gerfin*
Jaromierz Polanowski	X	X	X	*Ludwigshof*
Jeżewo	X	X	X	*Husselhof*
Kołobrzeg	*Colberg*	*Colberg*	?	*Kolberg*

Polish	Lubinus' map	Schmettau & Schulenburg's map	*Urmesstischblatt* map	*Messtischblatt* map
Lipki	*Upder Lind*	*Linde*	*Linde*	*Linde*
Liszkowo	X	*Raderang Katen*	*Lüschenkathen*	*Lischberg*
Lubowo	*Lubow*	*Lubow*	*Lubow*	*Lubow*
Łąkie	X	*Teich Katen*	*Lankenhof*	*Lankenhof*[5]
Łokwica	X	X	X	*Hildegardshöhe*
Myszyna	X	*mis Katen*	*Mishof*	*F. Missenhof*
Nacław	*Nutzlaff*	*Natzlaff*	*Natzlaf*	*Natzlaff*
Nowy Żelibórz	X	X	X	*Selberg B*
Podleśna	X	X	X	*Schmiedenhof*
Polanów	*Polnow*	*Pollnow*	*Pollnow*	*Pollnow*
Przytocko	*Pristke*	*Pritzig*	*Pritzig*	*Pritzig*
Przyborzyce	X	X	*Petershof*	*Louisenhof*
Przybrodzie	*Voort*	*Forth*	*Forth*	*Forth*
Racibórz Polanowski	X	X	X	*Heinrichhorst*
Rosocha	*Ratzoch*	*Rozog*	*Rozog*	*Rotzog*
Rzeczyca Mała	*Bavenretz*	*Kl. Reetz*	*Kl. Reetz*	*Kl. Reetz*
Rzeczyca Wielka	*Nedden Retz*	*Gr. Reetz*	*Gr. Reetz*	*Gr. Reetz*
Samostrzel	X	X	X	*Neuhof*
Stare Borne	*Hogeborne*	*Hohenborn*	*Hohenborn*	*Hohenborn*
Stary Żelibórz	X	*Vw. Selberg*	*Vw. Selberg*	*Sellberg*
Strzeżewo	X	X	X	*Karlshof*
Świerzenko	*L. Swirsen*	*Kl. Schwirsen*	*Kl. Schwirsen*	*Kl. Schwirsen*
Świerzno	*Grot Swirsen*	*Gr. Schwirsen*	*Gr. Schwirsen*	*Gr. Schwirsen*
Warblewo	*Warvelow*	*Warbelow*	*Warbelow*	*Varbelow*
Wianowiec	X	X	*Karlshof*	*Karlshof*
Wietrzno	*Vittrin*	*Vettrin*	*Vettrin*	*Vettrin*
Zaświecze	X	*Catten Katen*	*Lattenkathen*	*Lattenkathen*
Zdzieszewo	X	X	*X*	*Elsenhof*
Żydowo	*Sidow*	*Sydow*	*Sidow*	*Sydow*

[1] X – place name not registered.

[2] *Goien* was identified only on the early 17th century map (cf. section 3.1.1).

[3] Lubinus' *Rederang*, spelled *Raderang* on later Prussian maps, does not have unique Polish name. Hence, whenever discussed, the spelling used by particular map maker for the township is used. The case of *Raderang* is presented in detail in section 3.2.2.

[4] ? – no access to map sheets covering the township.

[5] Although the farmstead is presented on the *Messtischblatt* map, its name was not recorded.

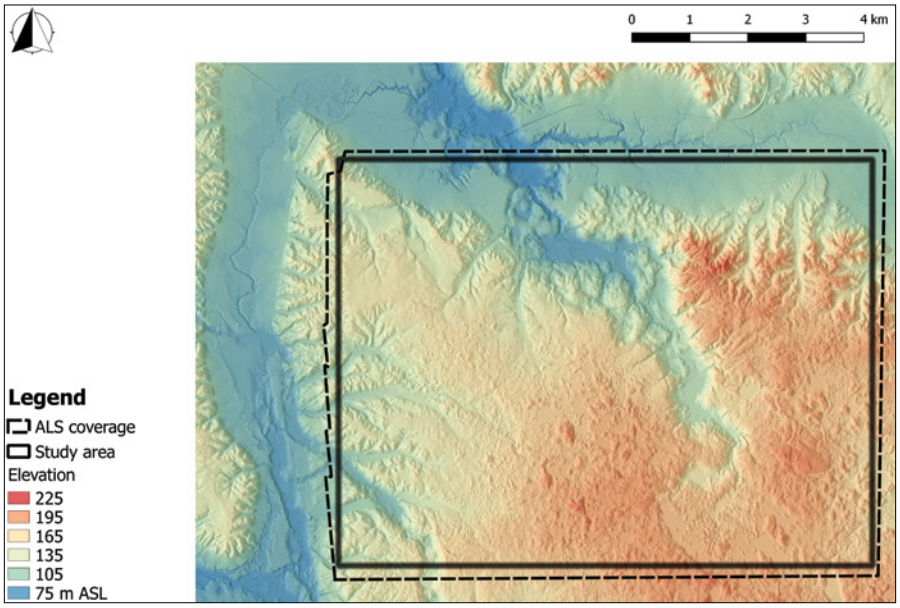

Figure 2. Topographic context of the study area. Hill-shade visualisation of Digital Terrain Model derived from ALS. Data outside the extent of the bespoke ALS survey commissioned by IA AMU was provided by Polanów Forest District administration.

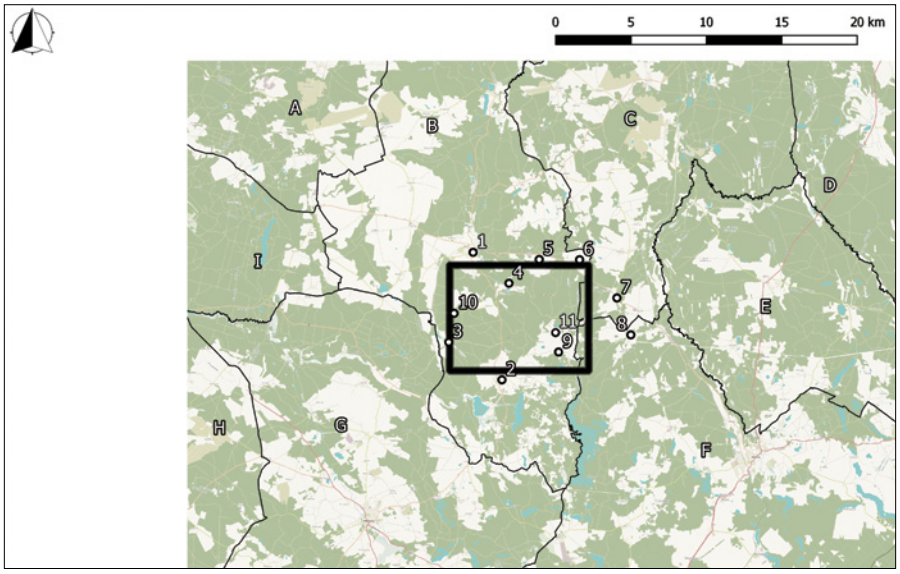

Figure 3. The study area within the context of the afforested landscapes of Pomerania. Forest districts: (A) Karnieszewice, (B) Polanów, (C) Warcino, (D) Trzebielino, (E) Dretyń, (F) Miastko, (G) Bobolice, (H) Tychowo, and (I) Manowo. The selected townships, marked as numbered points, were used in the analysis of the historic map, and are listed in the text. © OpenStreetMap Contributors and Forest Data Bank (Biuro Urządzania Lasu i Geodezji Leśnej, 2018).

and Vistula in the east. Wieżyca, at 328 metres ASL, is the highest peak in Pomerania, and more broadly speaking, the Baltic Uplands (Dickinson, 1964), and is located about 90 kilometres east of the study area.

The study area includes predominantly moraine landscape of Bytów Lakeland, which is flanked to the north and west by a section of the Pomeranian Urstromtal (Figure 2) that falls into the region of Polanów Heights (Florek, 2010; Kondracki, 2000; Solon *et al*., 2018). The rolling moraine plateau is covered with small knolls up to 30 metres high. It is bisected on a north-south axis by a tunnel valley now occupied by the Grabowa River, which has its sources not far from the south end of the valley. Another long tunnel valley cuts the south-western corner of the study area. The edges of the moraine plateau are dissected by short valleys, which originated during the last phase of the Vistulian glaciation, in permafrost conditions, and were reshaped in the Holocene. Abundant kettle holes, formed by dead-ice and often filled with silts and peat, are scattered across the plateau, mainly in the south-eastern part of the study area (Florek, 2010).

The West Pomeranian town of Polanów (German: *Pollnow*[2]; Figure 3:1) is located just outside the northern border of the study area. The area is flanked by the following villages: Rzeczyca Wielka (*Reetz*; Figure 3:5) and Rzeczyca Mała (*Klein Reetz*; Figure 3:6) in the northeast; Żydowo (*Sydow*; Figure 3:2) in the south; Wietrzno (*Vettrin*; Figure 3:10) and Chocimino (*Gutzmin*; Figure 3:3) in the west; and, located slightly farther away, Biała (*Bial*; Figure 3:7) and Świerzno (*Gross Schwirsen*; Figure 3:8) in the east. There are also two villages within the study area: Stary Żelibórz (*Sellberg*; Figure 3:11) and Nowy Żelibórz (*Selberg B*; Figure 3:9); and several hamlets: Przybrodzie (*Forth*; Figure 3:4), Bartlewo (*Bartelow*), and Łokwica (*Hildegardshöhe*), to name a few (cf. section 3.1).

Periglacial forms, abundant lakes and peatland, poor soils, environmental conditions, and historical reasons are behind the extensive afforestation of Pomerania (Figure 3). While 29.5% of Poland comprises woodland, the two coastal provinces of West Pomerania and (East) Pomerania are slightly higher at 35.6% and 36.4% respectively (Milewski, 2017). However, the percentage of forest cover may be locally much higher with, for instance 52% of land within the borders of Polanów Forest District[3] afforested, while over 72% of

[2] As a result of cultural and ethnic transformations, the vast majority of Pomeranian settlement has been given two names, in Polish and German respectively. In addition, numerous sites have also been named in Kashubian, a dialect of the extinct Pomeranian language. Therefore, the historic maps that are discussed throughout this volume have Latinized, Germanized or Polonized versions of Slavic place names, as well as younger genuine German and Polish place names (Chludziński, 2010; Lorentz, 1964; Rzetelska-Feleszko & Duma, 1985). To avoid confusion, selected place names that are commonly used within the text are listed in Table 1. The Polish version of the place name is used systematically and is often followed by its German counterpart. Unless stated otherwise, the German version of any place name derives from the 2nd edition of the *Messtischblatt* map.

[3] Forest district is a local administrative unit within the structure of Polish State Forest. There are 430 districts which together with 23 national parks, cover the entire land mass of the country (Milewski, 2017).

Table 2. Characteristics of archaeological sites identified through field-walking in accordance with the Polish Archaeological Record (AZP) in the study area.

Site number[1]	AZP map sheet number	Location within current forest stands	Early/late modern material recorded	Number of modern potsherds collected	Farmstead on modern maps within 100 metres of site[3]
1	16-25/95	No	Yes	11	No
2	16-25/92	Yes	Yes	11	No
3	16-25/91	No	Yes	10	Yes
4	16-26/18	No	Yes	11	No
5	16-25/93	No	Yes	7	No
6	16-26/15	No	Yes	13	No
7	16-26/16	No	Yes	22	Yes
8	16-26/19	No	Yes	12	No
9	16-26/107	No	No		N/A
10	16-26/106	No	Yes	6	No
11	16-26/99	Yes	Yes	14	No
12	16-26/98	Yes	No		N/A
13	16-26/115	No	Yes	2	No
14	16-26/112	No	Yes	5	No
15	16-26/87	No	No		N/A
16	16-26/113	No	Yes	3	No
17	16-26/114	No	No		N/A
18	16-26/86	No	Yes	1	No
19	16-26/82	No	Yes	8	Yes
20	16-26/83	No	Yes	1	No
21	16-26/81	No	Yes	9	Yes
22	16-26/88	No	No		N/A
23	16-26/75	No	Yes	1	No
24	16-26/74	No	Yes	3	No
25	16-26/58	Yes	Yes	2	No
26	16-26/59	Yes	No		N/A
27	16-26/57	Yes	Yes	5	No
28	16-26/60	Yes	Yes	5	No
29	16-26/62	Yes	Yes	4	No
30	16-27/12	No	Yes	4	No
31	16-27/16	Yes	No		N/A
32	16-27/11	No	Yes	8	No
33	16-27/13	No	Yes	8	No
34	16-27/14	No	Yes	7	No
35	16-27/10	No	No		N/A
36	17-26/5	Yes	No		N/A
37	17-26/4	No	No		N/A
38	17-26/1	No	No		N/A
39	17-26/2	No	No		N/A
40	17-26/3	No	Yes	3	No

Site number[1]	AZP map sheet number	Location within current forest stands	Early/late modern material recorded	Number of modern potsherds collected	Farmstead on modern maps within 100 metres of site[3]
41	17-25/36	No	No		N/A
42	17-25/35	No	Yes	4	No
43	17-25/32	Yes	Yes	12	Yes
44	17-25/33	No	No		N/A
45	17-25/34	No	No		N/A
46	17-25/31	Yes	Yes	4	No
47	17-25/30	No	Yes	11	Yes
48	17-25/29	No[2]	No		N/A
49	17-25/28	No[2]	No		N/A
50	17-25/27	No	Yes	3	No
51	17-25/44	Yes	Yes	5	Yes
52	17-25/46	No	Yes	6	No
53	18-26/3	No	Yes	6	Yes
54	18-26/2	No	Yes	3	Yes
55	17-26/7	No	No		N/A
56	17-26/6	No	Yes	2	Yes
57	17-27/1	No	Yes	4	Yes
58	17-27/2	No	Yes	5	No
59	17-27/3	No	Yes	6	Yes
60	17-27/4	Yes	Yes	5	Yes
61	16-27/15	No	Yes	5	No

[1] Numeration of sites as in Figure 4.
[2] Stray find with imprecise location.
[3] Only applicable for sites with recorded early/late modern potsherds.

the study area is covered by woodland. The existence of such compact forest was one of the main reasons why the area was subject of the bespoke ALS survey, commissioned by IA UAM.

The initial investigations of historic maps suggested that the forest history in the selected area reached at least the first half of the 17th century (section 3.1). On that basis, a continuous land-use was presumed. Indeed, it would make the region of Polanów unique given the late-medieval/early modern deforestation of Pomerania, and the significant change brought by late, 18th-20th century, afforestation. It was assumed that the *longue durée* of woodland could have impacted on the survival of archaeological monuments both dated to the period prior to the observed historic afforestation, and afterwards, hence, related to modern age.

Poor archaeological knowledge of the lands south of Polanów was another reason for choosing this area for the present study. Archaeological prospection in Poland relies heavily on field-walking survey, usually through the Polish Archaeological Record (AZP), a nation-wide programme of survey with methodology established over a half a century ago (Mazurowski, 1980;

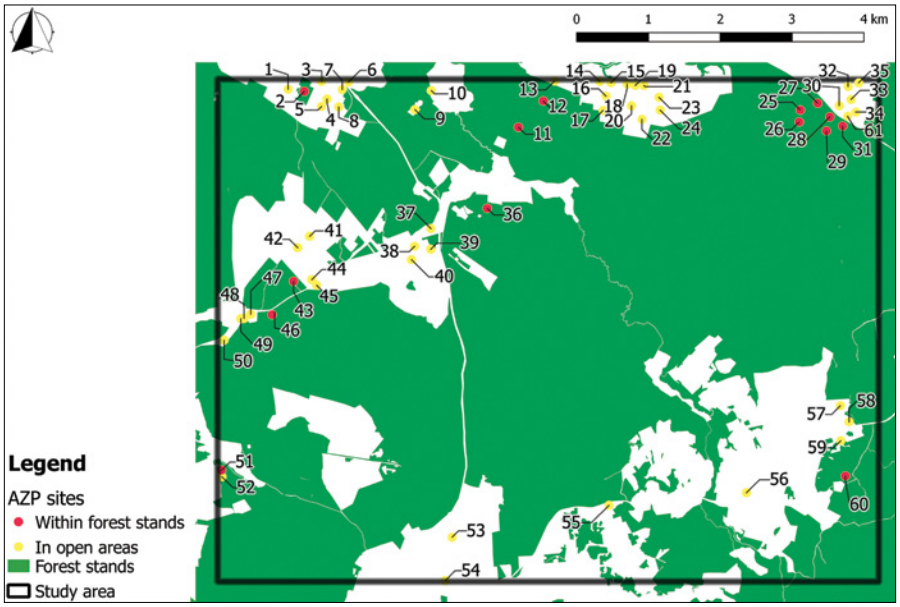

Figure 4. Distribution of archaeological sites identified within the scope of the AZP against the extent of present-day forest stands. All sites are listed in Table 2, while the sites within the forest are discussed in section 2.6 and listed in Table 7. © Forest extent: Forest Data Bank (Biuro Urządzania Lasu i Geodezji Leśnej, 2018).

Rączkowski, 2011). Within the scope of the AZP, woodland has usually been omitted due to the unlikeliness of discovering stray finds in the forest, issues with pre-GPS navigation within woods, and other reasons (Banaszek & Rączkowski, 2010). As a result, the vast majority of archaeological sites in Poland, and within the study area in particular (Figure 4), have been discovered within arable lands where ploughing exposed stray material on the field surface where it was identified by archaeologists. Several sites within present-day forest are investigated in detail in section 2.6. As a result of this predominant survey methodology, the concept of settlement voids was coined, and the area of Polanów, among many other regions of Pomerania, has been traditionally perceived as such. However, it is clear that bias in the archaeological record is the main reason behind the uneven distribution of archaeological sites within the study area rather than an effect of past activity (Banaszek, 2015a; Cowley, 2013, 2016), and, by choosing the study area, I seek to redress this misinterpretation. Indeed, initial survey of the area, undertaken with handheld GPS units in cooperation with employees of Polanów Forest District established the abundance of archaeological monuments within the woodland (Banaszek & Rączkowski, 2010).

II

SOURCE MATERIALS AND METHODS

Airborne laser scanning data is a key resource for studying the afforested landscape of Polanów. However, other datasets were important to understanding the character of the area, and for assessing the reliability of the remote sensed data interpretation. Present-day forestry data and historic maps were used to plan airborne laser scanning data collection, and thereafter to assess data quality and bias. A phase of desk-based interpretative mapping, during which ALS-derived visualisations were used, was followed by field observation and survey. Thereafter, vertical orthophotographs collected during the ALS sortie were interpreted, while traditional aerial reconnaissance was undertaken for selected unforested areas, gaps in the woodland. These datasets were supplemented by historic maps, which were used primarily to determine the longevity of both the settlement in the study area and the patterning of afforestation. Historic maps and modern forestry data were also used to evaluate bias in traditional, field-walking based, archaeological understanding of the landscape. Last but not least, historic aerial vertical photographs were used to investigate mid-20th century settlement and the remains of World War II fortifications.

2.1. Forestry data

All forest districts in Poland collect, process and manage data related to woodland within their boundaries. At the same time, data is transferred to the nation-wide database managed by the State Forest administration, which also includes information about private forests scattered across the country (Biuro Urządzania Lasu i Geodezji Leśnej, 2018). As a consequence of the post-World War II territorial changes, forests within Recovered Territories are predominantly managed by the State Forest administration. For instance, in West Pomerania private woodland covers only 2.6% of the total afforested area (Milewski, 2017), and privately owned forest amounts to only about

2% in the study area. It is notable that in 1900 private ownership amounted to 71.3% of forest in the Koszalin Administrative District (*Regierungsbezirk Köslin*), the part of the Prussian province of Pomerania that comprised eastern regions of Farther Pomerania, including Polanów (Stępiński, 2000). Each forest stand is characterised by several attributes such as an identifier, type, function, dominant tree species, dominant tree age and share within a stand, ecosystem, age class, and area. While some data is redundant from an archaeological point of view, some of it provides useful information about certain environmental conditions within the forest that affect the methodology and surveys discussed below.

The study area lies within Polanów Forest District, with a small strip of land in the east that falls into Warcino and Miastko Districts (Figure 3). While forestry data for Polanów District was provided by the district administration, data beyond its borders was extracted from the nation-wide database (Biuro Urządzania Lasu i Geodezji Leśnej, 2018). Before this dataset is used to assess the reliability of ALS outputs, and the results of other surveys, its character requires explanation.

On the one hand, forest within the study area, as documented by the forestry data, is well defined. This dataset provides information about forest stands that are owned or managed by the State Forest as well as by private owners. However, non-forest trees, or to be more precise, trees covering grounds beyond forest stands are not included in the database. With the reduction in total cultivated area due to the post-war migrations and economic transformation following the fall of communism in Poland (Mizgajski, 2001; Poławski, 2009) the woodland has encroached on land, generally on the fringes of the former forest. While large areas were intentionally afforested, some of the uncultivated fields and meadows are now covered with trees that have randomly colonised such ground. These have been partially incorporated at some point of late 20th century, remain now under forestry management, and are included in the dataset. However, some areas under secondary succession by non-forest trees have not been

Table 3. Percentage of all forest stands area within the study area dominated by particular species. © Forestry data: Polanów Forest District and Forest Data Bank (Biuro Urządzania Lasu i Geodezji Leśnej, 2018).

Coniferous		**Deciduous**		**Other**[1]	**Total**
Pine	31.48	Beech	25.74	1.68	
Spruce	12.18	Birch	13.59		
Larch	1.68	Oak	9.86		
Other[2]	0.05	Alder	3.04		
		Other[3]	0.70		
Total	45.39	Total	52.93	1.68	100%

[1] Clear-felling, swamps, infrastructure, etc.
[2] Common yew
[3] Sycamore, hazel, willow, cherry tree, apple tree, aspen, hornbeam, linden, horse-chestnut, elm.

transferred to the State Forest. These are not subject of processing and calculations discussed in this section.

On the other hand, recorded forest stands within the dataset do not represent only woodland, but may include forestry related buildings, roads, and other infrastructure, as well as glades, seed plantations, and uncultivated fields, which are afforested to a varied degree. Recent clear-felling, where no trees should be expected within a defined area are included as well. Thus, forestry data requires analysis and processing to provide basic statistics for the forest within the study area, which were presented in section 1.3, and are discussed further below.

In addition, it needs to be underlined that each stand is unique due to the location of individual stand within the forest, the age of dominant tree species and its share within each stand, soils and topography, type of understorey, thinning, and other woodland management practices, as well as presence of deadwood and windthrows. Therefore, two stands covered with one tree species, which was planted at the same time, may represent varied characteristics. As a result, the detailed approach to studying forest impact on the survey, which is built on different methods of archaeological prospection, on a stand by stand basis, is complex and does not show any obvious trends. Nevertheless, each tree species demands specific environmental conditions either to produce the biggest volume of timber or to respond to other, non-productive purposes. Thus, some characteristics of stands dominated by the same species are in broad terms shared due to controlled and managed distribution of species throughout woodland. As a result, processing of

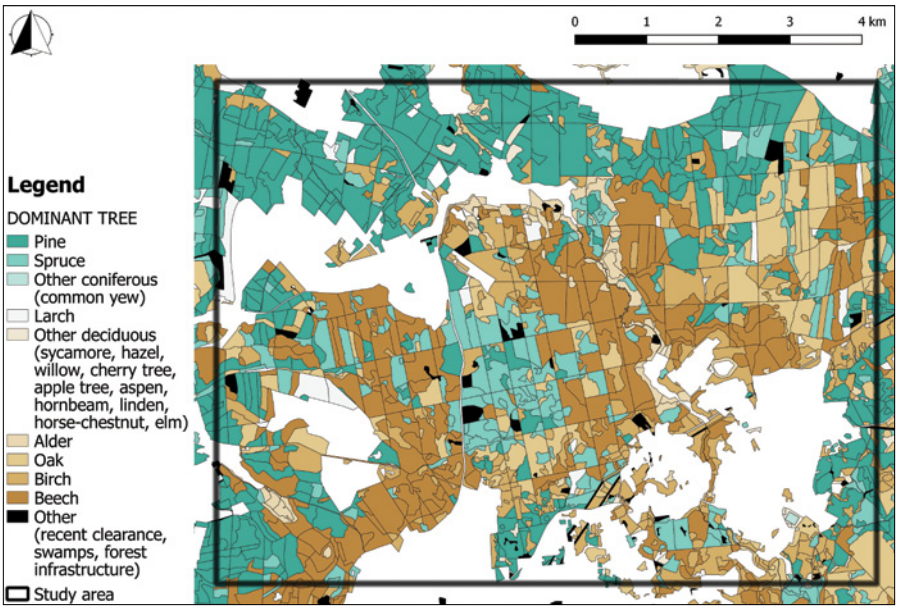

Figure 5. Forest extent and structure, as of January 1st, 2018. © Forestry data: Polanów Forest District and Forest Data Bank (Biuro Urządzania Lasu i Geodezji Leśnej, 2018).

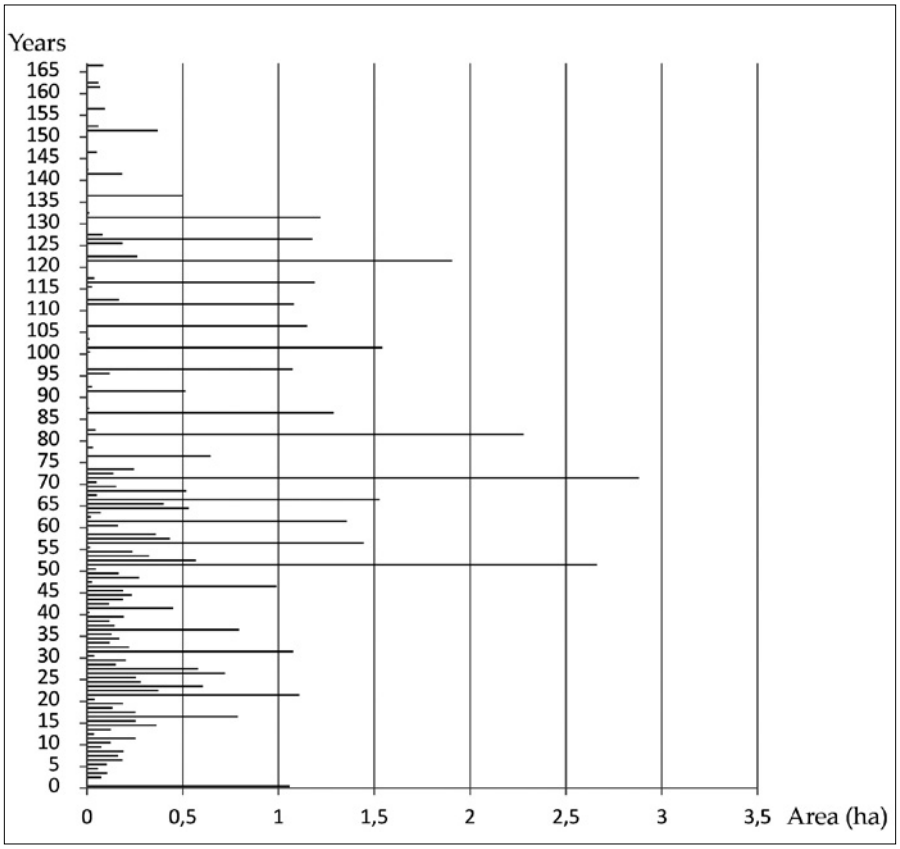

Figure 6. The age of forest stands, and area covered by trees planted in a single year. © Forestry data: Polanów Forest District and Forest Data Bank (Biuro Urządzania Lasu i Geodezji Leśnej, 2018).

remote sensing data is undertaken on a generalised, species by species, level to identify the impacts of the forest structure on data quality.

Basic statistics were calculated from the forestry data. The study area is covered with mixed deciduous (52.93%) and coniferous (45.39%) forest with the remaining 1.68% covered by other types of forestry related land-use (Table 3). Coniferous species dominate the northern area as well as being clustered in the centre of the area with some additional concentrations in the south-western and south-eastern corners (Figure 5). In addition, clustering of individual tree species is clearly visible. This is due to with historic reasons and environmental conditions, which are further discussed in section 3.1. Even though deciduous species dominate slightly over coniferous, the most common tree within the study area is pine, followed by beech and birch.

The mean age of forest stands within the study area is 58.5 years, while the average age weighted by area dominated by trees of the same age is 67.9 years (Figure 6). However, these figures should be taken with caution. Observable peaks in data occur every five years, suggesting an averaging

method of estimating forest stand age. For older trees, planted before World War II, these peaks are separated by years of virtually no data, while the age structure of younger trees is more complex. In addition, almost 10% of the forest is allegedly covered with trees planted in four years only (1896, 1936, 1946, and 1966), representing the most evident peaks in the area coverage. The first two dates correspond with the production dates of historic maps (cf. section 2.5 & Table 6), which were presumably used, in the lack of other evidence, to estimate the age of older stands. The third date relates to the establishment of the new, post-war, forestry administration in West Pomerania. Thus, 1946 was assigned to certain young stands that were planted in the previous decade. As a result, only the latest date seems to represent intensive afforestation over a single year. However, it too follows the five-year cycle, and as such, it should be understood as a broad estimate. Nonetheless, a substantial proportion of the forest represents stands dominated by trees planted in 19th century (Figure 7).

The stated age of individual forest stands does not explicitly document the forest age, nor its longevity. Timber production as well as natural hazards affect the age of individual stand. Nevertheless, when compared with other, historic datasets, it provides insight into historic land-use (cf. sections 2.5 & 3.1). The identification of areas that have been covered with forest for a long time, and in the last few centuries in particular, when mechanized farming caused exponential levelling of archaeological monuments, could prove to be informative for planning surveys within afforested landscapes. Indeed, it is assumed that long-lasting afforestation can have a positive role in the survival of archaeological earthworks. Thus, this detailed understanding

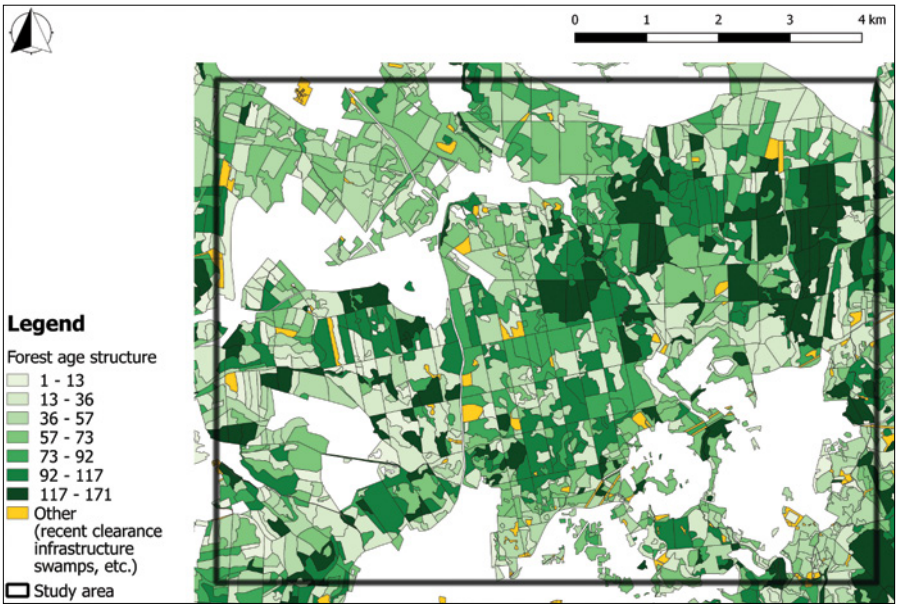

Figure 7. The age structure of forest in the study area. © Forestry data: Polanów Forest District and Forest Data Bank (Biuro Urządzania Lasu i Geodezji Leśnej, 2018).

of forest character and history is useful not only to survey early and late modern landscape, but also archaeological and landscape studies focused on prehistoric and medieval period.

2.2. Airborne laser scanning

Airborne laser scanning or airborne lidar is an active remote sensing technique that has seen exponential growth in applications for many purposes over the last few decades (Dong & Chen, 2017). The scanning device, lidar, emits light (laser) beams, and registers returning echo(s) imaging three-dimensional objects by means of point data (Wehr & Lohr, 1999). Since the position of the device and the scanning angle are known, the coordinates of individual point/echo returning to the scanner can be measured (Vosselman & Maas, 2010). During ALS survey the scanner is mounted on an aircraft, helicopter or unmanned aerial vehicle. In this case, the absolute position of the device is not fixed and thus, global navigation satellite systems are used to register position, while an inertial measurement unit records yaw, pitch and roll (Baltsavias, 1999).

ALS operating in the near infra-red (NIR) is commonly used in topographic surveys (Mallet & Bretar, 2009), in which dense point data is collected and processed into high resolution products, such as Digital Surface and Terrain Models, DSM and DTM respectively. Given that lidar pulses can penetrate forest canopy and other land-use related 'obstacles', the method has proved to be exceptionally productive in documenting areas where traditional photogrammetric and topographic surveys are ineffective or challenging (Hodgson *et al*., 2005; Reutebuch *et al*., 2003). In addition, the intensity data for each recorded echo shows some characteristics of the scanned surface

Table 4. Characteristics of the equipment used during ALS data collection, as well as flight and data parameters.

Flight height (above ground level)	950 m
Lidar	LiteMapper LMSQ680i (Full-waveform)
Digital camera	Hasselblad 39 Mpix
Data coordinate system	PUWG 1992 (EPSG: 2180)
Datum	Kronsztadt 86 (PL-KRON86-NH)
ALS data accuracy	Horizontal ≤ 0.5m +/- RMSE
	vertical ≤ 0.5m +/- RMSE
Average point density (m^2)	all returns 12.71
	last only 11.3
	ground only 9.18
Spacing (m)	all returns 0.28
	last only 0.3
	ground only 0.33
Ground Sampling Distance (orthophotographs)	13 cm

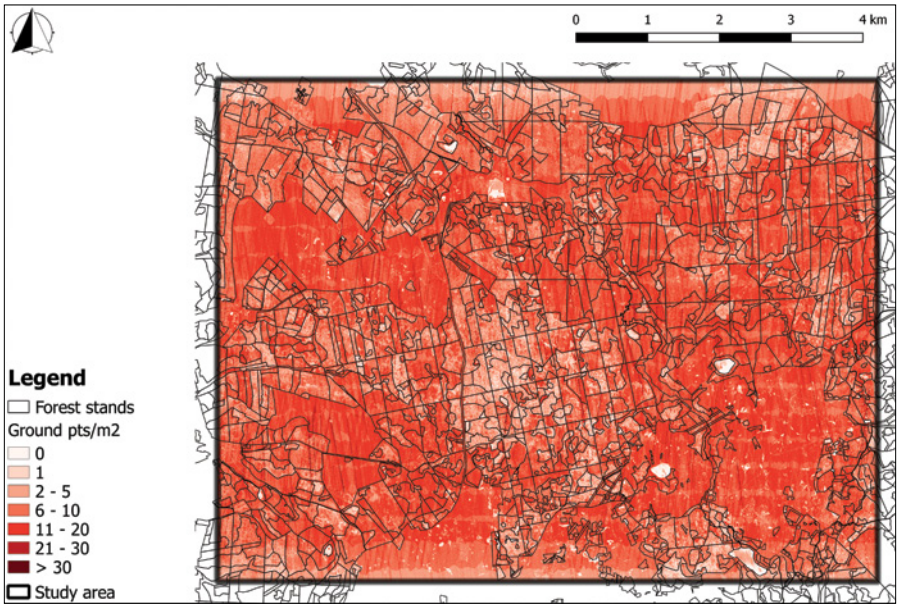

Figure 8. Distribution of ALS ground point density within a 1m^2 grid against the extent of individual tree stands within the study area. Note that while some stands show lesser ground point density (brighter areas), others represent high numbers (darker tones). © Forestry data: Polanów Forest District and Forest Data Bank (Biuro Urządzania Lasu i Geodezji Leśnej, 2018).

(Burton *et al*., 2011; Lang & McCarty, 2009). There are many factors affecting the intensity values making this data difficult to interpret, but if the scanners are pre-calibrated, the outputs are easier to understand (Kaasalainen *et al*., 2009). Nevertheless, scanners operating at various wavelengths are frequently used to determine chemical properties of a given target both on the ground and in the atmosphere (Browell *et al*., 1998; Moore *et al*., 1997; Utkin *et al*., 2002), and even dynamic phenomena such as wind velocity can be recorded by means of lidar measurements (Flesia & Korb, 1999).

Archaeological prospection is amongst the beneficiaries of ALS development with the vast majority of applications focused on detecting earthworks (Crutchley & Crow, 2009; Lasaponara & Masini, 2009; Opitz & Cowley, 2013) within afforested landscapes in particular (Chase *et al*., 2011; Doneus & Briese, 2010; Evans *et al*., 2013). The use of intensity data is still rare though it shows great potential (Briese *et al*., 2014; Challis *et al*., 2011). Beside bespoke ALS surveys, which are usually specified to provide high ground point densities to meet archaeological expectations, the use of 'general purpose' datasets is common. The latter have been often collected on a national level for non-archaeological purposes, usually flood-risk assessment related, and the open-data movement has opened up its use to archaeologists all over the world (Wężyk, 2014). As a result, large area archaeological mapping programmes, which foreground remote sensing data, are being pursued in some countries (Banaszek *et al*., 2018; Bofinger & Hesse, 2011). Elsewhere, available nation-wide data is used piecemeal,

and without explicit methodologies tend to produce unsystematic, difficult to interpret results (Banaszek *et al*., 2018; Wroniecki *et al*., 2015).

Understanding the methodology behind the application of ALS in archaeological prospection is key to delivering quality products from interpretative mapping (Doneus & Briese, 2010). Each stage of data acquisition, processing, analysis and mapping is a subjective interpretative process strongly dependent on knowledge (Banaszek, 2014). Only by knowing the parameters of data collection survey, the nature of the processes used in data analysis, and the methodology of final interpretation can the reliability of outcomes be assessed (Bollandsås *et al*., 2012; Risbøl *et al*., 2013). Pitfalls that are characteristic for each stage may significantly affect final outputs (Banaszek, 2014; Estornell *et al*., 2011; Hyyppä *et al*., 2005; Kiarszys & Szalast, 2014). Thus, given the nature of archaeological features, informed archaeological control over as many phases of the ALS survey as possible supports the production of more reliable results (Cap *et al*., 2018). By understanding the dataset and processes used, bias due to methodology can be identified and thus, inform archaeological interpretation.

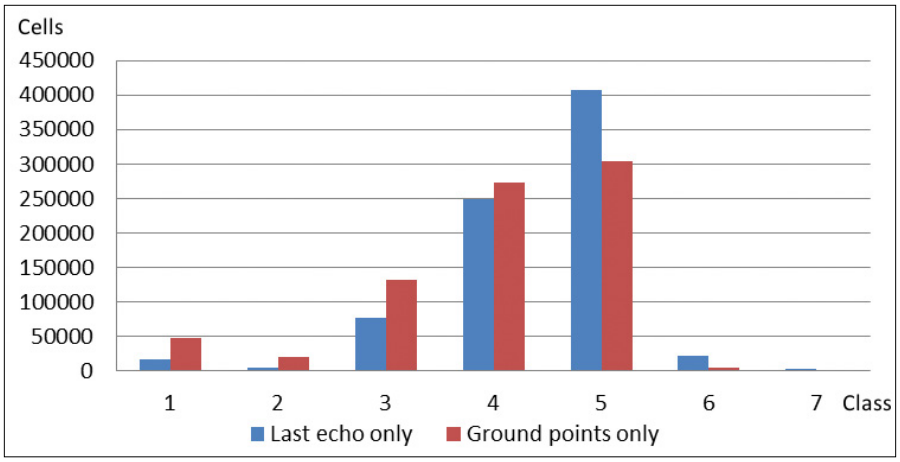

Figure 9. Point density within 1m² cell for last echo and ground points in the study area aggregated in seven classes: 1 – 0 pts/m²; 2 – 1 pt/m²; 3 – 2-5 pts/m²; 4 – 6-10 pts/m²; 5 – 11-20 pts/m²; 6 – 21-30 pts/m²; 7 – over 30 pts/m².

ALS data for the study area was collected during leaf-off conditions by MGGP Aero on 24th April 2012, with orthophotographs acquired during the same sortie. Data, flight, and equipment parameters are listed in Table 4. Point cloud data was supplied in .las files and initially classified by the provider. However, strip alignment as well as point classification did not meet archaeological expectations, and thus, the data was realigned and reclassified using Opals and LAStools software packages. Firstly, the automatic approach exploited 'nature' parameters offered by LAStools, while manual reclassification was undertaken locally. As a result of the commissioned high point density survey, a ground point density

of 9.18 pts/m^2 was achieved with spacing of 0.33 metres, which in turn produced DSM and DTM with spatial resolution of 0.5 metres.

Thereafter these products were used to create the following visualisations: multiple direction hill-shade (Devereux *et al*., 2008); local relief model (Hesse, 2010); sky-view factor (Zakšek *et al*., 2011); openness (Doneus, 2013); and slope aspect. These are commonly used for archaeological purposes, and present topographic data, including archaeological relief features, differently (Challis *et al*., 2011; Kiarszys & Banaszek, 2017; Kokalj & Hesse, 2017). The Lidar Visualisation Toolbox (Hesse, 2016) and Relief Visualization Toolbox (Kokalj *et al*., 2011; Zakšek *et al*., 2011) were used to produce the visualisations. Data management and spatial analyses were undertaken in Geographic Information Systems (GIS) environment and open-source QGIS software was used. Desk-based mapping phase produced targets which were subsequently visited during field survey.

Table 5. Mean ground point density, mean strip count, and their ratio for forest stands aggregated by dominant tree species within the study area.

	Mean ground point density	**Mean strip coverage**	**Ratio**		**Mean ground point density**	**Mean strip coverage**	**Ratio**
Entire forest	9.13	2.71	3.37	All deciduous	10.32	2.78	3.71
All coniferous	7.66	2.63	2.91	Beech	10.89	2.83	3.85
Pine	7.99	2.59	3.08	Birch	9.23	2.69	3.43
Spruce	6.72	2.73	2.46	Oak	10.31	2.73	3.78
Larch	7.78	2.72	2.86	Alder	10.36	2.95	3.51

If examined in detail, the ALS point distribution is regular, with some minor deviation and edge effects (Figure 8). It is evident that the surveyed area was systematically covered by 18 overlapping lines flown from east to west and back. Some 66.4% of the area was covered by three strips, 21.4% by two, 8% by one, and 2% by four. Lines scanned at one angle only lie within the outer sections, about 150-200 metres across, of the two outermost strips, and thus lie in the northernmost and southernmost parts of the study area. In a similar fashion, two strips (one from each side) closer to the centre of the study area, ca. 350-400 metres across, were scanned twice. In between the strips of land covered by three overlapping scans, limited areas were covered by two or four flight lines, subject to drift and roll of the aircraft. For the remaining about 2.2% of the study area no return was recorded, due to water bodies and tiny dispersed areas overgrown by dense vegetation that stopped the lidar beams. However, no data was recorded locally even within parts of the land that were covered by a few overlapping scans.

Beside the broad and fuzzy edged strips of higher density points visible in Figure 8, which result from the linear flight pattern and the fact that the most

of the area was covered by three scans, the point density map shows also a multitude of narrow, north-south aligned strips of ultrahigh density. These lines are as long as the width of a single flight line, ca. 1100 metres, and the accumulation of survey points within them is the highest, with a record number of 225 last echo points within $1m^2$. In principle, these high figures do not affect the quality of produced models, for the lines of ultrahigh density are not usually more than several metres across. However, such concentrations might affect the average point density, raising the question of whether the concentration of survey points along these narrow lines contributes to overstating the point density beyond them. Basic statistics for ALS points (last echo) distribution within a grid of $1m^2$ cells were scrutinized to better understand the data, producing an assessment aggregated in seven classes (Figure 9). For 0.7% of the study area only one point per square metre was collected (class 2), while 9.8% was covered by 2-5 pts/m^2 (class 3). The dominant classes, 4 (6-10 pts/m^2) and 5 (11-20 pts/m^2), represent 31.8% and 52.1% of the study area respectively. In addition, 2.9% of the area demonstrates coverage of 21-30 pts/m^2 (class 6), while 0.5% of more than 30 pts/m^2 (class 7). For the remaining 2.2% no data was collected (class 1). In broad terms, these figures show that the data is equally distributed amongst the study area, 87.3% of which was covered with six or more points per square metre. Only less than 2.9% of $1m^2$ cells within the surveyed region represent very poor or no coverage at all. However, to fully evaluate the spatial distribution of these low-density regions, water bodies should be excluded from calculations and the point distribution around these low values should show whether these are isolated individual cells or wider regions. The remaining 9.8% was covered with a density that is commonly used for 'general purpose' ALS surveys, which is widely used for varied purposes, including archaeological. The low fraction of ultrahigh data (class 7) shows that the concentration of survey points within the narrow strips discussed above does not have any significant impact on the overall coverage of the study area. Thus, the figures above demonstrate that the data acquisition was appropriate, with well-defined flight and scanning parameters.

Given the character of archaeological features in Pomerania and within the study area in particular (cf. section 3.2), ground point distribution is the most important factor in assessing the reliability of the ALS data. This derives from the impact which contemporary land-use has on the dispersion of last echo points, as well as depending on the quality of point cloud classification. Both of these factors are independent of sortie parameters and lie with the person setting the specification of the ALS survey in defining the point density required to overcome the limitations of vegetation cover within the surveyed area. In addition, the responsibility is with the data analyst who uses available classification methods and processes the data within a given intellectual and theoretical framework. In other words, point cloud classification is as interpretative in its character as reading of the ALS-derived visualisations. Understanding the character of expected

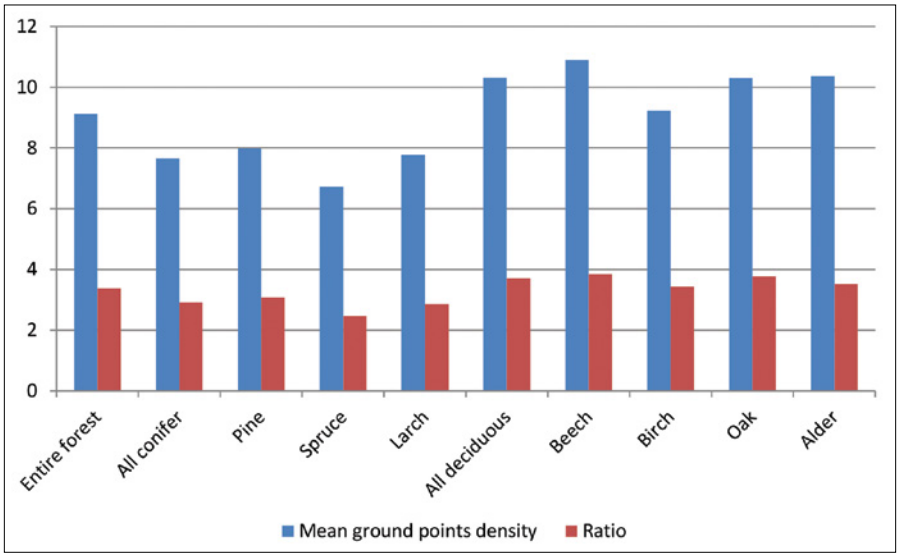

Figure 10. Mean ground point density and normalised ground point density for forest stands dominated by different tree species (cf. Table 5).

archaeological features is crucial to achieve correct classification (Kiarszys & Szalast, 2014). Otherwise, faint archaeological earthworks may be eliminated from classes used in the production of gridded ALS derivatives and, will thus, not be observable in models and visualisations.

Within the heavily afforested study area, the impact of vegetation cover on the distribution of ground points is notable in the increased number of no data and low-density cells, as well as in decreased values of the high-density classes (Figure 9). The number of no data cells (class 1) nearly tripled when compared with the last echo points distribution, and represents 6% of the area. The share of each of the three classes representing lower concentration values increased to the following values of the area: class 2 (one point per square metre) covers 2.5%; class 3 – 16.9% (2-5 pts/m^2); and class 4 – 34.8% (6-10 pts/m^2). At the same time, 38.9% of cells are class 5 (11-20 pts/m^2), 0.7% class 6 (21-30 pts/m^2), and 0.2% class 7 (30-160 pts/m^2). In other words, 8.5% of cells do not represent any coverage or show very poor coverage, a significant rise compared to last echo points, although still acceptable given the degree of afforestation. For 74.6% of the study area six ground points or more were registered, while the rest of the area was covered with an acceptable density of 2-5 pts/m^2. Nevertheless, given the complex structure of the forest, it is clear that the distribution of ground points under the canopy (Figure 8) shows local variation. This is caused by presence of trees of different species (Benham *et al.*, 2007), and requires further explanation.

Statistics calculated for aggregated forest stands classified by dominant tree species demonstrate varied penetration capacity of ALS. Different species affect the distribution of ground points under particular types of canopy. Although the mean ground point density for forest stands dominated by

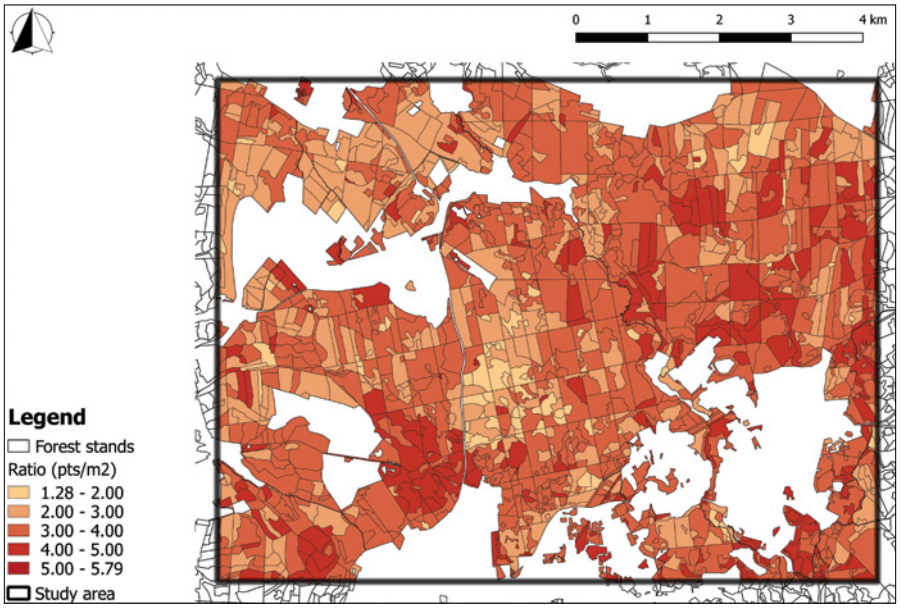

Figure 11. Normalized ground point density for forest stands. Stands with more open canopy are presented using dark tones, while areas where ALS canopy penetration was limited are bright. © Forestry data: Polanów Forest District and Forest Data Bank (Biuro Urządzania Lasu i Geodezji Leśnej, 2018). ALS data: Institute of Archaeology AMU.

individual tree species shows notable variation, this information requires normalization for two reasons (Table 5). Firstly, individual tree species are not evenly distributed across the area (Figure 5). Secondly, the uneven coverage of overlapping flight strips caused significant variation in distribution of last echo points (Figure 8). For instance, density figures for stands dominated by pine, which are located at the edges of the study area, with the largest cluster situated in the north, have been particularly affected by the edge effect. As described above, due to data acquisition methodology and parameters, the northernmost and southernmost strips were covered by one or two scans only. This notably reduced the number of points within one square metre, both in terms of last echo and ground points. Therefore, the mean strip coverage value for individual species was calculated (Table 5) to normalize the impact of tree species on ALS penetration capabilities and, deriving from this, the ground point distribution and spacing under the canopy. As a result, it is clear that pine stands were covered with the lowest number of overlapping strips showing the mean coverage value of 2.59 strips. Thereafter, mean ground point density was divided by mean strip coverage and the resulting ratio shows the ground point density figure for woodland as if the study area was covered by a single scan and thus, showing no overlapping effect.

The aggregated stands that are dominated by coniferous species show significantly lower normalised ground density values when compared with

deciduous forest and thus, the canopy penetration capabilities of lidar beams are limited to a greater degree (Figure 10). Within the study area, beech-dominated stands have the most open canopy and fortunately, the species covers more than a quarter of the forest (Table 3). Oak, birch, and alder follow and demonstrate significantly higher values than any of the coniferous species. Spruce-dominated stands, which were covered with a similar number of overlapping strips as larch and oak, were penetrated the least by ALS. A normalised ground point density value of 2.46 is notably lower than any other coniferous species, and constitutes 80% of the normalised density for pine and only 64% of the normalized density under beech.

Hence, the low mean ground point density within spruce-dominated forest stands does not result from poorer strip coverage, but rather from reduced ALS canopy penetration according to species (Figure 11). Given that the study area was covered by regular multiple overlapping flight strips, this limiting effect was in parts reduced, and a relatively high mean ground point density was achieved even under spruce. It is higher than the available 'general purpose' ALS data in Poland that was collected for the flood-risk assessment, and usually has an average last echo point density of 4 pts/m^2 (Wężyk, 2014; Wroniecki *et al*., 2015). Nevertheless, the lower figures for spruce-dominated stands as well as for less covered areas at the edges of the study area affect the resolution of the produced DTM.

It is worth noting that ALS penetration capabilities are further limited at a local scale, and individual tree stand can be scrutinized in detail. For instance, the lowest rationalized value of 1.28 ground points per square metre was recorded for a certain spruce-dominated stand. Although it was covered by a mean number of 2.92 strips, the mean ground point density recorded within the stand was only 3.74 pts/m^2. However, it is difficult to identify trends on such a detailed scale, while statistics for aggregated stands dominated by each tree species show generalised phenomena. As discussed in section 2.1, there are many factors which make each forest stand unique. Therefore, for instance, no clear impact of tree age on ground point distribution has been recognized. This was expected given that the tree shape changes over time, and so is the openness of the canopy of each forest stand. Nevertheless, the data characteristics discussed above demonstrate the importance of data analysis and survey methodology to inform the understanding of potential bias in the outputs of ALS surveys of afforested landscapes. Although the collected data is high quality, its distribution is uneven due to the factors discussed above. By understanding this phenomenon on local scale, the reliability of the data can be estimated. Indeed, in the case of Polanów, two areas of slightly poorer quality were identified. While the first, located on the northernmost and southernmost edges of the study area, relates to data collection methodology, the other, clustered in the centre, derives from limited penetration of coniferous, and in particular spruce, canopy.

2.3. Field survey methodology

The fieldwork phase of this project was conducted over spring and autumn 2015, and spring 2016, by the author who was occasionally accompanied by Włodzimierz Rączkowski and Kamila Oleś. In total, 22 days were spent mostly in the forest, during which a handheld GPS unit, Trimble Juno 3D, was used to navigate and record survey tracks (Figure 12). Since the GPS unit was loaded with ArcPad, ALS-derived visualisations were stored on the device and informed prospective walking. In addition, targets identified during the desk-based interpretative mapping were stored as a GIS layer and managed in the field.

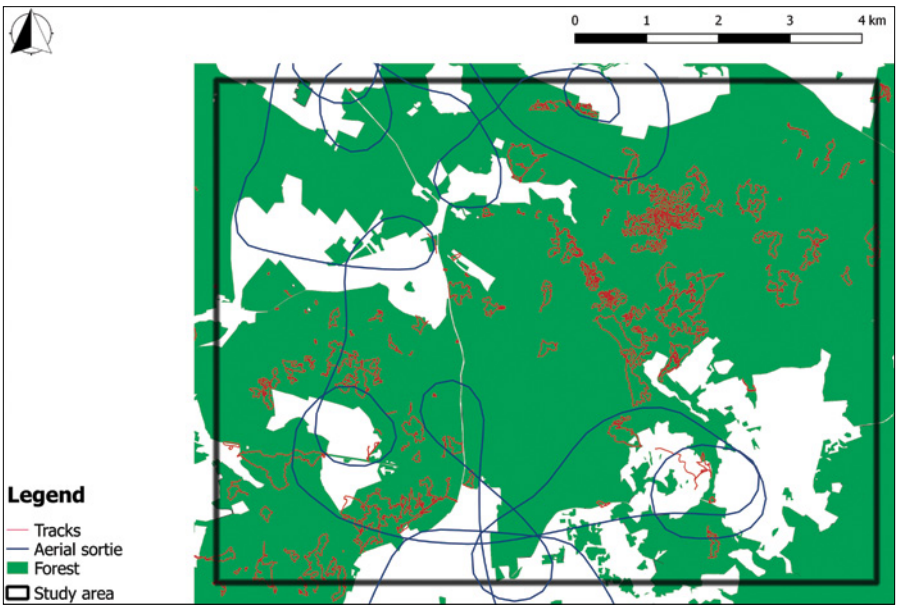

Figure 12. Areas covered with prospective walking, and observer-directed aerial reconnaissance. © Forestry data: Polanów Forest District and Forest Data Bank (Biuro Urządzania Lasu i Geodezji Leśnej, 2018) .

Field survey was directed towards visiting and assessing identified targets and thus, the recorded tracks do not cover the entire forest but the areas, where potential archaeological features were mapped during the desk-based phase. Basic attribute data fields were used to document the observed targets, and at least two photographs were taken of each potential archaeological monument. In addition, given that despite high-quality ALS data, many archaeological features were not observed in visualisations but were identifiable in the field, the landscape was explored to cover the areas where ALS survey proved to be ineffective and produced false negatives (cf. Risbøl *et al*., 2013; Cap *et al*., 2018; Banaszek *et al*., 2018). Thanks to this approach many additional monuments were identified and mapped.

2.4. Aerial imagery

Three types of aerial imagery were interpreted for discrete areas outside the forest: high-resolution orthophotographs collected during ALS sortie (Table 4); oblique photographs taken during aerial reconnaissance, undertaken by Włodzimierz Rączkowski on 22nd July 2015; and historic vertical photographs. While vertical imagery, the orthophotomaps and historic materials, were investigated in a GIS environment, the assessment of the oblique photographs made use of unrectified imagery for reasons discussed below.

The date of orthophotographs collection (24th April 2012) was conditioned by the decision to acquire ALS data in leaf-off conditions. Thus, the potential for cropmarking or grass parching to be recorded on the orthophotographs was very low as early spring is not ideal time for vegetation marks to develop (Wilson, 1982). In addition, the majority of unforested land in the study area is set to pasture, with only some small cultivated fields amongst them. Given that parching of grass demands even drier conditions than cropmarks, there were no expectations of identifying any levelled archaeological features from the interpretation of vertical imagery (Jones & Evans, 1975). Thus, orthophotographs were used solely as supplementary data providing an additional layer of information to the interpretation of ALS derivatives in open areas.

Collection of oblique aerial imagery was planned to be undertaken at a time of the year when cropmarking and grass parching is the most probable in Polish conditions (Cowley & Stichelbaut, 2012; Nowakowski *et al*., 2005). Nonetheless, due to its proximity to the Baltic Sea, Pomerania enjoys relatively mild climate, while damp summers are a common feature (Banaszek & Rączkowski, 2020). Indeed, at the time of the observer-directed aerial reconnaissance, the soil moisture deficit was relatively low (-109 to -100 mm) (IUNG, 2018). In these poor conditions, the reconnaissance targeted areas where two types of archaeological monuments were expected (Figure 12). Firstly, it aimed to cover open ground next to afforested barrow cemeteries, which were identified in ALS derivatives (Banaszek, 2015a). Secondly, it targeted areas where remains of World War II trenches, which are abundant in the forest, were expected to cut across fields and pastures (section 3.2.6). Although the reconnaissance produced oblique photographs that improve understanding of the present-day landscape (Figure 13), not a single cropmark related to fortifications was identified within the study area.

Finally, declassified aerial reconnaissance imagery collected by the United States Air Force during World War II was examined. Of the few sorties available for various parts of the study area in the National Archives and Records Administration in Washington D.C. (Cowley & Stichelbaut, 2012), one roll proved to be high quality, providing coverage of the north-western corner of the study area (D13971-D13973) taken on 7th July 1944 at an

Figure 13. Aerial view on Bartlewo (*Bartelow*) and Rączy Dół Lake (*Raderang See*) where remains of World War II trenches were expected in the open land. Photo by W. Rączkowski.

altitude of 35 000 feet. These offer a view of the landscape of Polanów a few months before the Red Army and the Polish People's Army conquered West Pomerania. Available at an approximate scale of 1:21 000, the photographs support the identification of landscape transformation between the production of the 2nd edition of the *Messtischblatt* map and the mid-1940s. As such, the imagery is the last landscape-scale documentation of the region prior to the massive post-war migration. The photographs offer an insight on mid-20th century land-use and were used to understand the processes of construction of World War II fortifications (cf. section 3.2.6).

2.5. Historic maps

A few series of historic maps were analysed for two purposes. Firstly, the maps were used to identify the longevity of afforestation within the study area and were juxtaposed with current forestry data (cf. Plit, 2010; Szymura *et al*., 2010). Secondly, the maps informed interpretation of the ALS derivatives for early and late modern land-use, the settlement pattern and road network. Understanding of recent landscape transformation is key to identify the character, visibility and distribution of the identified archaeological features (Cowley, 2016; Stevenson, 1975). In this sense, the interpretation of cartographic resources did not aim to investigate whether archaeological features from earlier periods were shown on a given historic map (Kiarszys, 2015).

Despite being commonly recognized as informative resources, the use of historic maps needs to be assessed for the purposes at hand, as they are

selective in what they show and may also be manipulated for political purposes (Koeman, 1968; Monmonier, 1996). Thus, the precision of surveying methods and how precisely objects are depicted on a map, as well as to the accuracy and techniques of representation may vary (Crone, 1978). In addition, the reliability is influenced by the ideology that lies behind every map – a given socio-cultural discourse, within which the maps were produced, and the purposes to which they were meant to respond (Harley, 1988, 1989).

Developments in modern cartography have encouraged a general perception that more recent cartographic sources are more accurate and precise. The shift from military purposes, which characterised early modern maps (Skelton, 1967, 1970), towards civil use driven by economic and land management needs (Bagrow, 2017), means that geographic information derived from a series of maps produced over centuries will always be inconsistent. To minimize the difference, maps produced in a similar, medium, scale were selected for analysis and interpretation (Table 6). Most of these maps (Schmettau & Schulenburg's, *Urmesstischblatt*, and *Messtischblatt*) were created by Prussian cartographers, while Polish surveyors produced the most recent within the selected set (Konias, 2010; Stelmach, 1991). The extent of map series examined was not limited to the study area, and the maps were produced for a nation-wide scale. Thus, only selected map sheets were analysed.

Table 6. The characteristics of analysed historic maps.

	Scale	**Map (series) production dates**	**Map sheet number and production date**	**Transformation method**
Lubinus'	1:227 000-240 000[1]	1618	Plate no 7[2] (1618)	N/A (not rectified)
Schmettau & Schulenburg's	1:50 000	1767-1787	16 (1780)	Thin plane spline
Urmesstischblatt	1:25 000	1826-1876	527 (1836) 528 (1839) 610 (1836) 611 (1838)	Thin plane spline
Messtischblatt	1:25 000	1870-1945	1865 (1896) 1866 (1896) 1965 (1896) 1966 (1896)	N/A[4]
			1865 (1936) 1866 (1936) 1965 (1932) 1966 (1935)	Polynomial (affine)
Topographic map	1:25 000	1962-1989	323.32 (1990[3])	N/A[5]

[1] Scale variability reflects whether the map is based on Pomeranian or Prussian units (Siedlik, 2014).

[2] The map was produced on 12 chalcographic plates which have been lost (Skrycki, 2013).

[3] The map sheet was published in 1990 and produced in 1989 by generalising topographic map 1:10 000 which was created in 1986 (Włodarczyk & Nowaczyk, 1990).

[4] Web Map Server (Główny Urząd Geodezji i Kartografii, 2017) .

[5] Web Map Server (Cartomatic, 2017).

In addition, an exceptional map of Pomerania, *Nova Illustrissimi Principatus Pomeraniae Descriptio…* produced by Eilhard Lubinus, by order of Philip II, Duke of Pomerania, and finished shortly before the Thirty Years' War, was used as background (Skrycki, 2013). Although this 17th century map was produced in smaller scale and has notably lesser geographic accuracy, the depicted woodland extent, and location of towns and villages was analysed to provide time depth to the interpretation of later sources. Given that the network of parallels and meridians is significantly distorted (Plit, 2010; Wolny, 1988), no attempts were made to rectify the oldest map. Thus, unlike other cartographic sources, the information presented on the 17th century map was analysed without adding it to GIS environment. Instead, results of rectification undertaken by Joanna Plit (Plit, 2010) are discussed (cf. section 3.1.1).

All of the used maps were produced by hand, and thereafter reproduced and printed, although digital copies were used for the analysis. Two series were available as Web Map Service (WMS), which provided the reference for rectifying other maps. The Polish topographic map was accessed via the national geoportal (Główny Urząd Geodezji i Kartografii, 2017), while the rectified 1st edition of the *Messtischblatt* map series was provided by Cartomatic (Cartomatic, 2017). Both WMS were set in a nation-wide coordinate system PUWG 1992 (EPSG: 2180), which was also assigned to older datasets. Being based on an accurate geodetic network, the 2nd edition of the *Messtischblatt* map were georeferenced using polynomial (affine) transformation (Affek, 2012, 2013). The older maps were rectified by means of thin plane spline to deal with local deformations in the imagery (Łuczak, 2015). Thereafter, a few layers of information were vectorised from each map, namely forest extent and classification, settlement pattern and outbuildings, and the road network. This data was used to identify late modern land-use and landscape transformations, which impacted the survival of archaeological monuments.

2.6. Archaeological data

Last but not least, the current archaeological information for the study area was scrutinized. As outlined in section 1.3, the Polish Archaeological Record has extensively relied on the results of field walking within the AZP programme (Rączkowski, 2006). Numerous archaeological sites have been mapped as a result of the survey, both those identified in the field and those known prior to the programme. Topographic maps, initially *Mapy Powiatowe*[4], at a scale of 1:25 000 (Królewicz & Żuk, 2015), and later 1:10 000, were used as background layer. Sites were drawn on the maps using symbols

[4] *Powiat* is the second-level unit of local administration in Poland, equivalent to a county, which usually comprises of a few municipalities (Polish *gmina*) and these maps were produced for each *powiat*.

corresponding to a classification based on number of stray finds and the site extent, which in turn was interpreted from the distribution of finds (Table 2). The programme was a notable success, leading to discovery of hundreds of thousands of previously unrecorded archaeological sites. Nonetheless, it has serious drawbacks, and unless approached critically, introduces significant bias to archaeological interpretation (Jaskanis, 1996). In pursuit of covering entire Poland, heritage agencies at various levels commissioned field walking surveys across the country. However, the results are uneven due to limited resources and often a lack of quality assurance. In addition, in most regions a single phase of survey has been undertaken. Thus, when analysed in detail, the land-use as well as temporary environmental and agricultural conditions affect the visibility of stray finds as site registration depends on recovery of artefacts, generally from the plough soil. Hence, the results are far from representing a full record of archaeological sites (Czerniak, 1996). Needless to say, due to the dependence on stray finds on the field surface predominantly within arable lands, other areas with different land-use type such as forest, pasture, and barren land have been omitted and marginalized, a phenomenon clearly visible throughout the study area (Banaszek & Rączkowski, 2010).

AZP map sheet boundaries did not follow the topographic map index, and the tiling system was specifically designed for the programme. Paper copies of the topographic maps with annotated archaeological sites are archived and managed by regional heritage agencies. These were scanned and rectified for the purposes of this survey. However, the original background maps were produced for military purposes in coordinate system PUWG 1942 (EPSG: 3333, 3334, 3335), and these cartographic resources were heavily censored and distorted prior to declassification for civil use in 1950s and 1960s (Królewicz & Żuk, 2015). As a result, the AZP sheets are non-cartometric, do not include projection information, and do not show any grid system and lines. In addition, paper copies kept by the heritage agencies have been distorted over time. Thus, the maps were georeferenced using thin plane spline transformation to deal with local deformations, while close attention was paid to quality assurance. Thereafter, archaeological information was vectorised and descriptive attributes were added to each site.

The study area includes the entire AZP map sheet number 17-26 and partially tiles around it (16-25; 16-26; 16-27; 17-25; 17-27; 18-25; 18-26; 18-27) where 61 archaeological sites were recorded prior to the ALS survey (Table 2). More than a half, 35, of the known sites are within the Pomeranian Urstromtal in the north part of the study area, while the remainder are scattered across the moraine plateau and clustered in arable lands enclosed by the forest (Figure 4). In 14 cases (23% of the records) sites are within present-day forest stands (Table 7), representing a surprisingly high number. However, if the field walking survey results are analysed against forestry data, it is clear that only a few sites were identified in the forest by the AZP surveyors. While six sites (nos 25-29, 31) were recognized in lands that were afforested

after the survey, additional five (nos 2, 11, 43, 51, 60) were discovered within present-day forest stands that have not been afforested or are only partially covered with trees.

In addition, site no. 46 is mislocated. According to site description, it should be situated at the bottom of a valley surrounded by knolls (Janocha & Skrzypek, 1991), whereas on the map it sits on the slopes of the knoll. The study area was covered by the AZP survey on a map tile by tile basis in late 1980s and early 1990s (Table 7). Although the updated topographic map of the area was available at the time (cf. Table 6), the AZP map tiling system did not change, and it was still based on the original *Mapy Powiatowe*. Regardless of whether archaeologists at the time of the AZP survey had access to the newly produced topographic maps, the results of field walking were added to the outdated and distorted cartographic resources. If both maps are examined, it is clear that the area where the archaeological site was depicted on the AZP map sheet was afforested after the older map was produced and before the new map was created. This corresponds with the dominant tree age as well. In 1950s, at the time of map creation, in due

Table 7. AZP sites within forest stands. A comparison of dominant tree age and discovery/verification date. © Forestry data: Polanów Forest District and Forest Data Bank (Biuro Urządzania Lasu i Geodezji Leśnej, 2018) .

Site no[1]	AZP survey date	Dominant tree	Dominant tree age
2	Spring 1987	Other[2]	N/A
11	Spring and autumn 1986	Sycamore and other[3]	91
12	Spring and autumn 1986	Pine	86
25	Spring and autumn 1986	Oak	23
26	Spring and autumn 1986	Oak	23
27	Spring and autumn 1986	Oak	23
28	Spring and autumn 1986	Pine	23
29	Spring and autumn 1986	Birch	11
31	Spring 1991	Pine	23
36	Spring 1993	Beech	N/A[4]
43	Spring 1991	Birch and other[5]	61
46	Spring 1991	Pine	68
51	Spring 1991	Other[6]	N/A
60	Spring 1991	Other[7]	N/A

[1] Site numeration as in Table 2.

[2] Site within built environment (Polanów Forest District headquarters).

[3] Forest dale surrounded by sycamore trees.

[4] The site, an early medieval fort, is excluded from forest management and so the statistics for this stand are not available.

[5] Forest stand includes both arable land managed by the forest district administration and areas covered with birch.

[6] Non-woodland areas which are managed by the forest district administration.

[7] Pasture managed by the forest district administration.

course of post-war afforestation, young trees covered the current forest stand and were most likely not included by map makers, who relied also on earlier, German topographic resources, the *Messtischblatt* map, according to which the plot was deforested. However, when the area was surveyed by field walking, the forest border had shifted to the west. So, having identified the archaeological site next to the woodland, the AZP surveyors placed it within a field surrounded by the forest as visible on the original topographic map, without taking into account this change.

Only the remaining two sites, nos 12 and 36, were afforested at the date when AZP survey was undertaken. The former is a long barrow discovered during field walking (Skrzypek, 2010), while the latter site is an early medieval fort which was already reported in 1846, and subject to trial excavations in 1968 (Łosiński *et al*., 1971; Skrzypek, 2010). Both earthworks are well preserved and excluded from current forest management. Given the location of the long barrow next to a track, it was most likely fortuitously encountered by archaeologists travelling from one cluster of cultivated fields to another rather than a result of planned coverage of woodland.

It is clear that the forest was a conceptual no-go zone for the AZP surveyors. In addition, the single, probably fortuitous, discovery of the long barrow did not stimulate any further survey of woodland. This did not change until 2008, when preliminary archaeological survey of the forest was undertaken by archaeologists and foresters (Banaszek & Rączkowski, 2010). As a result of this cooperation, a few dozens of ancient monuments were discovered and a decision was made to cover the area with ALS survey, the results of which are discussed below.

III

RESULTS

Landscape studies are not well-developed in Polish archaeology, which is dominated by traditional, site and excavations oriented, research (Rączkowski, 2002). Field walking survey is the only prospective method that has been commonly accepted by archaeologists and which addresses off-site and broader scale (Rączkowski, 2011). Undoubtedly the AZP has produced useful results. However, its reductive methodology and vocabulary mean that it suffers from narrow conceptual categories, which in turn influence the archaeological narratives that are constructed from it (Rączkowski, 2018). The levelled character of most archaeological sites in Poland has had major impact on the research model and archaeological practice. Indeed, only limited types of 'traditionally interesting' (i.e. prehistoric and medieval) monuments have survived as earthworks or architectural remains, including prehistoric and medieval forts, along with medieval churches and castles. As a result, there has not been a serious attempt to change the dominant practice and take an interest in landscape features outside smoothed arable land. Hence, the understanding of landscape and earthworks is generally poor. Field systems and cultivation remains, tracks and pathways, mining, resource exploitation and production sites, the remains of water management, and traces of past conflicts are not studied thoroughly and extensively. In addition, most of these features date to the early and late modern period which has often been neglected by Polish archaeologists, and only recently attracted some attention (e.g. Kiarszys, 2016; Kobiałka *et al*., 2017; Piekalski, 2017).

Nonetheless, despite a general lack of experience in reading archaeological topography and remote sensing data, including aerial images (Rączkowski, 2005), a growing interest in ALS data and derivatives in Polish archaeology is noticeable, and some of the results of these new 'landscape oriented' surveys have been published over the last few years (Gojda & Kobyliński, 2018; Pawleta & Zapłata, 2015). However, these surveys are still often localised and comprise undeveloped case studies without deep understanding of the observed archaeological monuments. In some cases, authors refer to European examples and literature, while in others the landscape is

investigated superficially. In short order over the last few years the growing accessibility of ALS data and derivatives had led to the widespread recognition of earthworks within woodland, challenging the way in which the national archaeological record is constructed, and how heritage agencies operate (Banaszek *et al*., 2018). The forest where such monuments survive is not, however, the most accessible environment for traditional archaeological field survey, though it is still not completely impenetrable. The abundance of earthworks recently recorded throughout the country demonstrates how forested and other, non-arable, lands have fallen almost completely outside the intellectual framework of traditional Polish archaeology. Indeed, only a handful of surveys investigated afforested earthworks and other levelled sites within woodland prior to ALS 'frenzy' (Banaszek & Rączkowski, 2010; Krasnodębski *et al*., 2011; Rola, 2015).

In addition, historic, pre-digital earthwork surveys, which were generally limited to monumental sites (prehistoric and medieval forts) never developed into an elaborate approach. For instance, a survey of early medieval forts in Pomerania (e.g. Łosiński *et al*., 1971; Olczak & Siuchniński, 1989) produced site plans but focussed on test pits and estimating chronology through pottery sequences. These plans do not demonstrate sophisticated understanding of surveyed sites, nor graphic and interpretative skills in depicting the earthworks. Moreover, there is little attempt to interpret the earthworks by reading the archaeological topography (Halliday, 2013) to understand sequences of activities, for example (e.g. see Bowden 1999 for this approach to earthwork survey in the United Kingdom).

Since little attention has been put towards identifying and understanding landscape features in Polish archaeology, there is no conceptual framework, which could serve as a model for interpreting monuments in different landscapes. To date, except for targeted monumental sites, such as early medieval forts (Olczak & Siuchniński, 1976), no typology has been constructed for earthworks. Nor has the chronology of particular monuments been established through examination of spatial relationships with other earthworks or as a result of targeted excavations. In addition, limited interest in exploring early and late modern landscapes means that features produced in this period are poorly understood. It is notable that some local surveys using ALS data, have recently delivered results which could be extrapolated to other regions (Mazurek *et al*., 2017; Piekalski, 2017). These, however, do not benefit from any developed tradition of surveying earthworks, and it is difficult to have high levels of confidence in interpretation. Thus, in most cases, a broad-brush horizontal scanning of archaeological monuments in a given area is presented rather than an in-depth approach to a particular location.

As a result, limited or virtually no attention is placed on the palimpsest character of the landscape, a metaphor, through which the multi-temporal layering is explicitly captured (Crawford, 1953; Lucas, 2005). Successive human-environment interactions reproduce, transform, and erase earlier

remains, and produce new landscapes, which are temporal and subject to continuous change. Later activities either completely erase earlier remains or add new scars and bruises to the older features. Thus, a 'true' or 'cumulative' palimpsest is created (Bailey, 2007). Such landscape transformation produces survival zones, within which earlier remains are still observable as earthworks. The zones result from land-use change in the past that has reduced the scale and pace of transformation, for instance smoothing through continuous ploughing. Nonetheless, within and beyond the survival zones, the most recent activity should be acknowledged as a starting point. First, the understanding of multiple landscape temporalities needs to be established to recognize the character of the earlier archaeological monument. Regardless of whether palimpsest is being untangled into single layers or perceived as an inherent material feature (Lucas, 2012), there is a necessity to understand individual temporalities through a conceptual framework while interpreting particular monuments.

Survival zones have never been conceptualized in Polish archaeology, and no attempt has been made to establish a framework for interpreting earthworks. The material discussed below addresses the lack of the framework, and aims to construct one to better understand the early and late modern layer in the palimpsest. This approach starts from a position that without well-established reference points, the latest land-use character needs to be clarified to understand the recent history of the landscape. By acknowledging modern transformations, and filtering features which result from them, attempts to study earlier remains are made. Therefore, in the first instance, the results presented here relate to the modern history of woodland, which constitutes a crucial land-use type within the study area. Through analysis of historic maps, the balance between afforestation and deforestation, and thus, the extent of settlement and cultivation extent, is studied to determine the longevity of the forest. This phenomenon is analysed for the last 250 years, a period covered in detail by historic cartography. Thereafter, monuments from the early and late modern period are studied to understand the latest layers within the palimpsest. Spatial and temporal relations, explored through ALS derivatives and historic maps, support the establishment of chronologies of particular monument types. As a result, layers of human-environment interactions are scrutinized, and the zones of survival established.

3.1. A brief history of modern forest (and settlement)

The forest is a dynamic environment and its structure, borders and extent have changed over time. Particular areas might have been covered with woodland for a long time, while others may have been cleared at some point, turned into fields or pastures and in time afforested again. Plantations, which replaced the primordial forest in Pomerania, can either be isolated or clustered, thus forming extensive woodland. The balance between

the arable land and managed forest (which has served as a resource for fuel, construction material, and game) has always been variable, changing with cultivation techniques, population and material demands, economic conditions, ownership, legislature, amongst other factors. Although pollen analysis proves to be successful in identifying general land-use pattern in a given moment of time, the extent of local woodland can only be tracked in detail if documentary sources are available. In many cases to understand the spatial dimensions of a forest, historic maps are the only useful source as these document land-use patterns across extensive areas. Because of this, the results of analysis presented below are limited to the late modern age, for which the historic maps offering insights into land-use patterns are available.

3.1.1. Early 17th century

As presented in section 2.6, the oldest cartographic source investigated in this survey is the early 17th century map created by Eilhard Lubinus. It appears that the map maker distinguished coniferous plantations from deciduous forests. As presented on the map, the former are small, isolated, and adjacent to towns and villages, while the latter often cover extensive lands (Plit, 2009). The plantations, which could have served as a source of fuel for settlers, were most likely dominated by fast growing pine trees (Plit, 2009). In many cases, the coniferous forests, as presented by Lubinus, are located in areas that are not the most obvious environment for this type of trees. This indicates that these were plantations created to meet certain purposes. The latter, the deciduous forest, was extensively grazed with location very often responding to the environmental potential, which may suggest long afforestation (Plit, 2010). Nonetheless, in a few cases land of different environmental characteristics is also covered with deciduous forest. This proves that the environmental relationship is complex, and resulted from human interference with the land over the centuries prior to the map creation.

Joanna Plit attempted to interpret the extent of the forest for the Polanów *Gmina* as presented on the *Nova Illustrissimi Principatus Pomeraniae Descriptio…* map (Plit, 2010). Her interpretation builds on settlement and hydrographic evidence, which was also illustrated by Lubinus, while she compares this spatial information with later, 18th century maps. Figure 14A presents Plit's results for deciduous forest south of Polanów against the settlements identified on the early 17th century map, and the evidence is juxtaposed with the appropriate fragment of the map (Figure 14B). The extent of the forest was plotted against present-day borders of the Polanów *Gmina*, and since Plit's analysis was undertaken only for this administrative unit, forest extent in the east is limited to the *gmina* borders. Although Plit was aware of limitations of this approach (Plit, 2007), in this case she does not comment on the outcomes of her analysis and offers only a map view (Plit, 2010), which might be misleading unless the errors in the 17th century map are identified.

Since Lubinus did not have access to precise measurement tools and there was no triangulation network available at the time, the dislocation of townships is notable in many cases. In addition, it is argued that the map maker did not visit every part of Pomerania, and these areas were mapped either on the basis of unknown local sources, which do not survive, or thanks to oral evidence, which might have significantly propagated errors (Skrycki, 2013). The dislocation in township locations is clearly visible for the study area. For instance, Gołogóra (Lubinus' *Bredenerg*) is depicted to the northeast of Żydowo (Lubinus' *Sidow*), while in reality it is further south on the other side of the Kamienno Lake, which is the biggest lake located beyond woodland on this fragment of the 17th century map (Figure 14B). In the east, both Świerzno (Lubinus' *Grot Swirsen*) and Świerzenko (Lubinus' *L. Swirsen*) should be shown to the southeast of Biała (Lubinus' *Bial*). In the west, Wietrzno (Lubinus' *Vittrin*) is actually to the southeast of Rosocha (Lubinus' *Ratzoch*). In addition, the Bobięcińskie Wielkie Lake, the largest water body on this map fragment, should be orientated roughly north-south rather than on an east-west axis (cf. the largest lake on Figure 3). Finally, Żydowo, in reality located to the northeast of the Radew River (Lubinus' *Raddus fl.*), is depicted on the west bank of the river. There are also other notable map errors and these demonstrate that Lubinus' cartography should be approached with care. If the rectangular case study area (Figure 14A) was presented against the earliest map, it would form a rather irregular polygon (Figure 14B).

As argued in section 2.5, the map is a medium through which various ideas can be communicated but these sources are often taken uncritically. Maps are perfect tools to manipulate the reader, who often does not contest the dehumanised God's-like view that is offered by map makers. Given the dislocation errors, and that there is no other reliable source data against which the results of Plit's analysis could be compared, it is difficult to establish how accurate Lubinus' depiction of deciduous forest extent is, and where the data 'upgraded' by Plit lies. Therefore, I believe that a descriptive narrative of the extent of the forest in Lubinus' map should provide 'soft' and fuzzy results rather than 'hard' mapping outcomes produced by Plit. To put it in other words, narrative better deals with uncertainty.

In regards to the study area, the deciduous forest, as presented on the map, extends between Biała, Świerzno, Świerzenko, and Gatka (Lubinus' *Thom Gande*) in the east; Polanów (Lubinus' *Polnow*), Rzeczyca Wielka (Lubinus' *Nedden Retz*), Rzeczyca Mała (Lubinus' *Bavenretz*), and Przybrodzie (Lubinus' *Voort*) in the north; and Wietrzno, Rosocha, and Chocimino (Lubinus' *Gutzmin*) in the west. In addition, the forest is partially limited by Żydowo and Czyżewo (Lubinus' *Glowitz*) in the south. Nonetheless, the woodland continues towards the borders of the Duchy of Pomerania with Biały Bór (Lubinus' *De Ball de Olde*), which at the time of map creation, was controlled by the Kingdom of Poland. The woodland is also flanked by *Goien* in the east and *Scheferei* in the west. The former most likely constitutes

a township that was later deserted and could not be identified on any of the later maps investigated in this survey. The latter represents a sheep house (German *Schäferei*). Sheep dominated animal husbandry in the early modern age in Pomerania (Szultka, 2003a) and later cartography provides evidence of a sheep house in Chocimino (cf. sections 3.1.1-3.1.5 & 3.2.4), which is likely the same as the one shown on the early 17th century map. In addition, close to Chocimino, *Mole* is shown, representing a (water?) mill (German *Mühle*).

According to Lubinus there were three settlements completely enclosed by the forest. Bobięcino (Lubinus' *Papentzin*), located on the east shore of the Bobięcińskie Wielkie Lake, Lipki (Lubinus' *Upder Lind*) on the other side of the lake, and *Rederang*, on the shores of the Rączy Dół Lake (*Raderang See*) close to the source of the Grabowa River. The map maker must have been aware that these townships were surrounded by forest. It was not an exceptional situation given that there are several other settlements inside various woodlands in different parts of the mapped country. Since Lubinus used the simplest symbol to represent the three townships, these should be understood as small villages without a church or a mill. The blank, unforested space around each place name is rather caused by chalcography, a technique that was used to print the map, which required empty spaces to distinguish one map feature from another in print, and does not indicate the past reality. Thus, while settlers must have been cultivating the land adjacent to the villages, the extent of these fields cannot be established on the basis of the map alone.

The uncertainty of Lubinus' map makes estimations of the forest extent difficult, in particular in this relatively small study area. Since the plotted results of Plit's analysis are not reliable at a medium scale, a descriptive method is used instead. It is impossible to say whether individual hills or valleys were afforested, however, a generalized forest coverage can be assumed. For these reasons, Przybrodzie, *Rederang*, and Chocimino, were selected as pivotal points for analysis. According to Lubinus, Przybrodzie, standing on the Grabowa River, close to the southern edge of the Pomeranian Urstromtal, was at the border of two land-use types. Broadly speaking, the open land north of the settlement, with forest extending to the south, although there must have been some cultivated fields and pastures around the village. From here, access to Polanów, Rzeczyca Wielka, Rzeczyca Mała, and Warblewo (Lubinus' *Warvelow*) could have taken place through open land, while travelling south would require crossing the forest (Figure 15). However, reaching Biała in the east, or Wietrzno and Rosocha in the west, might have been achieved through or near the forest border. Although the map maker depicts deciduous forest on both banks of the Grabowa River, it is uncertain how far north the woodland reached.

To access *Rederang*, located in the south-eastern part of the study area, one would have to cross the woodland from every direction, while the open land would be concentrated closest to the village and the Rączy Dół Lake. However, it is impossible to establish how extensive the forest was in

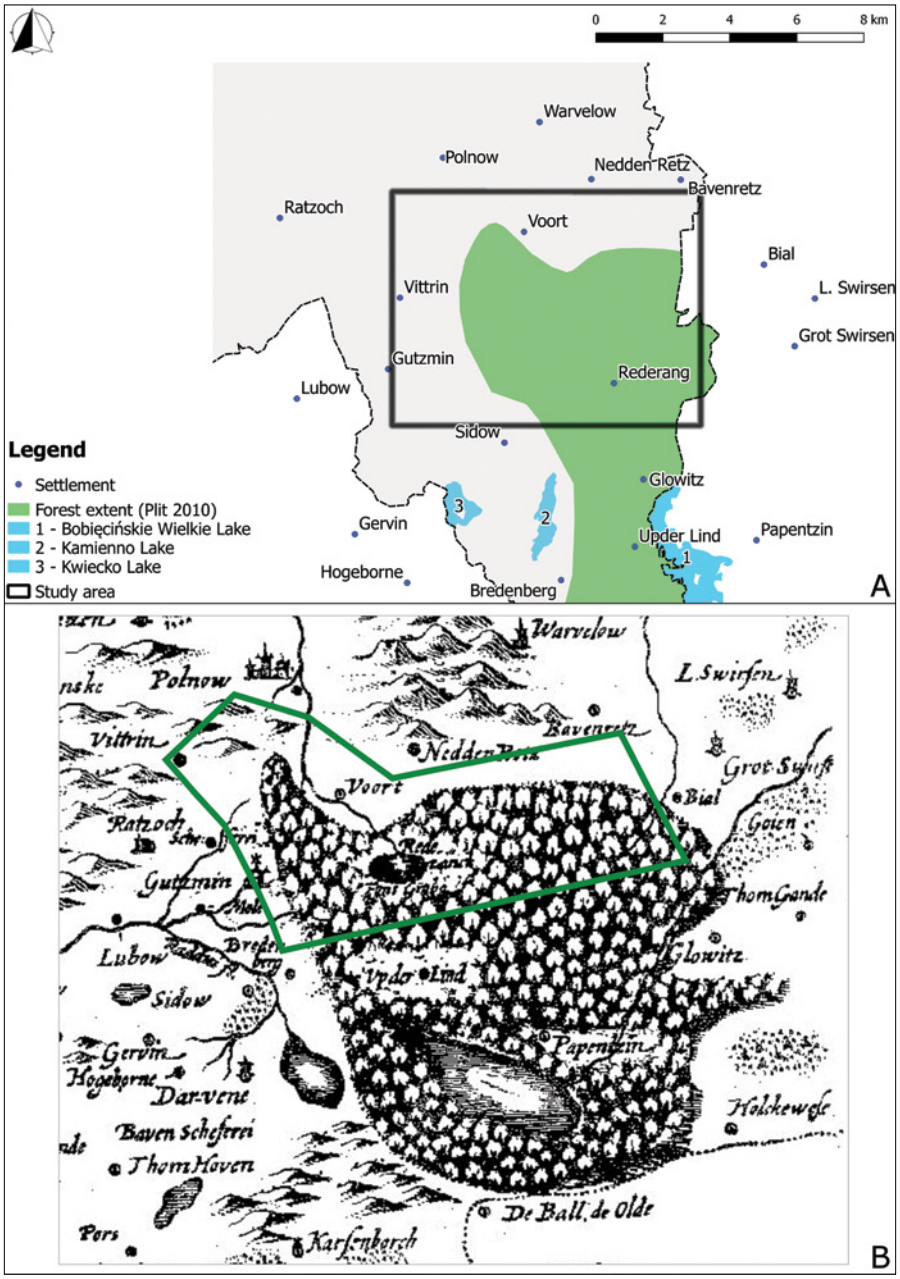

Figure 14. (A) Forest extent according to Lubinus as mapped by Plit (Plit, 2010) for the Polanów *Gmina* and townships mentioned on the 17th century map. (B) Fragment of *Nova Illustrissimi Principatus Pomeraniae Descriptio…* map with the study area (green polygon) distorted to match the map errors and added to the map on the basis of township location. Except from *Goien*, the deserted village that cannot be identified on any of the investigated later maps, other townships presented on 'B' and not repeated on 'A' are located beyond the extent of 'A' and thus, not visible. *Mole*, situated to the southwest of Chocimino (Lubinus' *Gutzmin*) represents a mill, while *Scheferei,* north of Chocimino, and *Baven Scheferei*, to the southwest of Drzewiany (Lubinus' *Darvene*), refer to sheep house and 'new'/'small' sheep house respectively.

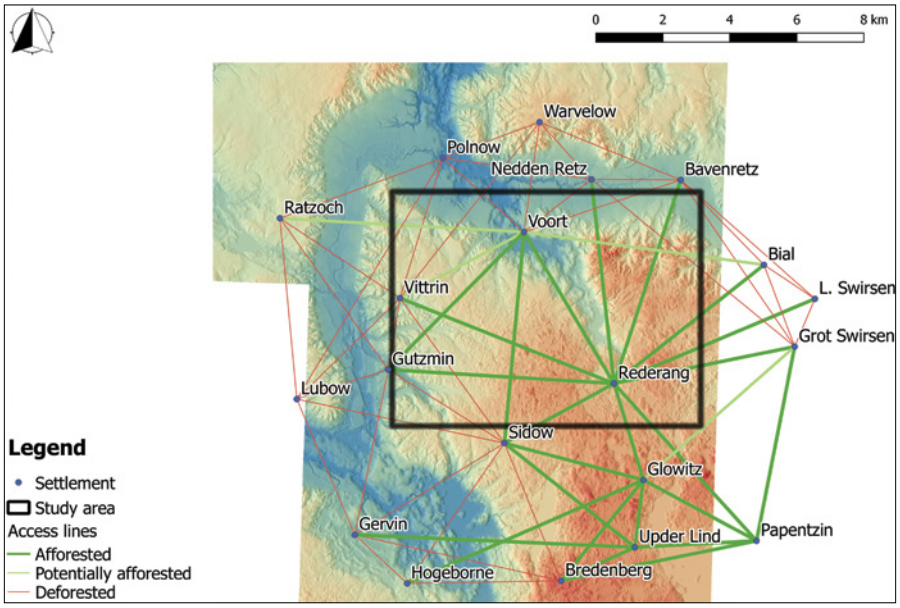

Figure 15. A model of accessibility between neighbouring townships mapped by Lubinus in vicinity of the study area. 'Afforested' lines indicate that forest had to be traversed while moving from point A to B, whereas 'potentially afforested' might have required crossing woodland or the movement took place near the forest. 'Deforested' lines cut through open area. While the model is not based on any road network, it copes with dislocations and uncertainty of Lubinus' map to illustrate estimated forest extent in a different manner than Figure 14A. 'Afforested' and 'potentially afforested' lines indicate that the woodland could/had to be crossed at some point along the line, however, without showing precisely where. Data outside the extent of the bespoke ALS survey commissioned by IA AMU was provided by Polanów Forest District.

any direction. In the case of Chocimino, it is clear that woodland covered the land east of the village. The access from the north (from/to Wietrzno and Rosocha), west (from/to Lubowo (Lubinus' *Lubow*)), and south (from/to Górawino (Lubinus' *Gervin*) and Żydowo (Lubinus' *Sidow*)) was open.

The deciduous forest, as presented by Lubinus, was concentrated in the central and south-eastern part of the study area, excluding arable land adjacent to *Rederang* and areas close to Żydowo, which most likely were also under cultivation. If we assume that Lubinus mapped every township in the area, the settlement distribution may also indicate the extent of the forest. If we include deserted villages (Figure 14B), *Rederang* seems to be the most isolated in the early 1600s. Although the townships of Żydowo and Czyżewo (Lubinus' *Glowitz*) to the south are not far, the distance to townships in other directions is notably longer, even without taking the environmental 'obstacles' into consideration, which include steep slopes, rivers, and bogs.

3.1.2. Late 18th century

All but one (cf. Figure 15) of the townships mapped by Lubinus in the vicinities of the study area were noted on the late 18th century Schmettau

& Schulenburg's map (Figure 16). The latter source offers, for the first time, a closer look at the land-use pattern in medium scale (cf. section 2.5). It is notable that townships on the map are marked with a complex area symbol, which includes (often) clustered houses with surrounding gardens and a church (if one existed), with the exception of *Raderang*, where a single building is presented.

In addition, several 'huts' (German *Kathen*) are clustered in the east and southeast of the study area. These farmsteads were either established after Lubinus mapped the Duchy of Pomerania and before the late 18th century map was created or were insignificant in the early 17th century, and thus omitted by the map maker. In some cases, hut names derive from other settlements nearby. *Raderang Katen* derives from *Raderang*, while *Bijaller Katen* from *Bial* (Biała, located east of the study area, beyond the extent of Figure 16). This suggests a parent-child relationship and the late establishment of these farmsteads. Other place names derive from local environmental features, such as Myszyna (*mis Katen*, 'meadow huts'), and Łąkie (*Teich Katen*, 'pond huts'). Finally, *Selberg* (Stary Żelibórz) is marked as *Vr.* (*Vorwerk*) – an estate, which suggests its importance in comparison to the huts. The late 18th century map takes also note of various outbuildings within or around the study area. A mill is located to the southwest of Chocimino (*Gudzmin*) (not covered by Figure 16), which might represent the building mapped by Lubinus (cf. Figure 14) with another, 'castle mill' (*Schloss Muhle*) just outside the northern borders of the study area. In addition, a sheep-house (*Schäff* – German *Schäfferei*) is located to the northeast of Chocimino.

Schmettau & Schulenburg's map includes also, for the first time, the road network (cf. section 3.2.3), while four parts of the woodland are named. In fact, Lubinus also occasionally noted the forest name. For instance woodland next to Kołobrzeg (Lubinus' *Colberg*) is called *Colbergische Wald* (Kołobrzeg Woods), though, the name of the woodland south of Polanów is not marked. In the late 18th century, the western part of the *Vettrinscher Wald* woodland derives its name from Wietrzno (*Vettrin*). The name of the northern part, *Pollnowscher Eichwald* (Polanów Oakwood), indicates that it was owned by the citizens of Polanów. The name of the central part of the forest is derived from *Raderang* (*Raderangsches Holz*) with the south-eastern part (*Bijallsche Holz*) referring to Biała. In addition, Schmettau & Schulenburg's map provides evidence of a spruce forest north of Polanów (*Pollnowsche Ficht Heide*). These names do not only suggest ownership or importance of the forest due to its longevity (vast areas of Pomerania were afforested at the time when the Schmettau & Schulenburg's map was created, however, only a few woods are known by name) but also show the dominant tree species in certain areas (*Fichte*/spruce, *Eiche*/oak), and the variety of usage. *Holz* (wood) suggests that the area was exploited to produce wood, while *Wald* (forest) suggest that it was a 'proper' (deciduous) woodland in which grazing, browsing, and foraging most likely have taken place. The latter is discussed in section 3.2.4.

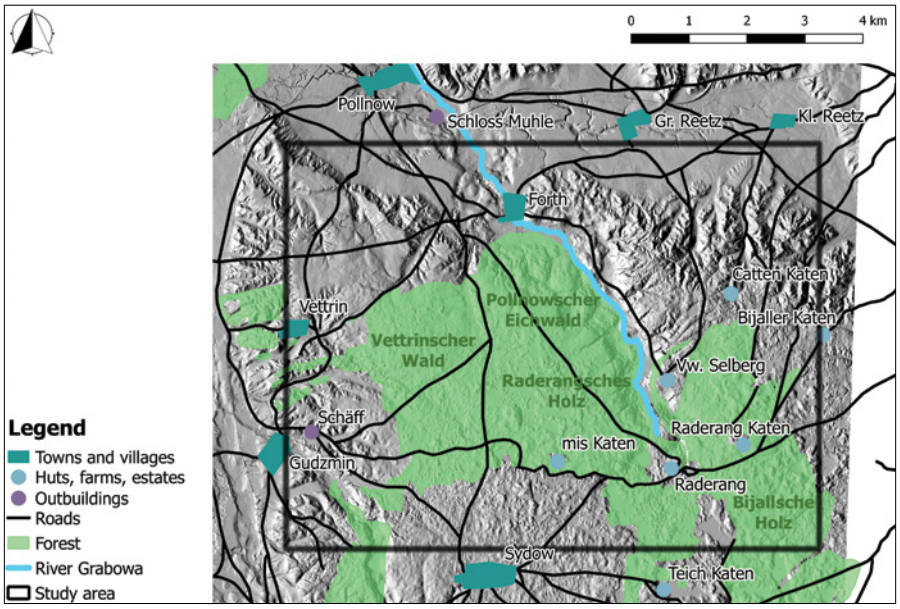

Figure 16. The settlement pattern, forest extent and road network in the study area as presented on the rectified Schmettau & Schulenburg's map plotted against shaded DTM. Data outside the extent of the bespoke ALS survey commissioned by IA AMU was provided by Polanów Forest District. Slight dislocation of features is due to the imprecise 18th century map production techniques and scale in which Schmettau & Schulenburg's map was created (cf. Table 6).

Given the uncertainties regarding the interpretation of Lubinus' map, a comparison of the extent of the forest as presented by the early 17th cartographer and as shown on the late 18th century map is not straightforward. However, the settlement analysis might indirectly demonstrate how the woodland was affected by encroaching agriculture. Assuming that both maps show every settlement that was occupied at the time of map creation, it seems that the eastern and south-eastern part of the study area was deforested immediately prior to the production of the Schmettau & Schulenburg's map. The establishment of new huts and estates might have put the forest east of the Grabowa River under pressure. Clearly, the location of these new settlements was not random. They were located outside lands managed/owned by the well-established townships. While fields surrounding Żydowo (*Sydow*) were enclosed by the forest, Myszyna or Łąkie were established beyond the cultivated land. This suggests colonisation, which opened up new areas that were previously not cultivated (Szultka, 2003a). Since there are no new settlements in the northern and north-western part of the study area, it means that these areas were already parcelled, and there was no space or reason to have new settlements there. The location of Zaświecze (*Catten Katen*), Biała *(Bijaller Katen*) and Stary Żelibórz (*Vorwerk Selberg*) might also have taken place outside the land managed by settlers of *Forth, Gr. Reetz*, *Kl. Reetz*, and *Bial*, and caused deforestation around these new settlements.

3.1.3. Early 19th century

In principle, the encroaching settlement continues to affect the forest in the first half of 19th century (Figure 17). The well-established towns and villages, as well as the huts and estates, that were mapped in the late 1700s for the first time, thrive in the following century. The names of some of the latter changed, for instance Myszyna (*Mishof*) and Łąkie (*Lankenhof*), formerly *mis Katen* and *Teich Katen* respectively, with suffix *–hof*, meaning 'farm', commonly replacing *Katen*. In addition, 'huts near Biała' (*Bijaller Katen*) were turned into *Vorwerk zu Bial* (the Biała estate) demonstrating the stabilisation of settlement and the development of the farms. Nonetheless, numerous new farms were established, some of which were unnamed at the time when the *Urmesstischblatt* map was produced (cf. Table 6). These settlements cluster in the southeast part of the study area. Again, these new farms, as well as new townships first noted on Schmettau & Schulenburg's map are located either at the edge of the forest or within the woodland. Surrounded by small bands of cultivated land, these isolated farms are enclosed by trees. Only Wianowiec (*Karlshof*), located north of Stary Żelibórz (*Vw. Selberg*), is situated in different environs. It sits in the centre of a deforested upland triangle between Stary Żelibórz, Przybrodzie (*Forth*), and Rzeczyca Mała (*Kl. Reetz*), which was deforested at least since the late 18th century (cf. Figure 16). Perhaps the location of Wianowiec resulted from developments in agriculture, which made cultivation on moraine heights more productive. Again, no new farms were established between Żydowo (*Sidow*) and Chocimino (*Gutzmin*), and further to the north, around Wietrzno (*Vettrin*), Polanów (*Pollnow*), Rzeczyca Wielka (*Gr. Reetz*), and Rzeczyca Mała (*Kl. Reetz*). This suggests that the colonization, which is observed already on Schmettau & Schulenburg's map, took place in areas that were not previously cultivated. In addition, the number of farmsteads situated next to the well-established *Raderang* increased. A cluster of seven farms, as presented on the early 19th century map, proves that it was a significant settlement in the region (cf. section 3.2.3). Finally, the *Urmesstischblatt* map provides evidence of a few outbuildings and production sites located both within the study area (a sheep house in Chocimino (*Gutzminer Schäf*), and a lime kiln (*Kalkofen*), situated between Przybrodzie and Wianowiec) and beyond it (a common/people's mill (*Volk Mühle*) in the north, and a brickyard in the south (*Ziegelei*)).

Despite the ongoing colonisation, the forest, as presented on the early 19th century map, covers larger area than previously. Planned afforestation took place and covered the surroundings of Zaświecze (*Lattenkathen*), Biała[5] (*Vw. zu Bial*) and Chocimino with small plantations occurring elsewhere. The place name of the forest next to Chocimino (*Gutzminer Holz* – Chocimino Wood) indicates the purpose of the afforestation. However, the area where

[5] The post-war Polish administration included *Vw. zu Bial* as part of the village of Biała (*Bial*) without discriminating its name.

the label was inserted by the map maker coincides with woodland that was already marked on Schmettau & Schulenburg's map. Hence, the newly afforested area should be understood as covered with young plantations. The main part of the forest, located west of the River Grabowa, is no longer called by three different names (cf. Figure 16). *Adelich Pollnower Wald* (Common Polanów Forest) suggests that the entire woodland belonged to the town in the first half of 19th century, though, it might have been also

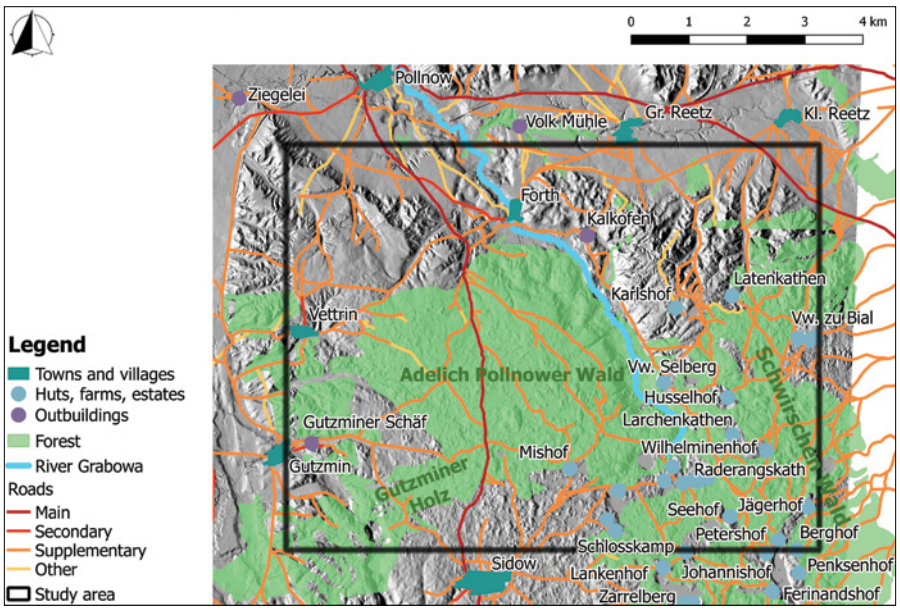

Figure 17. The settlement pattern, forest extent and road network in the study area as presented on the rectified *Urmesstischblatt* map sheets plotted against shaded DTM. Data outside the extent of the bespoke ALS survey commissioned by IA AMU was provided by Polanów Forest District. Slight dislocation of features results from imprecise 19th century map production techniques and the map scale (cf. Table 6).

used by others for grazing, browsing and foraging (Wachowiak, 1993). The spruce forest mapped by Schmettau & Schulenburg north of Polanów is called *Pollnower Stadt Wald* (Polanów Town Forest), a name that does not indicate common use. Finally, the former Biała Forest is now called Świerzno Forest (*Schwirschen Wald*). Together with the Common Polanów Forest, this suggests a tendency to aggregate woodland and assign it to local administrative units. Hence a greater control over woodland is assumed together with a growing interest in managing wood and treating it as commodity. Although the *Urmesstischblatt* map makers did not differentiate between tree species, the information derived from previous (Schmettau & Schulenburg's map) and later (*Messtischblatt*) sources suggest that both Polanów and Świerzno Forests and Chocimino Wood were predominantly deciduous with limited coniferous.

3.1.4. Late 19th century

The 1st edition of the *Messtischblatt* map produced in the late 19th century provides evidence of notable change in the settlement pattern and in the extent of the forest (Figure 18). The numbers of newly established farms are significant and these concentrate in two areas. Firstly, in the south-eastern corner of the study area the well-established settlements attracted new developments. Many new farms were established around *Raderang* making it a linearly extended settlement, while other farms were concentrated around Żydowo (*Sydow*) and Stary Żelibórz (*Sellberg*). In addition, multiple and dispersed townships, such as Bartlewo (*Bartelow*) and Samostrzel (*Neuhof*) colonised areas that were previously afforested. Most of these were single farms, while another estate, Nowy Żelibórz (*Selberg B*) that included several farms was located east of *Raderang*. Secondly, numerous isolated farms were established within a triangle defined by Polanów (*Pollnow*), Przybrodzie (*Forth*), and Wietrzno (*Vettrin*). Some of these were situated in the long deforested lands, for instance Jaromierz Polanowski (*Ludwigshof*), Podleśna (*Schmiedenhof*), and Strzeżewo (*Karlshof*). Others were set either at the border of the forest (as it is presented on the *Urmesstischblatt* map) or within woodland (e.g. Łokwica (*Hildegardshöhe*) and Racibórz Polanowski (*Heinrichhorst*)) thus, causing notable deforestation.

This significant increase of townships most likely does not relate to different methodology used to create various maps (single and small farms are also noted on the *Urmesstischblatt* map which indicates that all settlements were mapped) but was caused by the abolition of serfdom in Prussian Pomerania. This process started in 1807 and was completed by 1865 (Wachowiak, 1993). As a result, vast estates were reorganised and often transferred for a fee to individual farmers who previously were assigned to the lords of the manor in a strict, almost slavish, manner. Perhaps some of the farms that were mapped for the first time on the *Urmesstischblatt* map also resulted from this abolition. However, it surely took some time for other farmers to pay-off the land from the landlords. Thus, the later - *Messtischblatt* map presents this process in more persuasive way.

In this context, the land between Żydowo and Chocimino (*Gutzmin*), the central part of the study area, and the uplands between Stary Żelibórz, Zaświecze (*Lattenkathen*), and *Vw. Bial* show stable land-use. In general, the degree of afforestation in these regions did not change. At the same time, a substantial part of the study area was afforested in a planned manner. Land between Wianowiec (*Karlshof*) and Zaświecze (*Lattenkathen*) in the south, and Rzeczyca Wielka (*Gr. Reetz*) and Rzeczyca Mała (*Kl. Reetz*) in the north were covered with woodland shortly before the map creation. Within moraine uplands both deciduous and coniferous trees were planted, while some light soils of the Pomeranian Urstromtal were covered with coniferous plantations. In fact, substantial amounts of beech, oak and spruce in the uplands and pine in the lowlands are still growing today (cf. Figures 5 & 7). As a result, farms

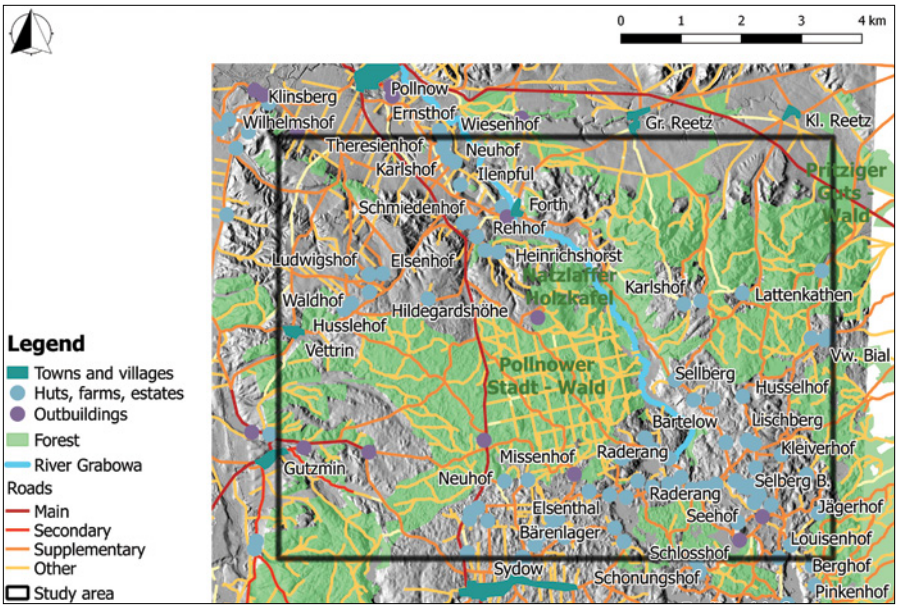

Figure 18. The settlement pattern, forest extent and road network in the study area as presented on the 1st edition of the *Messtischblatt* map plotted against a shaded DTM. Data outside the extent of the bespoke ALS survey commissioned by IA AMU was provided by Polanów Forest District. Slight dislocation of features results from scale in which the map was created (cf. Table 6). While most of the new farms were named by late 19th century map makers, other were assigned to well established townships (e.g. *zu Sydow* – to Żydowo). Due to the numbers of settlements not all names are shown on this figure.

east of the Grabowa River and north of Stary Żelibórz were tightly enclosed by the forest. In addition, small coniferous plantations were established in the north-western corner of the study area.

The *Messtischblatt* map also provides evidence of other buildings within the study area. A sheep house to the northeast of Chocimino is marked on the map together with a barn to the east of it. In the north-western corner a shed was constructed, while in the opposite, south-eastern corner, a brickyard was set up (the southernmost outbuilding in Figure 18) near a school. Four forester houses were constructed: in Myszyna (*Missenhof*), east of Chocimino and next to the Polanów-Żydowo road; in the north part of the Polanów Town Forest (*Pollnower Stadt-Wald*), and next to Przybrodzie. Beyond the study area, other production sites (the brickyard west of Polanów, and a mill between the town and Rzeczyca Wielka) continue to be operational, while a few additional buildings were constructed in the suburbs of Polanów.

Construction of forester houses, as well as the establishment of a regular road network within the woodland (cf. section 3.2.3) and the ongoing afforestation prove that throughout the 19th century, wood became an even higher value commodity with the industrial revolution causing high demand for fuel and construction material. Forest management became an extremely important sector, and to operate on an industrial scale, it

required vast resources. As a result, grazing, browsing and foraging in the forest, which to some extent limited the regeneration of trees, were banned in mid 1800s (cf. section 3.2.4). This changed the forest structure and usage. While the central part of the woodland still formed a part of the Polanów Town Forest in the late 19th century, two completely new names occur on the *Messtischblatt* map. *Pritziger Guts-Wald* is situated in the north-eastern corner of the study area and refers to an estate (German *Gut*) in Przytocko (*Pritzig*), a village east of Rzeczyca Mała and north of Biała (*Bial*). Hence, it is assumed that the new coniferous plantations in that area were established for the purposes of the estate. While Przytocko is located close to the plantations it was attributed to, Nacław (*Natzlaff*), from which the name *Natzlaffer Holzkafel* (Nacław wood area) derives, is situated about 11 kilometres west of Polanów. This name was not given to a new plantation, but attributed to the northernmost part of the former Polanów Town Forest, flanked by the newly deforested area in the west and the River Grabowa in the east. Hence, the town of Polanów might have transferred the rights to use the resources in this area to the family von Senden, the owners of an estate in Nacław. In fact, the regular forestry-related road grid covers solely the woodland that is still marked as Polanów Town Forest, lying between the Grabowa River and the Polanów-Żydowo road. There is no regular road system within the *Natzlaffer Holzkafel* and this indicates a slightly different approach to forest management, which was, however, unified later (see below).

3.1.5. Pre-World War II

Produced a few years before World War II, the 2nd edition of the *Messtischblatt* map presents the peak of settlement within the study area (Figure 19). Several new farms are dispersed amongst townships in the area under cultivation to the southeast and northwest of the Polanów Town Forest. However, the deforestation stopped and while no additional areas were cleared, others were afforested. This applies to grounds between Wietrzno (*Vettin*) and Polanów (*Pollnow*), and locally to the Pomeranian Urstromtal. Nonetheless, many new outbuildings were constructed. All of these marked on the 1st edition of the *Messtischblatt* map continue to be in use, with the exception of a forester house situated between *Natzlaffer Holzkafel* and the Polanów Town Forest (*Pollnower Stadt – Wald*). In this case, the house was turned into a shed. In addition, several new barns and sheds were built, and some of these concentrate along the Polanów-Żydowo (*Sydow*) road. Next to it, a narrow-gauge railway connecting Polanów with Gołogóra (cf. section 3.2.3) was constructed with a spur to the southeast of Łokwica (*Hildegardshöhe*). This provides evidence that wood from the Polanów Town Forest was temporarily stored in sheds, and thereafter transported by rail to the town where there was a saw mill. In addition, a barn was located to the southwest of Rzeczyca Wielka (*Gr.* Reetz), and a shooting range was set up at the edge of the Chocimino Forest (*Gutzminer Wald*) (cf. section 3.2.6).

The place name of Chocimino Forest was again marked on the map, and likewise the name of Wietrzno Forest (*Vettriner Wald*) is shown together with *Natzlaffer Holzkafel* and *Pritziger Guts – Wald* discussed above.

It is notable that the woodland to the west of the Grabowa River, with the exception of the newly established plantations, is dissected by a regular road grid. In the case of the Polanów and Wietrzno woods, the grid orientation is the same, while for the Chocimino Forest and *Natzlaffer Holzkafel* it adjusts to the extent of woodland and local topography. Nonetheless, the road network within the forest east of the river does not demonstrate any regularity despite the stability of this afforestation. Given the scale on which the regular road network was established on the other bank of the Grabowa River, its absence in the eastern part of the study area represents a specific decision in regards to forestry management. This was presumably related to environmental conditions, and the tree species covering uplands and lowlands. In addition, except from the Przytocko Estate Forest (*Priziger Guts – Wald*), which seems to cover only a limited area, the woodland between Stary Żelibórz (*Sellberg*) in the south, and Rzeczyca Wielka and Rzeczyca Mała in the north, does not have a name. Neither edition of the *Messtischblatt* map, on both of which the former Świerzno Forest (*Schwirschen Wald*) (cf. Figure 17) was disturbed by the growing settlement, take note of any place name in this area.

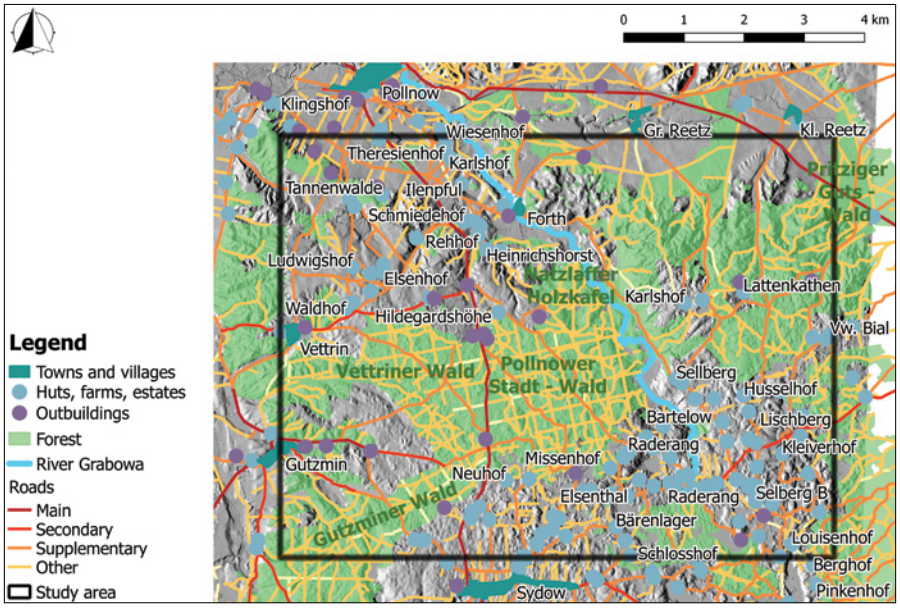

Figure 19. The settlement pattern, forest extent and road network in the study area as presented on the 2nd edition of the *Messtischblatt* map plotted against a shaded DTM. Data outside the extent of the bespoke ALS survey commissioned by IA AMU was provided by Polanów Forest District. Slight dislocation of features results from scale at which the map was created (cf. Table 6). In a similar fashion to the 1st edition of the *Messtischblatt* map, most of the new farms were named by 20th century map makers, while other were assigned to well established townships (e.g. *zu Sydow* – to Żydowo). Due to the numbers of settlements not all names are shown on the figure.

3.1.6. Post-World War II and present-day

The Polish topographic map produced after World War II presents significant change in the land-use (Figure 20) with all place names in Polish. The expansion of the town of Polanów took place at the cost of deserted farms. Isolated townships located in the south-eastern and north-western part of the study area were abandoned, with only some surviving the post-war migration. Ongoing afforestation enclosed the remaining farms and covered land which had been cultivated over the last few centuries. The forest encroached closer to Żydowo than at any point since the late 18th century (cf. Figure 16). A belt of coniferous plantations separated Wietrzno from Polanów. Farms located between Stary Żelibórz and the Pomeranian Urstromtal were completely wiped from the landscape with the surrounding fields turned into woodland. In addition, the well-established townships of Przybrodzie and *Raderang* lost their population and significance (cf. section 3.2.2).

With depopulation and afforestation came modification of the road network (cf. section 3.2.3), while outbuildings, once scattered across the study area, disappeared. A school building and a brickyard in the south-eastern corner, a sheep house next to Chocimino, and barns and a shed in the central and north-western part of the study area, were abandoned or reused for alternative purposes. Nonetheless, a few new production sites, for instance related to exploitation of gravel, to the west of Racibórz Polanowski, were established. These, however, represent a fraction of what was observed before World War II. A regular road network related to forestry survived in woodland to the west of Grabowa River, and can be observed also in plantations to the north of Wietrzno, some of which were set up in 1930s, when west slopes of moraine upland were afforested. In contrast, the forest east of the river does not have a gridded road network.

The ongoing rural depopulation and afforestation mean that today even fewer farms are present in the study area with additional ground covered with plantations (Figure 21). Consolidation of the afforested land gives the impression of a solid forest complex that encloses spatially limited cultivated area. In addition, urban sprawl and growing suburbs of Polanów are notable in the north-western corner of the study area.

3.1.7. The longevity of the forest

Historic maps offer a detailed view on the pattern of afforestation over last 250 years. In addition, the early 17th *Nova Illustrissimi Principatus Pomeraniae Descriptio…* map provides a background for understanding the longevity of the forest. Although this map was used for estimating the degree of afforestation on a regional, Pomerania-wide, scale (Kunz, 2012), due to its errors and generalisation, it was excluded from detailed processing because of 'fuzzy' results. At the same time, each of the analysed maps that were produced at a similar, medium, scale proves to be comparable

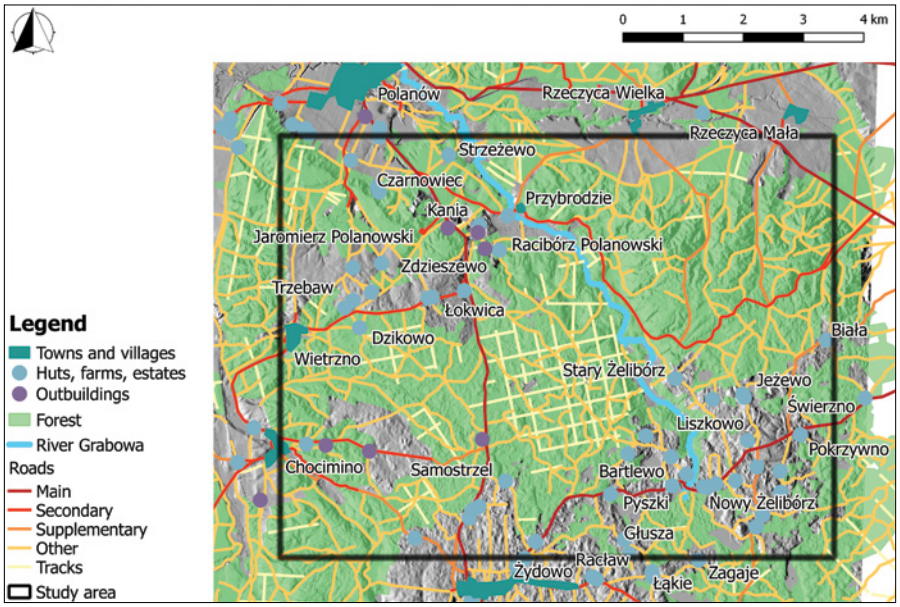

Figure 20. The settlement pattern, forest extent and road network in the study area as presented on Polish topographic map plotted against a shaded DTM. Data outside the extent of the bespoke ALS survey commissioned by IA AMU was provided by Polanów Forest District. Slight dislocation of features results from scale in which the map was created (cf. Table 6). Farms and other place names were renamed after World War II and some townships were often clustered without following previous administrative borders.

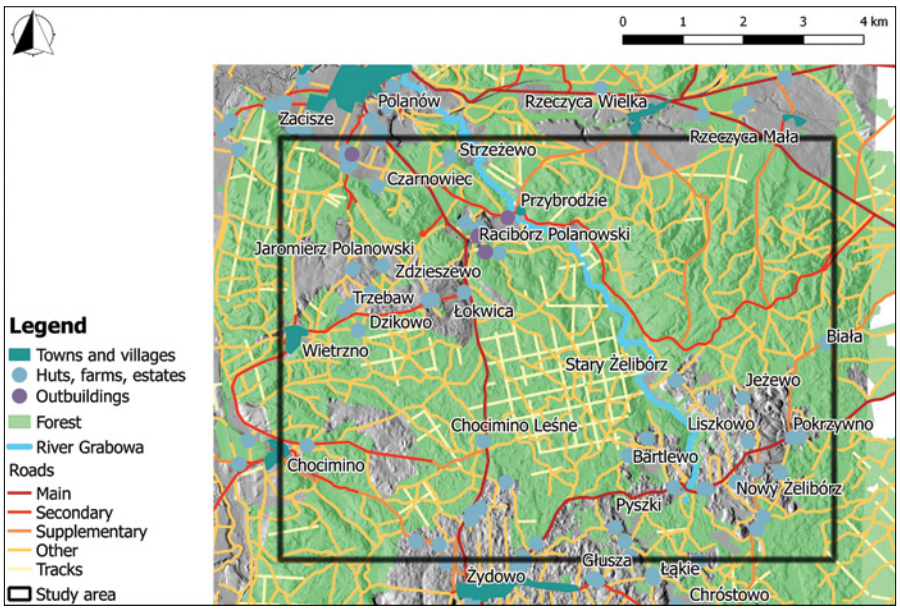

Figure 21. The current settlement pattern, forest extent and road network in the study area plotted against a shaded DTM. Data outside the extent of the bespoke ALS survey commissioned by IA AMU was provided by Polanów Forest District. © Forestry data: Polanów Forest District and Forest Data Bank (Biuro Urządzania Lasu i Geodezji Leśnej, 2018).

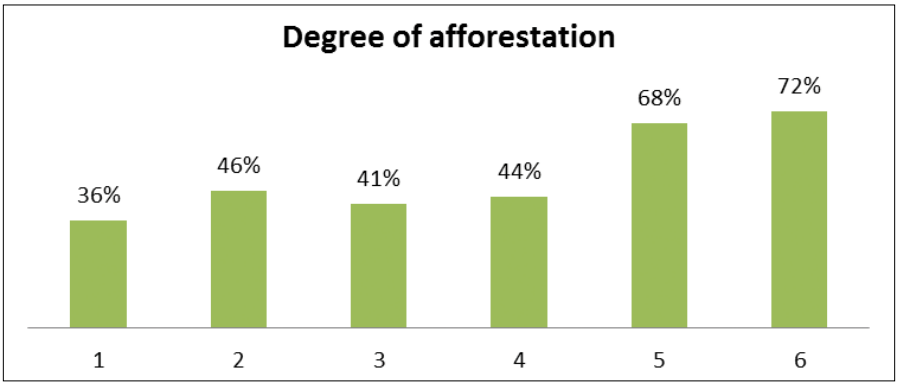

Figure 22. Afforestation of the study area as presented on historic maps (1 – Schmettau & Schulenburg's map; 2 – *Urmesstischblatt*; 3 – *Messtischblatt*, 1st ed.; 4 – *Messtischblatt*, 2nd ed.; 5 – Polish topographic map), and today (6).

with others. As a result, metrics can be calculated and although some level of uncertainty, due to different map making methodologies, should be acknowledged, the analysis offers a general understanding of the degree of afforestation (Figure 22).

It is clear that today the study area has approximately twice as much forest when compared to the late 18th century. Although planned afforestation took place in the 19th and early 20th century, it was matched by the impact of growing population. A steep change in land-use and population occurred in the aftermath of World War II, while the ongoing economic transformation

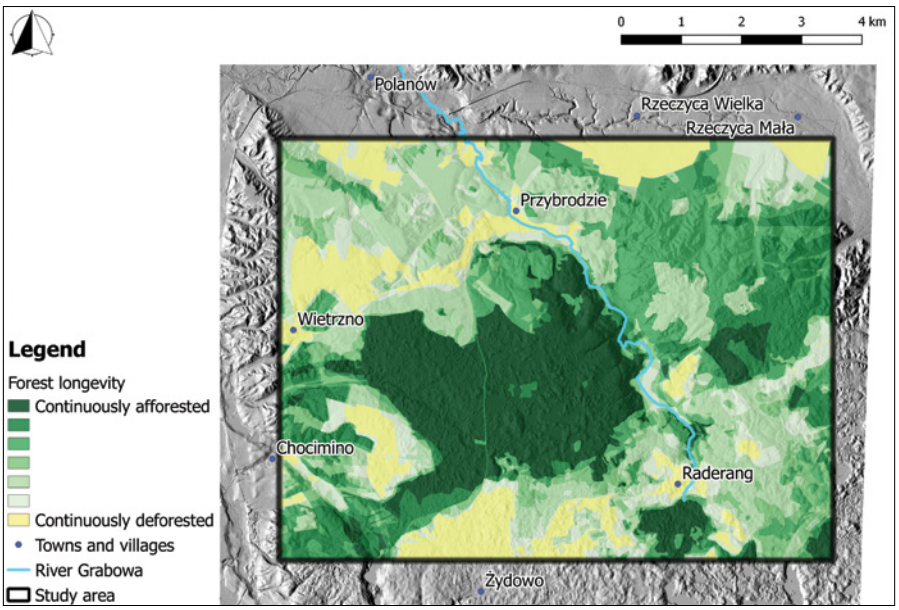

Figure 23. The longevity of forest within study area plotted against a shaded DTM. Data outside the extent of the bespoke ALS survey commissioned by IA AMU was provided by Polanów Forest District. Town and village names are taken from Polish topographic maps, with the exception of *Raderang*.

since late 1980s means that additional ground is being converted into woodland. When compared with regional figures, the study area has been afforested to a notably greater degree. According to Mieczysław Kunz, from small scale maps the degree of afforestation for Pomerania was: 20% in 1789; 24% in 1870; 21% in 1902; 32% in 1959; 34% in 1984; and 37% in 2006 (Kunz, 2012). Hence, the woodland within the study area can be understood as a well-established and discrete forest complex throughout the centuries. Nonetheless, even here, local land-use change affected the stability of woodland (Figure 23).

On the one hand, large areas around Żydowo, Wietrzno, Polanów, Rzeczyca Wielka, and Rzeczyca Mała, as well as limited and enclosed land next to *Raderang*, Przybrodzie, Stary Żelibórz, and Chocimino have been continuously deforested since at least the late 18th century. On the other hand, substantial parts of the woodland, predominantly, but not limited to, the central part of the study area, has been continuously afforested. In addition, areas which have been covered with trees since the early 19th century are in close spatial relationship with the most stable woodland, while other areas show greater variability in land-use. If the location error of about 100-200 metres that is characteristic for the late 18th and early 19th century maps (Szymura *et al*., 2010) is taken into account, the results of analysis at the presented scale should be taken with caution. Undoubtedly minor shifts of mapped features occurred at the edges of cultivated grounds and woodland. Nonetheless, these uncertainties do not change the general pattern. Further analysis of land-use change demonstrates differences in the temporality of the forest. Once afforested large areas adjacent to

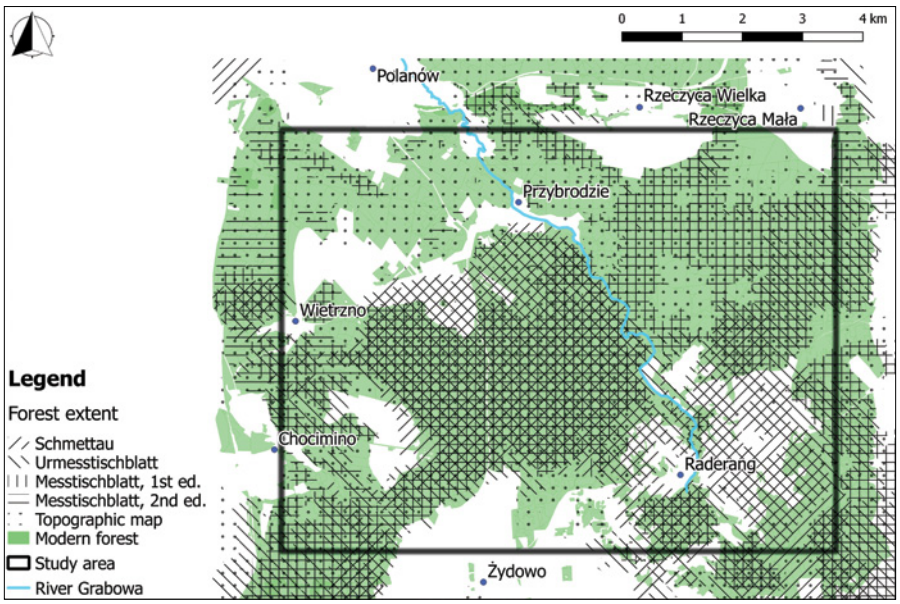

Figure 24. Forest extent as presented on the analysed historic maps and currently.

Raderang and sections of the former woodland east of Wietrzno were cleared in the 19th century (Figure 24), while some patches of land have recently been afforested again. On the other hand, extensive plantations covered once open land in the northern and north-western part of the study area in the late 1900s. Afforestation, which took place in the early 19th century in the northeast and southwest can also be traced.

The results of the analysis presented above enhance the understanding of early and late modern land-use. In addition, these outcomes constitute a base layer for the identification of archaeological features within and beyond present-day woodland, and inform the interpretation of ALS-derived visualisations. Thus, the poorly recognised relationship between the observed archaeological topography and forest management can be addressed. In addition, the outcomes improve the understanding of archaeological features related to woodland exploitation (cf. section 3.2.5). Finally, the results feed into the discussion of the survival zones for the early and late modern archaeological monuments (cf. section 3.3).

3.2. The early and late modern landscape

Fluctuations in the extent of forest cover are the most significant and extensive changes in the land-use pattern within the study area over the last few centuries, and the historic maps demonstrate the scale of these processes. While deforestation resulted from an increase in population and a dispersed settlement patterns rather than natural factors, the planned afforestation initially took place on poor soils and covered areas that were difficult to cultivate, for instance steep slopes. Thereafter, a decline in the post-war population stimulated the growth of significant and coordinated afforestation throughout the study area with minor natural secondary regeneration alongside.

3.2.1. Cultivation remains in the modern-day forest

While it is widely acknowledged that modern cultivation techniques cause levelling of archaeological earthworks (RCAHMS, 2009) and smoothing of natural relief (Banaszek, 2015b), afforested landscapes often have an abundance of archaeological monuments, which are often far better preserved than sites within arable ground (Doneus & Briese, 2010). In this case, the survival of archaeological earthworks is due to less frequent, or even absent, ploughing, as well as a lack of deliberate clearance through which construction material is removed and placed on headlands. However, as the historic maps clearly demonstrate it, some areas of recent afforestation were cultivated over certain periods of time prior to afforestation. This significant change of land-use can lead to survival of cultivation marks and offers precise dating of these remains, if the date of afforestation is known. If the landscape is understood as a palimpsest (Crawford, 1953; Mlekuž, 2013), in which case the later strata of human-derived remains overlay, smooth

or erase the earlier, the afforestation is a positive post-depositional process (Schiffer, 1996). It is characterized by long intervals between forestry related ploughing that result from the extended growth time of the wood, a product that is still the main reason for the existence of woodland in Poland. In this way, the potential transformation and removal of earlier monuments is to a certain degree 'delayed', when compared to the cultivated area.

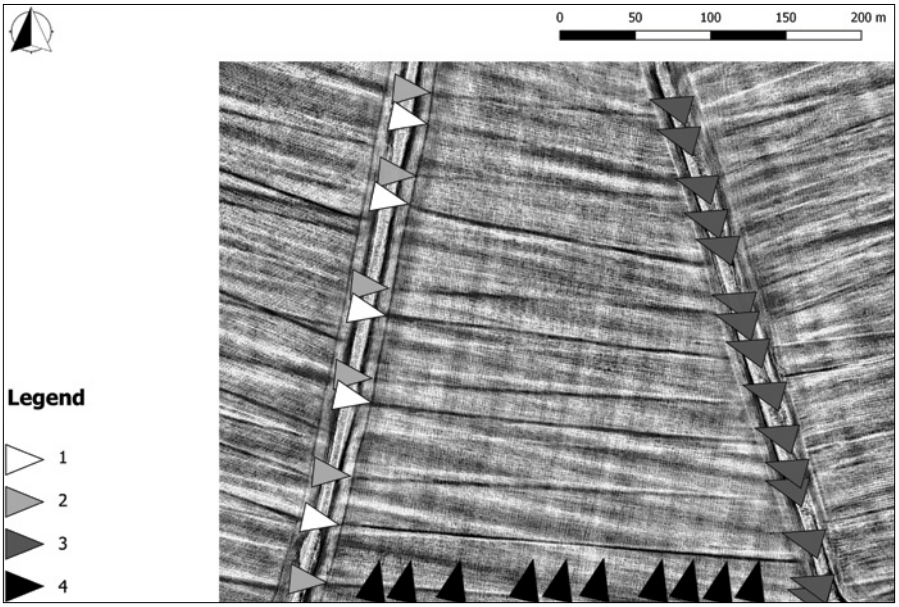

Figure 25. Currently cultivated fields in Rzeczyca Wielka. At least four phases of cultivation marks were identified (1 – the most recent; 4 – the oldest), however, it is difficult to identify when the change in farming practice occurred. The orientation of the triangle indicates the furrow direction. ALS-derived DTM visualization: local dominance superimposed on positive openness.

Thus, while older cultivation marks have been significantly reduced and modified within currently farmed land, afforestation over many centuries has preserved the fossil surfaces of once cultivated areas. The evidence of earlier cultivation marks can only be recognized where they lie beneath later structures or outside the zone of later ploughing (Halliday, 2001). Whereas historic cultivation marks survive within the present-day fields, untangling their phases and dating is difficult (Figure 25). If a field has been continuously ploughed and no chronological reference point survives within it, dating of various cultivation phases is solely relative, in contrast to the date of afforestation which can be derived from historic maps and forestry data. In this way assigning types of cultivation marks under the forest canopy to certain periods is possible – an approach that has not been widely adopted in Poland (Dobiegała & Jakubczak, 2018; Solecki, 2018).

This is true for recent cultivation marks in particular. Figure 26 illustrates young forest stands south of Rzeczyca Mała where patterns of most likely early

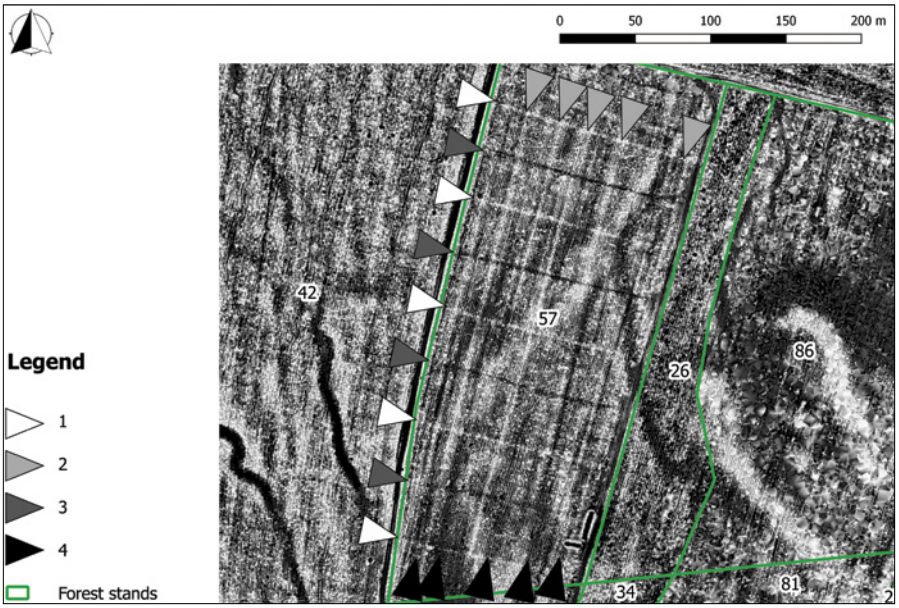

Figure 26. Afforested, formerly cultivated lands in Rzeczyca Mała, where two ploughing phases (younger – 1, 3 and older – 2, 4) are visible within a central forest stand. The orientation of triangle indicates the direction of the ridges (1, 2) and furrows (3, 4). Deep ploughing of contemporary forestry has created clear narrow scars on the area covered with the 26 years old trees. ALS-derived DTM visualization: local dominance superimposed on positive openness; with dominant tree age for each forest stand indicated by numbers.

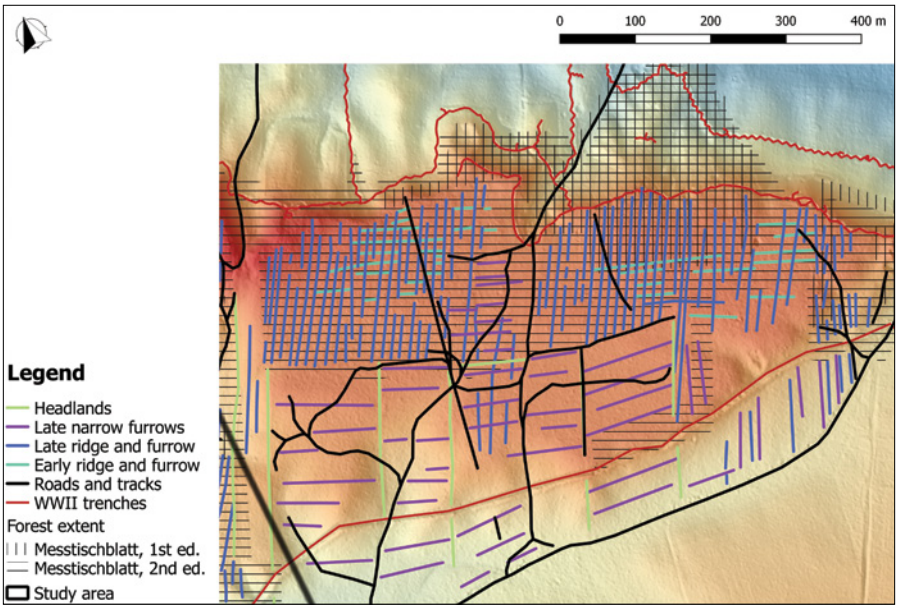

Figure 27. Located to the southwest of Polanów, *Stein Berg*, is covered with multi-phased cultivation remains, tracks and trenches. When analysed alongside historic maps the dating of the field systems can be deciphered. ALS-derived DTM visualization: colour-coded height values (from blue to red) superimposed on slope visualisation.

mechanized ploughing are visible. Three forest stands in the area (western, central, and eastern) are marked with dominant tree ages of about 42, 57, and 86 years respectively, while the eastern stand was divided in two about 26 years ago and a narrow strip of pine trees was planted in the western part of the stand. Although pine trees covering the western stand were planted about 1976, only the central stand was deforested immediately after World War II, as the western stand was already afforested when the 2nd edition of the *Messtischblatt* map was produced. As a result, sharp furrows and narrow ridges, which alternate every 36-38 metres cut across the stand and overlay the earlier cultivation marks perpendicularly. These are also faintly visible within the western stand with a slightly different incident angle. Thus, the afforestation of the central stand about 1961 preserved the patterns of cultivation and helps the interpretation of the cultivation remains. Whenever this type of marks is recognized within arable and barren land, a mid-20th century chronology may be argued as the earliest dating. In addition, older cultivation marks recognized within the central stand can be understood as pre-1960s, and arguably pre-World War II, given the post-war migration and later transformations of the farming practice.

Lying in the north-western corner of the study area, *Stein Berg* (Stone Hill, whose German name has not been translated into Polish), offers a view on other cultivation marks within woodland. Together with Święta Góra (Holy Hill, on top of which a Pomeranian Catholic sanctuary was located until its destruction in the 17th century (Bastowska, 2011; Siemiński, 2010)), it forms a moraine embankment dominating the Pomeranian Urstromtal (Figure 2). The flat-top hills are separated by a small gap, situated to the north-west of *Stein Berg*, which rises over 55 metres above the extensive valley floor. Another U-shaped valley, 35 metres below the flat top, separates the embankment from the rest of the moraine upland to the south. Today the hill, unforested on late 18th and early 19th century maps, is completely covered with trees – predominantly pine, with some larch and birch on the north-eastern slopes. Afforestation, which started in late 1800s and continued in the early 20th century (Figure 27) was completed shortly after World War II.

The hill is covered with the remains of at least three phases of cultivation, with the most recent clustered in the south-west. A grid of headlands covers the grounds between the edge of coniferous plantations marked on the 2nd edition of the *Messtischblatt* map and the valley floor to the south. Narrow furrows, set perpendicular to the slope, are located 22-28 metres apart with no observable ridges. In addition, a few tracks follow the course of some headlands, while other banks are cut by an anti-tank ditch, constructed in late World War II (cf. section 3.2.6). Hence, the remains of a field system, which were afforested during or immediately after the war (dominant pine trees covering the area are 68-73 years old), represent an early 20th century practice. These remains postdate the ridge and furrow, traces of which are clearly visible in other parts of the embankment (Figure 28). The latter cluster in the north of the plateau, and have been almost entirely covered with trees

Figure 28. A palimpsest of early modern cultivation remains and other archaeological features on *Stein Berg.* ALS-derived DTM visualization: local dominance superimposed on positive openness.

since the 1930s, with some parts of the land afforested since the late 1800s. Regular and straight furrows, the centres of which are usually 12 metres apart (with a range from 11 to 15 metres) follow the slope direction, and have been largely erased from the lower section of the hill, beyond the border of the 1930s forest. Similar, though older marks, are orientated perpendicularly to the former and lie underneath them.

It is notable that the two clusters of ridge and furrow remains are separated by a smoothed strip of land in the centre of the plateau. Here, a track from Polanów, which is located to the northeast of the hill, braids after reaching the ridge of the embankment. The eastern, older section of the track follows the grid of abandoned field system before it joins the road on the valley floor to the south of the hill. The later, forestry related, western part of the track takes a meandering line across the plateau. Traces of a younger field system are present between the old track and the western cluster of the ridge and furrow remains. The smoother texture of the later system has erased most of the earlier marks with only a few furrows visible within its area. Given that the northern part of the hill was afforested at a similar date (prior to the 1930s), this strip of land provides evidence of a transition from an old field system (straight ridge and furrow) to the new, which occurred shortly before the area was afforested. Thus, the latest date for the remains of ridge and furrow within the study area is the early 1900s, and certainly prior to the 1930s.

The remains of a small field (Figure 29) lying to the southeast of Wietrzno, seem to offer the earliest date that can be derived from historic maps for

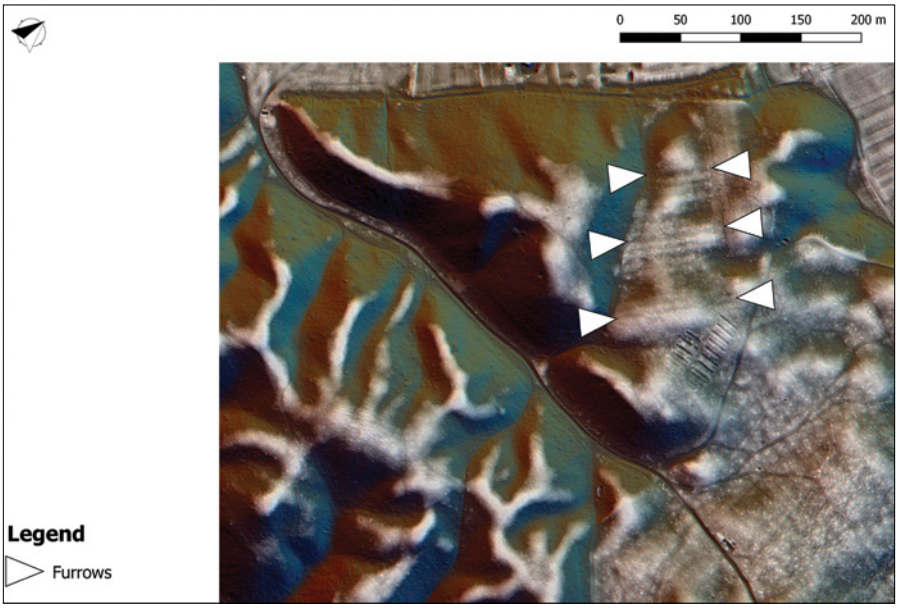

Figure 29. A small field near Wietrzno with narrow remains of straight ridge and furrow. ALS-derived DTM visualization: local dominance superimposed on hill-shading from multiple directions (Red – channel 14; Blue – channel 1; Green – channel 3).

ridge and furrow traces. The field, which is within deforested land on the late 18th century map, is already covered with forest on the *Urmesstischblatt* map and has been continuously afforested for the last 200 years. Here, centres of individual furrows are 7-9 metres apart and cut the gentle, northwest slopes perpendicularly. While some other faint remains of ridge and furrow are visible east of this field, these were subject to smoothing as this area was cultivated at least until the 1930s, when the 2nd edition of the *Messtischblatt* map was produced.

While the evidence of prehistoric, medieval and early modern cultivation has been thoroughly studied in British archaeology (e.g. Beresford & Saint Joseph, 1979) and elsewhere (e.g. Ewald, 1969; Sittler, 2004) over the last half century and more, and as a result, chronological relations with Roman, medieval and later features have been locally recognized (Halliday, 2001), in Poland, the subject is little understood. A few published papers (Affek, 2016; Solecki, 2018) only scratch the surface of the subject and usually derive the dates of the ridge and furrow remains from examples and evidence elsewhere in Europe. This research often does not acknowledge post-depositional processes and the factors influencing the survival of plough marks. Instead, the earliest possible dates related to cultivation immediately after a medieval town or village was established, for instance, are sought. This is unsatisfactory, as in this example, the longevity of use of the same field pattern is not taken into account. This is certainly an important consideration, as British examples demonstrate that the same furlongs could have been managed for many centuries (Hall, 1982). Hence, there are not

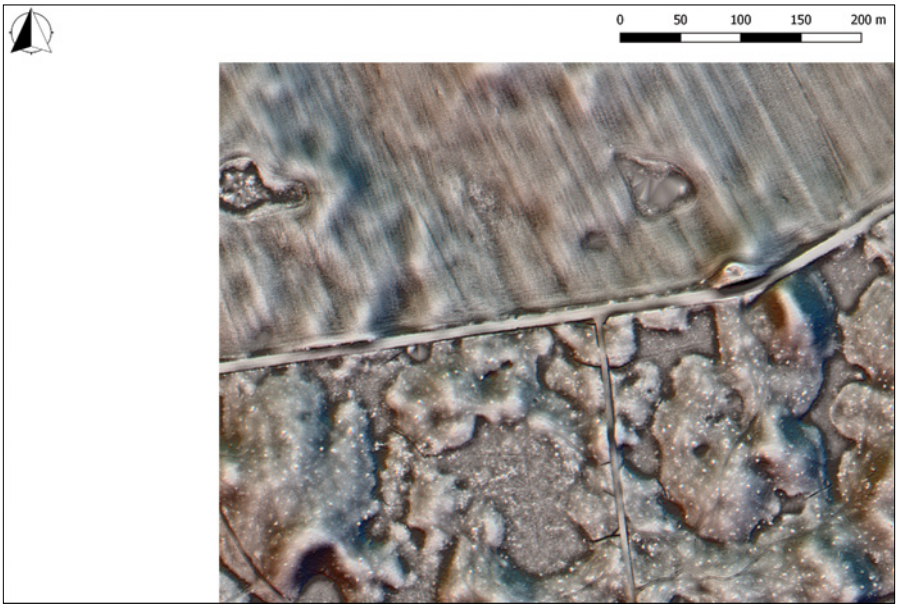

Figure 30. Once completely covered with forest (as demonstrated by the Schmettau & Schulenburg's map and the *Urmesstischblatt*) the area east of Wietrzno has been subdivided since the late 19th century, when fields north of the main east to west road were established following deforestation, and which remain to the present. The texture of the woodland is clearly distinguishable from the arable lands, where earthworks and natural relief have been smoothed. ALS-derived DTM visualization: local dominance superimposed on hill-shading from multiple directions (Red – channel 14; Blue – channel 1; Green – channel 3).

many cases in which the establishment of early dates of cultivation remains is easy. Indeed, the continuous reuse of a field may selectively transform, eliminate or strengthen earlier patterns, often without any indication of the nature of any of the processes involved. Nonetheless, what is observed today is often the evidence of late use, dated to the time before the change in land-use patterns occurred that led to the survival of the remains. That said, the remains of substantial earthworks, which survived later transformations, can be observed.

It is clear that within the study area afforestation allowed for the survival of ridge and furrow remains, and through the interpretation of ALS derivatives and historic maps, the dates for such cultivation remains can be broadly estimated. The straight furrows are of late modern date, and demonstrate similarities to other examples across Europe where straight rig replaced older, curvilinear, ones in 18th century (Halliday, 2001; RCAHMS, 2001). While limited clusters of straight ridge survive in marginal zones of the study area, there is no evidence of the older type of medieval, curvilinear ridge and furrow. If this was present here, it must have been levelled by later farming practice with the evidence from *Stein Berg* demonstrating how rapidly older agricultural remains can disappear beneath modern ploughing. However, it is remarkable how persistent medieval broad ridges can be – effectively usually requiring intensive modern ploughing to erase them

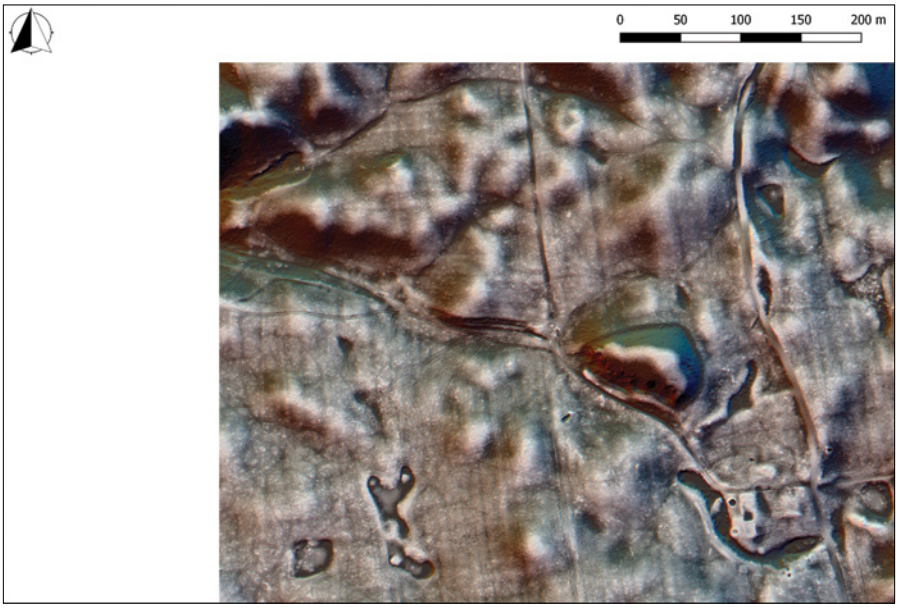

Figure 31. Once completely deforested, the area around Wianowiec (*Karlshof*), was entirely afforested after World War II. The smooth texture of former fields differs markedly from long-afforested grounds near Wietrzno (cf. Figure 30). ALS-derived DTM visualization: local dominance superimposed on hill-shading from multiple directions (Red – channel 14; Blue – channel 1; Green – channel 3).

completely (Hall & Palmer, 2000). Thus, given that classic broad medieval ridging is a product of a land holding system, perhaps it never existed in Pomerania. Indeed, neither there nor elsewhere in Poland there is a clear evidence of medieval ridge and furrow. Nonetheless, within the study area, land where medieval cultivation remains could have been situated must have been also intensively ploughed in later years. Thus, older cultivation marks should not be expected either within the open and arable present-day landscapes (Figure 30) or within the smooth textures of the once deforested land, enclosed with the forest after World War II (Figure 31). The capacity of ALS to record different textures allows for the recognition of various long-lasting activities, which slowly built the observed landscape throughout the late modern period (Mlekuž, 2014). This feeds also into the approach to identifying the survival zones.

A partially afforested checkerboard field system covering extensive land adjacent to Żydowo is another example of an anthropogenic landscape texture (Figure 32). Headlands and lynchets joining one another at right angles suggest planned and organised colonisation, which must have taken place in the late 18th-early 19th century (Szultka, 2003a). Historic maps show that the forest extent did not change significantly in this area between the production of the *Urmesstischblatt* map and 1930s, and even today, except from a patch of land in the northeast of Żydowo, the grid of fields ends at the forest boundary. However, as discussed above, the observed agricultural

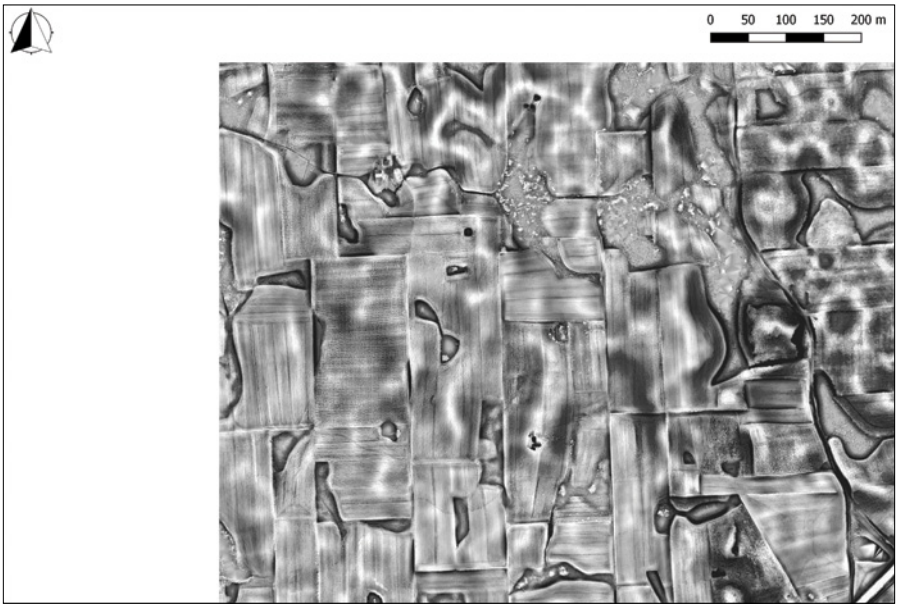

Figure 32. A regular pattern of fields in Żydowo. ALS-derived DTM visualization: local dominance superimposed on sky-view factor.

remains were strengthened and modified over the years. While some fields are cultivated today, other were transformed into pasture or covered with scrub vegetation. Thus, it is difficult to identify when the field system was established, though it still structures the space around Żydowo, despite the change in farming practice and technology, and the population that cultivates the land.

Finally, remains of an older field system were identified (Figure 33) away from any farmsteads inhabited today. Three clusters of banks are located in the modern-day forest, and their survival is due to a long and continuous afforestation. Historic maps demonstrate that a patch of the well-established woodland between the Polanów-Żydowo road (the main road shown on Figure 33) and the part of the Polanów Town Forest known as *Natzlaffer Holzkafel* by the end of 1800s, was deforested shortly before the 1st edition of the *Messtischblatt* map was produced (Figure 18). This area continued to be under cultivation until World War II (Figure 19), while in the post-war period is has been largely afforested again, leaving only small fields within the woodland (Figure 20). Over the last 250 years, deforestation in this area peaked in the 1930s, and the forest extent as shown on the 2nd edition of the *Messtischblatt* map is presented on Figure 33.

Banks, which make up this field system, are located beyond the land that was cultivated in the first half of the 20th century, except from a few features in the west. The faint remains of the latter are located between an anti-tank ditch and the currently farmed small fields, surviving in area that was under cultivation after the *Urmesstischblatt* map was produced and before World

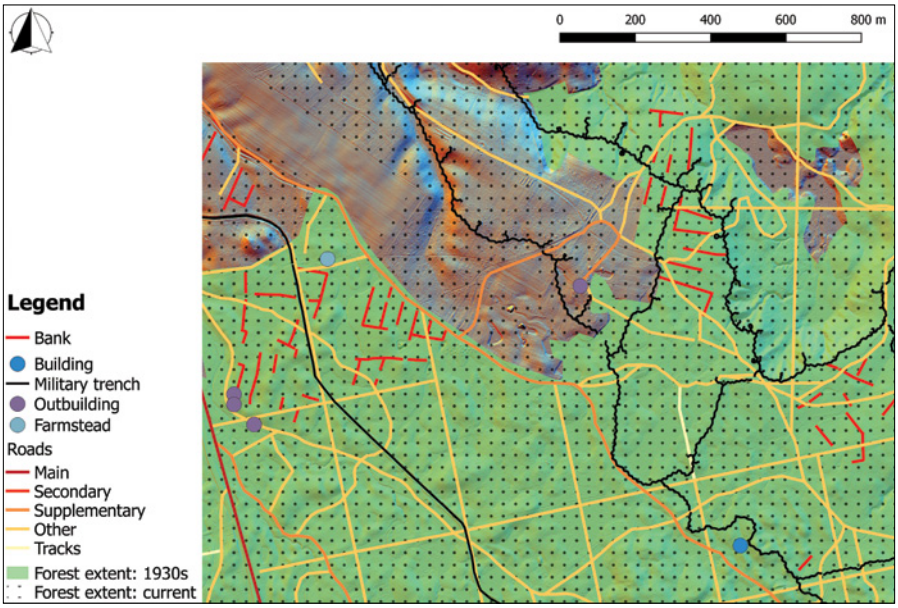

Figure 33. Remains of banks forming an early modern field system situated to the southeast of Łokwica. Roads, outbuildings, and farmstead as shown on the 2nd edition of the *Messtischblatt* map. World War II fortifications mapped through interpretation of ALS derivatives (cf. section 3.2.6). The remains of a building were identified in the south-eastern corner of the study area (cf. section 3.2.2). ALS-derived DTM visualization: hill-shading from multiple directions (Red – channel 14; Blue – channel 1; Green – channel 3).

War II. In fact, the other two clusters of banks survived in an area that has been continuously afforested at least since the late 18th century.

To argue for an early chronology of these banks, all uncertainties have to be eliminated first. Also, the potential impact of a farmstead, remains of which lie north of the western cluster of banks, and are flanked by the World War II fortifications and the currently cultivated field, requires explanation. A small farm in the area was mapped in 1930s, and as such, it is probably an early 20th century farmstead. Although it is adjacent to the banks, there is no evidence to believe that the banks were constructed while the farm was inhabited. Indeed, the banks are cut by many features that predate the farm, including the anti-tank ditch. Although this seems contradictory, as the fortification was constructed in the mid-1940s (cf. section 3.2.6), locally it followed the course of the gridded road network that was already mapped in late 1800s (Figures 18 & 33). This suggests that the banks had already been disturbed by the time the farm was established. In a similar fashion, the two clusters of banks in the east were disturbed by a road system established in the late 19th century with World War II infantry trenches disturbing the features in the mid-20th century.

Whereas a seemingly regular pattern of banks is visible in the western and central cluster, the features in the east are less regular. Despite the difference, all banks are broadly similar in size, up to 0.2 metres high and 3-6 metres across. Wherever a pattern is evident, the banks lie about 42-48 metres

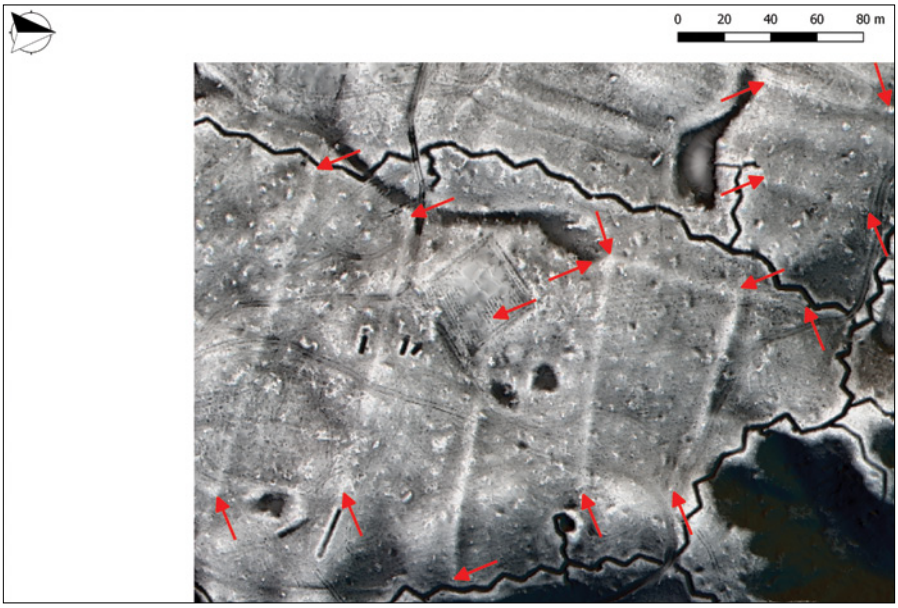

Figure 34. The banks of the early modern field system are cut by roads, World War II infantry trenches, and forestry related enclosure (cf. section 3.2.5). ALS-derived DTM visualization: local dominance superimposed on sky-view factor and hill-shading from multiple directions (Red – channel 14; Blue – channel 1; Green – channel 3).

apart. This pattern is not repeated in any of the later field systems with no other features, including forestry-related strips (cf. section 3.2.5), showing a similar distribution.

Although there is no clear evidence to support definite dating of the linear features discussed above, other discoveries in the area, including remains of a building situated a few hundred metres south of the banks (cf. section 3.2.2), and the analysis of historic road networks (cf. section 3.2.3), together suggest that the field system discussed above was in use in the early modern age. It might have been established even earlier, but the available sources do not evidence such an argument.

3.2.2. The settlements

The expansion of settlement in the study area peaked in the 1930s and early 1940s. Thereafter, the post-war migrations caused notable depopulation. Isolated farmsteads were abandoned immediately after the war or over the following decades, leading to the afforestation of once cultivated land, and following a pattern that is common in many parts of Poland (Majewska, 2017; Zapłata, 2015). Hence, numerous abandoned modern settlement remains survive throughout the study area, mainly in the southeast and northwest of the area. Historic maps document that most of these farmsteads were established in the 19th and early 20th centuries and were not occupied for long. The well-established townships of Polanów, Rzeczyca Wielka, Rzeczyca Mała, Biała, Wietrzno, Przybrodzie,

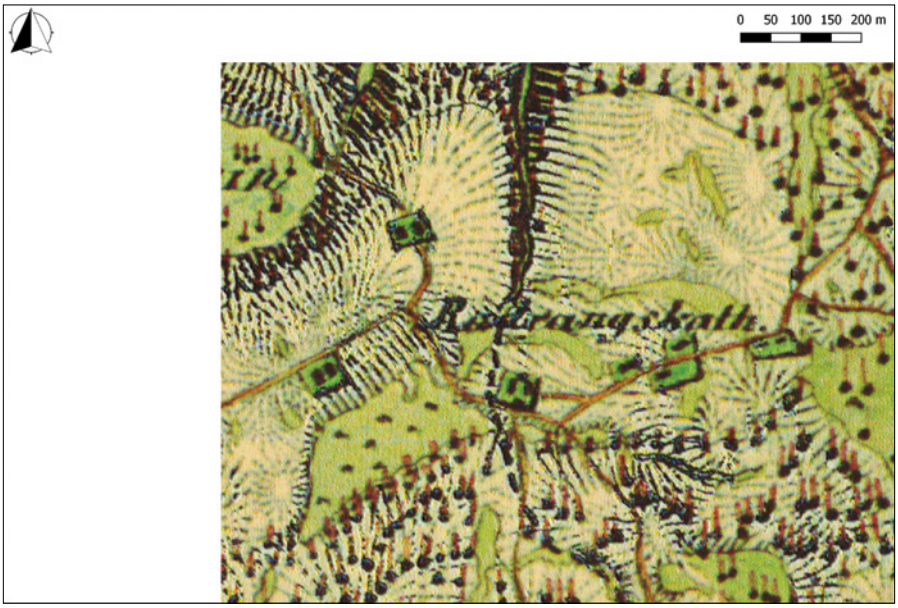

Figure 35. Isolated farms of *Raderang* as shown on the *Urmesstischblatt* map.

Chocimino, Żydowo, and *Raderang*, which were all mapped by Lubinus are still largely occupied today, although the case of *Raderang* is unique and discussed below.

In between these core settlements listed above, isolated farmsteads were later established. The late 18th century map shows the estate in Stary Żelibórz, four other locations with huts (Figure 16), and some additional huts just beyond the southern boundary of the study area. The *Urmesstischblatt* map documents the well-established townships as clustered and organized entities, with the exception of *Raderang*. Here, a chain of isolated farms is mapped using discrete symbols, while individual settlements are also scattered elsewhere, throughout the study area. There are 24 farms depicted on the map (Figure 17), including seven in *Raderang*, and three in Biała (the 18th century *Bijaller Katen* turned into *Vorwerk zu Bial*). The settlement of *Raderang* (Figure 35) follows the course of the main road (cf. section 3.2.3), and this pattern makes it completely different from the other well-established townships. For some of the isolated farms, the symbol used shows three buildings, with two or one building depicted elsewhere, suggesting either a shorter settlement history or poorer homesteads. In addition, some of the medium or smaller farms are not named.

The 1st edition of the *Messtischblatt* map shows a significant growth in the settlement (Figure 18), within the same broad patterns. The well-established and organized townships grew bigger and expanded in all directions. In *Raderang*, a few additional isolated farms were constructed, while in Biała (*Vorwerk zu Bial*) the configuration of buildings changed, although the number of individual homesteads remained the same.

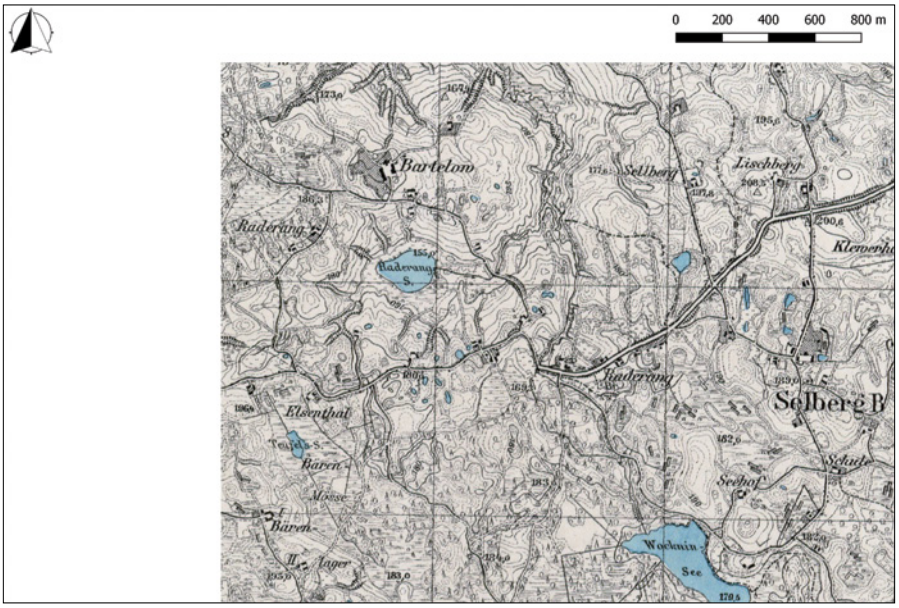

Figure 36. Dispersed settlement of *Raderang* flanked by the elaborate and organized townships of Bartlewo (*Bartelow*) and Nowy Żelibórz (*Selberg B*) as shown on the 2nd edition of the *Messtischblatt* map.

Nonetheless, in total, 86 isolated farmsteads were occupied in the late 19th century, including 20 hamlets in the previously uninhabited grounds between Wietrzno, Polanów, and Przybrodzie. A few decades later, when the 2nd edition of the *Messtischblatt* map was produced, the total number of individual farms within the study area reached 110 (Figure 19). Historic maps do not demonstrate any abandonment prior to World War II. A hut or farm established in a certain period was thereafter continuously settled, while upgrades and refurbishment of the houses and outbuildings are not observable on the maps.

At the time when the Polish topographic map was produced, the number of inhabited farms was significantly lower (Figure 20). Only 50 isolated farmsteads were occupied, including four newly constructed (single or multiple occupancy) buildings, and one converted sheep house (cf. section 3.2.4). While Polanów was expanding, other well-established townships did not attract as many inhabitants. For instance, in Przybrodzie, only two households are evidenced, in contrast to the eight farms marked there on the 2nd edition of the *Messtischblatt* map. Today, the abandonment of historic buildings continues. Out of 50 currently inhabited isolated households within the study area, four were constructed after the topographic map was produced. These new constructions have a suburban character and cluster in areas adjacent to Polanów and Żydowo. In other words, slightly more than a third of farms established before World War II are currently inhabited, while other have fallen into ruins, most of which are enclosed by the forest.

Figure 37. A recently abandoned farmstead in *Raderan*g.

In the case of *Raderang*, only three of the 14 farmsteads mapped in 1930s are occupied today. However, despite the continuous, yet dispersed settlement, *Raderang* has not existed as an entity throughout the post-war reality. Its seemingly unorganized plan has caused individual farms within the well-established township, which had been mapped by Lubinus (Figure 14), to be assigned to different settlements nearby. Some farms on the western end joined adjacent hamlets to form Pyszki. Others, located further away, came by the name of Grabowiec, a name that was used until a partial abandonment of

Figure 38. The foundation of a farm house in Wianowiec (*Karlshof*) covered with mixed forest.

the farms and an update in place names was undertaken a few decades after World War II. Finally, most of the farms of the former *Raderang* have been assigned either to Bartlewo (*Bartelow*) or Nowy Żelibórz (*Selberg B*), which were established after the *Urmesstischblatt* map had been produced. Both of these 19th century farmsteads were more elaborately constructed and better organized when compared to the older huts in *Raderang (*Figure 36). Indeed, this might have been the reason to assign the isolated and smaller farmsteads to these two well-organized townships by the 'historically unbiased' Polish settlers and administration. As a result, the historically significant *Raderang* (for the reasons presented in section 3.2.3), linguistically and organisationally ceased to exist, despite the fact that settlements forming it were not cleansed during the war, and are partially occupied even today.

The ongoing process of post-war abandonment of farmsteads throughout the study area means that their remains survive in varied conditions. While some are enclosed by deliberately planted forest (i.e. Wianowiec and Zaświecze), others are scattered throughout unploughed lands with encroaching secondary woodland regeneration, a factor that determines their survival and visibility in ALS derivatives. If farmsteads were abandoned recently, unroofed structures are still observable (Figure 37). Elsewhere, only the foundations of houses (Figure 38) and outbuildings remain (Figure 39) deep in the woods.

While in most cases the remains of modern settlement are easy to recognize in ALS derivatives (Figure 40), the vegetation enclosing other deserted farmsteads often makes individual features indistinguishable. Secondary regeneration is a common feature for farms that were inhabited immediately after the war. As a result, the farms that were recently abandoned, and are located on the edge of derelict areas, arable land, and managed forest, are enclosed by willow, hornbeam, and pine, as well as covered with ivy and nettles. Therefore, the canopy and understorey are notably denser when compared with adult plantation trees, a factor locally obstructing ALS ground point density and the quality of ALS derivatives.

Nonetheless, in most cases remains of gardens and infields, extraction pits and hollow ways, which accompany houses and outbuildings are visible in ALS-derived visualisations. In addition, old fruit trees, predominantly peach and apple, are commonly situated next to farmsteads, providing evidence of the once occupied landscape, now deserted and often enclosed by plantations (Figure 41). Unless dead and rotting, these trees are the only living memories of pre-war reality still embedded within the landscape. As such, they do not give evidence of military encounters but resemble more peaceful, every-day, activities (Kobiałka *et al*., 2015).

In addition, the remains of a building (Figure 42) in an area where no farmstead has been noted on any of the analysed historic maps, were identified near the presumably early modern field system (Figure 33) discussed in section 3.2.1. A two compartment rectangular building, measuring 9.5 metres in length and 5.5 metres across over the wall footings,

Figure 39. The remains of a rectangular barn in Zaświecze (*Lattenkathen*) now enclosed by the forest.

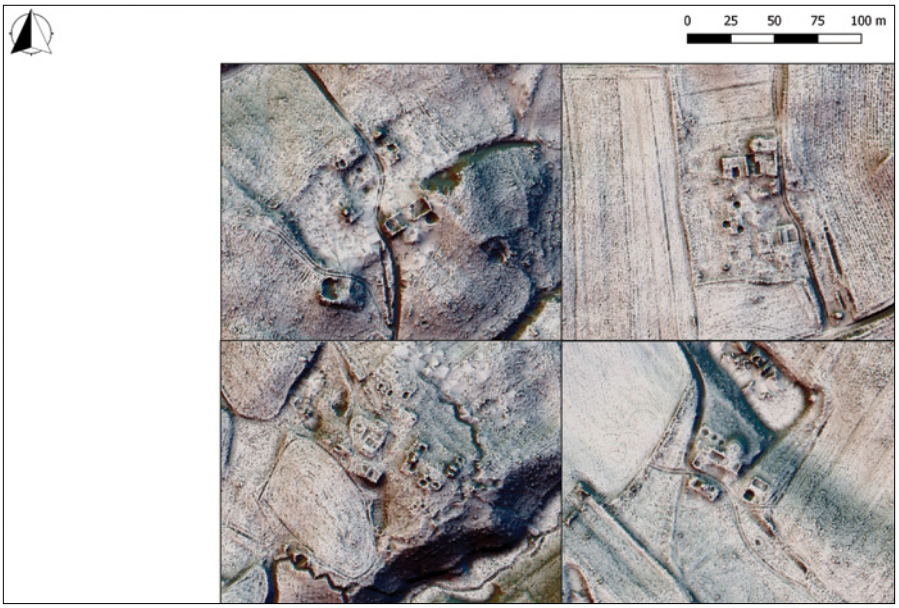

Figure 40. Deserted farmsteads in Zaświecze (*Lattenkathen*) (top left), Biała (*Vorwerk zu Bial*) (top right), Przyborzyce (*Louisenhof*) (bottom left), and Zdzieszewo (*Elsenhof*) (bottom right). With the exception of Zaświecze, which was afforested in a planned manner, townships are generally covered with secondary regeneration. Barn remains in Zaświecze (cf. Figure 39) are clearly visible as large, rectangular structure, while the zig-zag line at Przyborzyce represents World War II trenches (cf. section 3.2.6). ALS-derived DTM visualization: sky-view factor superimposed on hill-shading from multiple directions (Red – channel 14; Blue – channel 1; Green – channel 3).

Figure 41. A swing, wooden stick hanging on a wire, mounted on a cherry tree adjacent to farmstead in Wianowiec (*Karlshof*) offers a joyful, but ultimately, tragic perspective on a once inhabited and open landscape.

is defined by stone walls (about 1.5-1.7 metres across), which are not higher than 0.3 metres. An internal wall, also constructed of large boulders, separates the smaller north-western compartment from a slightly larger room in the southeast. The outline of the footings of the building are clearly visible except for the south-east which has been damaged, while there is no clear indication of where the entrance might have been.

The unworked large boulders used as construction material, the relatively poor state of preservation despite the lack of any late modern cultivation in the area, and dissimilarities in form in relation to other, later, remains of deserted farmsteads in the study area altogether suggest early date of use. In addition, individual farms and huts were included on the late 18th century map elsewhere (cf. section 3.1.2), for instance in *Raderang*, Myszyna (*mis Katen*), and Biała (*Bijaller Katen*). This suggest that if this farm was in use while the Schmettau & Schulenburg's map was produced, it should also have been included on the map. In fact, the remains of this two-compartment

building are only several dozen metres away from the Polanów-*Raderang* road. This was an important road, for reasons discussed in section 3.2.3, and it was precisely mapped in the late 18th century together with the landforms through which it ran. For all these reasons, a late dating of the building is unlikely, and together with the field system that survived nearby, it should be understood as early modern. To assume earlier, medieval or late-medieval date, would require additional argumentation, and for a building of this age in such environs it would be exceptional.

The fact that this farmstead was not depicted on the early 17th century map is not definite either. The map produced by Lubinus was at a notably smaller scale than other, late modern, maps (cf. section 2.5). Hence, it is likely that this minor and isolated farmstead could have been omitted by the map maker if it was settled at the time. Alternatively, the farm might have been used, and consequently disused, after *Nova Illustrissimi Principatus Pomeraniae Descriptio…* map was produced and before the Schmettau & Schulenburg's map was completed.

The archaeological sites identified through field-walking (cf. sections 2.6 & 3.3) provide evidence of modern farmsteads within the study area other than what can be derived from the historic maps. Only a few sites where modern potsherds were detected during the AZP survey (Figure 4; Table 2) relate to the deserted farmsteads identified on historic maps. The distribution of these sites relates to archaeological practice and discovery strategies, while it is clear that the understanding of the modern landscape is limited by the methods of archaeological prospection applied. It is worth noting that the late 18th century map includes small, isolated, farms,

Figure 42. The remains of the early modern building identified in the forest, to the southeast of Łokwica. View looking along the northern side wall of the north-western compartment, with the partition wall in the left foreground of the image, and the western end wall beyond.

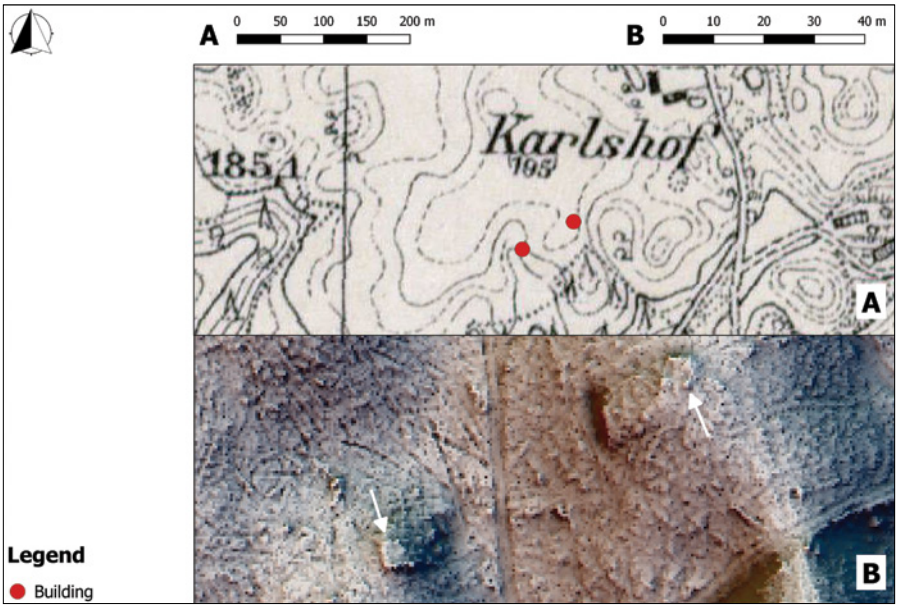

Figure 43. The remains of two buildings located in the once open landscape of Wianowiec (*Karlshof*). A: Location of buildings on the 2nd edition of the *Messtischblatt* map. B: ALS-derived DTM visualization: sky-view factor superimposed on hill-shading from multiple directions (Red – channel 14; Blue – channel 1; Green – channel 3).

and acknowledging that Schmettau & Schulenburg's map reflects precisely the settlements in the area at the time of substantial agrarian reform, which led to great rearrangement of the settlement pattern in Pomerania (Szultka, 2003a). Thus, early modern dates can be assumed both for the remains of the building enclosed by the forest discussed above, as well as for some other archaeological sites scattered throughout the arable land within the study area (cf. section 3.3). Such an assumption should not be made without taking account of the constraints of the applied methods of archaeological prospection (cf. section 2.6).

Finally, the remains of two additional buildings (Figure 43), which also have not been included in any of the analysed historic maps, were identified in Wianowiec (*Karlshof*). Two square structures situated about 80 metres apart are defined by an internal platform enclosed by the remains of stone walls. Similar in size, about 5.5 metres across and 6 metres long, the buildings are within the area that was deforested between the late 18th century and mid-1900s. The isolated farmstead of Wianowiec (*Karlshof*), which is marked for the first time on the *Urmesstischblatt* map, is located about 180 metres to the northeast of the easternmost structure. The open land to the north of Stary Żelibórz was completely afforested shortly after World War II (cf. section 3.1.6) with the remains of these buildings situated about 40 metres to the north of a patchy coniferous plantation that was established in late 1800s, and which is clearly visible on the 2nd edition of the *Messtischblatt* map (Figure 43A).

Given the relatively small size of the square structures, it is unlikely that these are remains of a farmstead that was established after the *Messtischblatt* map was updated in the 1930s. The deserted houses from this period that have been identified elsewhere are usually at least twice the size. In addition, the remains of the early 20th century farms always comprise tightly clustered houses, outbuildings, and other structures (Figure 40), whereas these buildings are isolated. The distance separating the two square monuments is too big to understand them as a single farm either. Furthermore, barns and sheds, several of which are scattered across the study area were recorded by the late German map makers (i.e. included on both editions of the *Messtischblatt* map). Hence, the two rectangular structures should not be understood as late 19th-early 20th century outbuildings, for these were precisely mapped.

It is likely that these structures were in use in the early modern period and deserted before the late 18th century. However, they were situated in an open, presumably arable, landscape of Wianowiec (*Karlshof*) for at least 150 years. Perhaps the fact that both structures are situated on top of small knolls that are separated by a narrow valley made the late modern cultivation difficult in the area, and allowed for the survival of the buildings. Thus, the lack of the late 20th century mechanised agriculture, due to the post-war afforestation of the area, did not affect the monuments either. At the same time, if there was a field system surrounding both structures, it might have been erased by late modern agriculture, which used to cover a substantial part of the land adjacent to Wianowiec (*Karlshof*), as no older cultivation remains survived in the area completely smoothed out before World War II (Figure 31).

3.2.3. Road and transportation networks

Historic roads and tracks, the material evidence of movement, which connected various places scattered throughout the landscape, themselves form specific places, where particular type of human activity took place. These linear features were either constructed purposely (i.e. causeways and bridges) or created unintentionally, as a result of repeated movement, which caused soil erosion leading to the formation of hollow-ways. Nonetheless, the identification of the historic road network is complicated, and historic routes are often interpreted on the basis of material evidence uncovered during excavations (Rączkowski & Nowakowski, 2002). Thereafter, dots on a map, representing places where, for instance, prehistoric amber beads were unearthed, are joined up by archaeologists to form the Amber Route, ideologically the most significant road in the prehistory of Poland (Wielowiejski, 1970). The reuse and repeated improvement of once established roads and tracks often causes the erasure or covering up of the remains of earlier evidence. Nevertheless, sections of historic roads in Poland have been detected through excavations (Filipowiak, 1963; Sadowska-Topór, 1999), as well as the interpretation of aerial imagery (Rączkowski & Nowakowski,

2002) and ALS derivatives (Banaszek, 2015a), and can be identified also in the study area.

Broadly speaking, the present-day road network (Figure 21) in the study area is the same as that depicted on the late 18th century map (Figure 16), and has presumably had a longer history (see below). Historic maps demonstrate that later, 19th and 20th century, roads and forestry tracks follow older patterns, although the ongoing use makes the identification of older sections difficult. Therefore, in most cases, establishing the earliest date for a given track or road is not possible through the interpretation of ALS derivatives alone. Nonetheless, the late modifications of the road system, which created short sections of abandoned roads and tracks, are observable both in historic maps and ALS-derived visualisations. As a result, the dates of local transformations of the road network can be established. These often relate to the straightening of the course of a road in the second half of 20th century (Figure 44), but can also reveal earlier, 19th century modifications (Figure 45).

The late 18th century map (Figure 16) provides evidence of roads connecting Przybrodzie and Stary Żelibórz, as well as Stary Żelibórz and Rzeczyca Wielka, sections of which are shown on Figure 45 as A-O and O-Q respectively. Nonetheless, these roads were improved and used also later, when other tracks and roads were added, some of which are in use even today, whereas others were abandoned at some point. The *Urmesstischblatt* map provides evidence of another road (A-I-H-E-G) which is not marked on any of the *Messtischblatt* maps. In the late 19th century, two additional roads linked Stary Żelibórz with Wianowiec (J-H-E-F & A-B-C-D), forming a network which survived World War II and is occasionally used for forestry-related purposes today. In the post-war reality, the road improvements removed Stary Żelibórz from the main track to Przybrodzie. A new, forestry-related, asphalt road (A-B-C-E-P), continues northeast, towards the main road, which cuts the north-eastern corner of the study area (cf. Figure 20). The main forestry-related road in the area presented on Figure 45 partially follows the course of earlier roads (A-B-C), while its other sections were constructed after the war (C-E-P).

The 19th century improvements straightened the main track from Stary Żelibórz to Przybrodzie. A deep hollow-way which cuts through the slopes (Figure 46) of the Grabowa River valley connected Polanów through Przybrodzie with the rapidly growing settlements scattered throughout the south-eastern corner of the study area, east of *Raderang* (cf. Figures 17-18). To facilitate movement, the old road (Figure 45:N-M), whose bends are depicted on the *Urmesstischblatt* map, was replaced with a new, straight line (O-N-L). Both reach the ford on a small gully (K-L), however, the older section (L-M), which runs at the bottom of the Grabowa River valley is not visible, presumably covered with accumulating peat. From here, the road continues northwards (K-J-A) and braids locally. This short section (N-M) is the oldest part of the road networks in the study area which can be dated with confidence, and its early chronology derives from the late 18th century

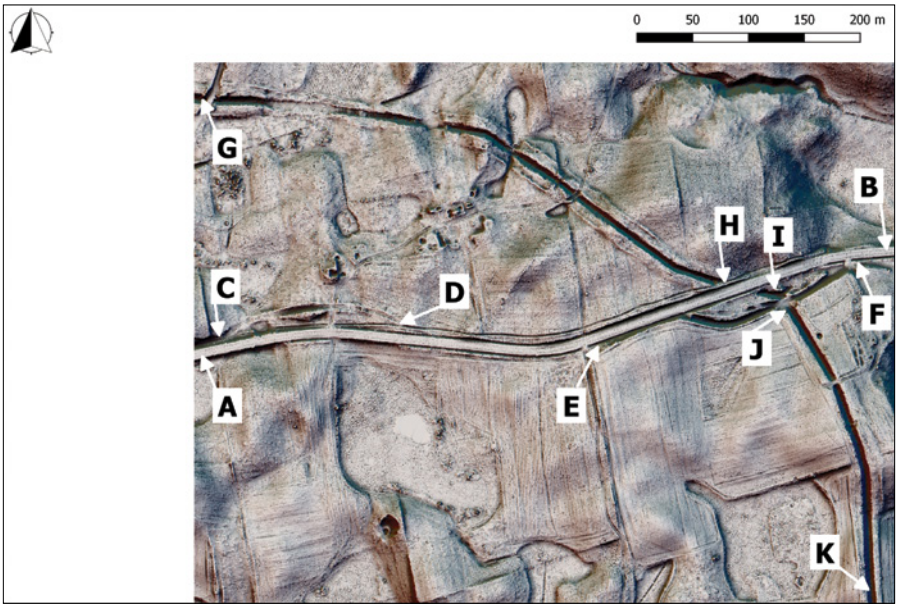

Figure 44. Linear features west of Pyszki. The straightening of the main road between Żydowo and Nowy Żelibórz (A-B) in the second half of the 20th century led to survival of former bends in the road (C-D and E-F). These are precisely depicted on both editions of the *Messtischblatt* map, though the road is already recorded on the late 18th century map. The construction of an anti-tank ditch during World War II (G-H, I, and J-K) respected the older line of the road, while the late 20th century modernization disturbed the anti-tank ditch, providing a relative sequence of events. ALS-derived DTM visualization: sky-view factor superimposed on hill-shading from multiple directions (Red – channel 14; Blue – channel 1; Green – channel 3).

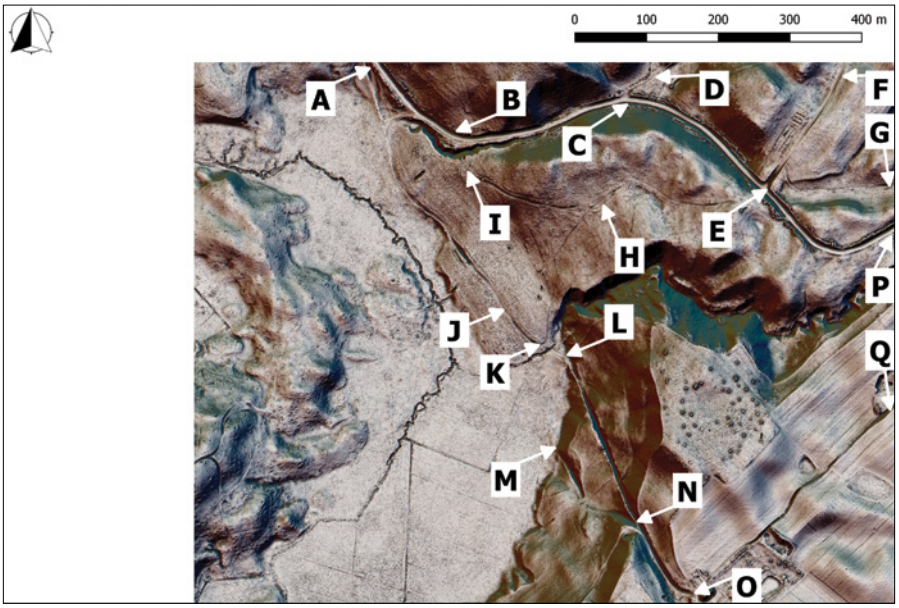

Figure 45. A palimpsest of roads and tracks on the eastern banks of the Grabowa River. ALS-derived DTM visualization: sky-view factor superimposed on hill-shading from multiple directions (Red – channel 14; Blue – channel 1; Green – channel 3).

Figure 46. A hollow-way in Stary Żelibórz constructed and heavily used between late 1800s and the mid-20th century, now split off from the current forestry-related road networks.

map. Another example is section I-H of the longer road (A-I-H-E-G), which is shown on the *Urmesstischblatt* map, and in general was no longer in use when the *Messtischblatt* maps were produced. While A-I cannot be tracked anymore, H-E formed a part of the later road to Wianowiec (J-H-E-F), and E-G is mostly covered with recent forestry-related tracks.

This example shows clearly how difficult the interpretation of the historic road system is due to its constant usage. Although the road networks as presented on late 18th century map most likely follow the earlier pattern, the later modifications and improvements mean that the older roads are not visible. It is notable that the A-I-H-E-G road shows how the remains of a single road can vary. While section I-H is clearly visible as a deep and braided hollow-way, other sections are either disturbed by later movement (H-E & E-G) or completely invisible (A-I). It is the varying combinations of slope, soil and geology, the intensity of movement, and later transformations that conspire to either preserve or erase historic roads. Nonetheless, the analysis of historic maps against ALS-derived visualisations shows that the cartographic sources investigated in this survey are reliable in depicting the road networks.

If analysed in detail, the road networks as presented on the Schmettau & Schulenburg's map offer interesting information on the environment and communication in the study area. When analysed with the settlement pattern and later maps, some assumptions regarding the early modern road system can be made. One of the most striking features on the late 18th century map is that one of the roads, to the east of *Raderang*, braids over a short distance (Figure 16), and then rejoins the main line. This situation is not observable elsewhere in the study area, and is not repeated in this place on the other, later maps. In fact, the 19th and 20th century, as well as the current course of

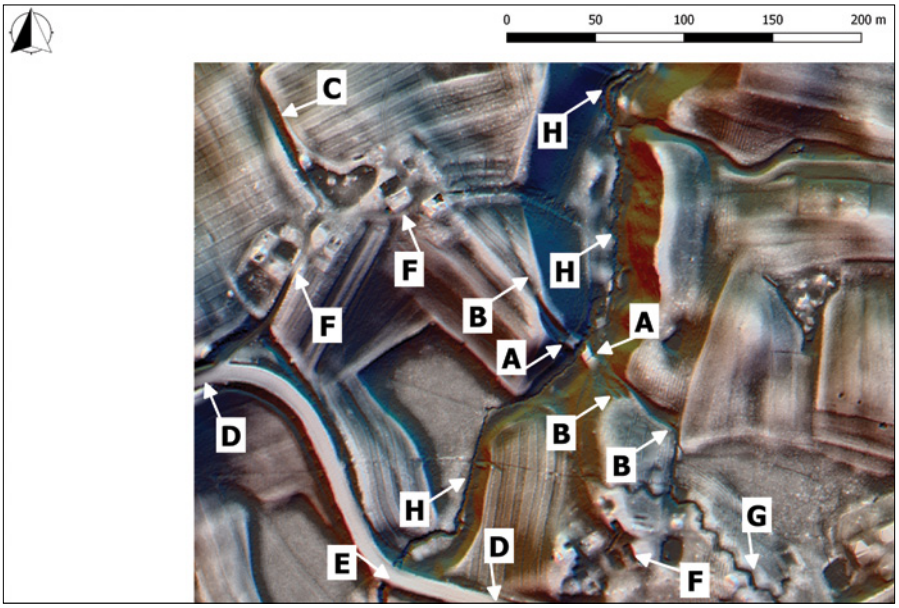

Figure 47. The remains of the early modern bridge on the Grabowa River and the Polanów-Świerzno road situated amongst deserted farmsteads in *Raderang*. ALS-derived DTM visualization: local dominance superimposed on hill-shading from multiple directions (Red – channel 14; Blue – channel 1; Green – channel 3).

the road follows the southern of the two splinters presented on the Schmettau & Schulenburg's map, which crosses the Grabowa River near its source.

Although missing on later maps, the northern splinter was identified through the interpretation of ALS derivatives. Remains of a hollow-way are clearly visible on both banks of the river, fading away the farther from the Grabowa River they get (Figure 47:B). The shallow ditch of the road becomes deeper and braids whenever it crosses the rim of the valley and heads towards the river, where there are the remains of a bridge (Figure 47:A). Short causeways (Figure 48) on both banks stand about 2.3 metres above the partially regulated river (Figure 47:H). The western causeway is 5.2 metres long and 12.3 metres across, while the eastern is 4.9 metres long and 11.2 metres across. The missing bridge was most likely constructed of wood and lies about 160 metres to the northeast of the currently used crossing (Figure 47:E). According to the Schmettau & Schulenburg's map, the distance between the two furthest points of the braiding road is about 130 metres. Given that the late 18th century map was produced at 1:50 000 scale (Table 6), and accepting minor locational error, it is clear that both crossings were used at the time of map production. The northern bridge was later abandoned and it was already in ruins by the time the *Urmesstischblatt* map was produced. The remains of three deserted farmsteads lie adjacent to the crossing (Figure 47:F), with the north-westernmost representing the sole farm in *Raderang* as presented on the Schmettau & Schulenburg's map. The old road to Polanów passed the farmstead and continued to the north-west

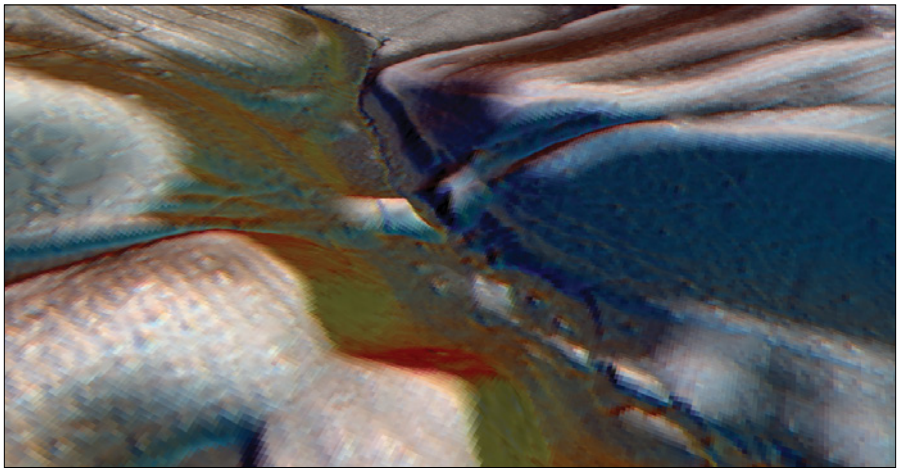

Figure 48. A pseudo-3D view of the remains of the bridge and hollow-ways in *Raderang* from the northeast. ALS-derived DTM visualization: local dominance superimposed on hill-shading from multiple directions (Red – channel 14; Blue – channel 1; Green – channel 3).

(Figure 47:C). The remains of the World War II infantry trench (Figure 47:G) also cross the river nearby (cf. section 3.2.6).

Unlike subsequent cartography, the late 18th century map does not distinguish the importance of roads, which are all shown with the same black line (Figures 16-20). Nonetheless, the presence of the presumably older, northern bridge, which was thereafter replaced by the newly constructed crossing to the south, suggests that *Raderang* was an important point in the early modern transportation network. Although today there is only one, local road in the area, which connects Żydowo and Świerzno (Figure 3), and crosses the Grabowa River (Figure 47:D), at the time the Schmettau & Schulenburg's map was produced more roads converged in this area. Firstly, a road to Żydowo split from the road to Polanów, which cut across the Polanów Town Forest, and later, a few hundred metres to the west of the bridge, it branched to Chocimino, via Myszyna. The bridge at *Raderang* provides the southernmost crossing of the Grabowa, with another located in Przybrodzie (*Forth*), five kilometres down the river. In fact, both Polish and German versions of the latter place name mean 'ford'. Given that a bridge over the Grabowa River in Polanów was constructed as late as the early 19th century, and that there is no indication of a crossing in the area of the town on the late 18th century map, both crossings channelled movement along and across the river.

Given the chaotic late 18th century road networks around Rzeczyca Wielka and Rzeczyca Mała, where many short roads meet at odd angles, suggesting local usage rather than longer routes, it is more likely that the communication between Polanów (and lands located further to the northwest of the study area) and Świerzno (and other places to the southeast of the study area), ran through *Raderang* rather than Przybrodzie. A straight road connecting Polanów and Żydowo, and its subsidiary, branching towards *Raderang*,

Figure 49. An abandoned section of a once important road connecting Polanów and *Raderang*.

were important for north-south and east-west (across the Grabowa River) communication. Both of these roads cut through the Polanów Town Forest, and while the former is still one of the main roads in the area, the status of the latter has diminished to a forestry related route (Figure 33) with sections through pastures completely abandoned (Figure 49). It is next to this road that the early modern remains of a two-compartment building were identified amongst traces of a field system (cf. sections 3.2.1-3.2.2). Tucked between the remains of the World War II infantry trench and the road, the building has a close relationship with the road and may have been in use in the early 17th century, when both Polanów and *Raderang* were mapped by Lubinus, or even earlier, as the crossing over the Grabowa River was surely needed at least from 1313 A.D., when Polanów was recognized a town.

The decline in the status of the road to *Raderang* was caused by the construction of a bridge over the Grabowa River in Polanów. From the early 1800s roads from Polanów to Żydowo, and from Polanów to Świerzno via Rzeczyca Wielka and Rzeczyca Mała gained importance, as demonstrated in the late historic maps (Figure 17-20). The new bridge allowed easier, east-west, transportation along the Pomeranian Urstromtal in comparison to a route across to the more challenging afforested, hilly, and damp moraine upland. At the same time, on the eastern bank of the Grabowa River, the road linking Przybrodzie and Stary Żelibórz was extended south-eastwards. Half a century later, when the 1st edition of the *Messtischblatt* map was produced, several new settlements were aligned with it to the south of Stary Żelibórz, while the newly established estate in Nowy Żelibórz was situated at its end (Figure 18). As discussed above, some sections of this road splintered later and left monumental remains of

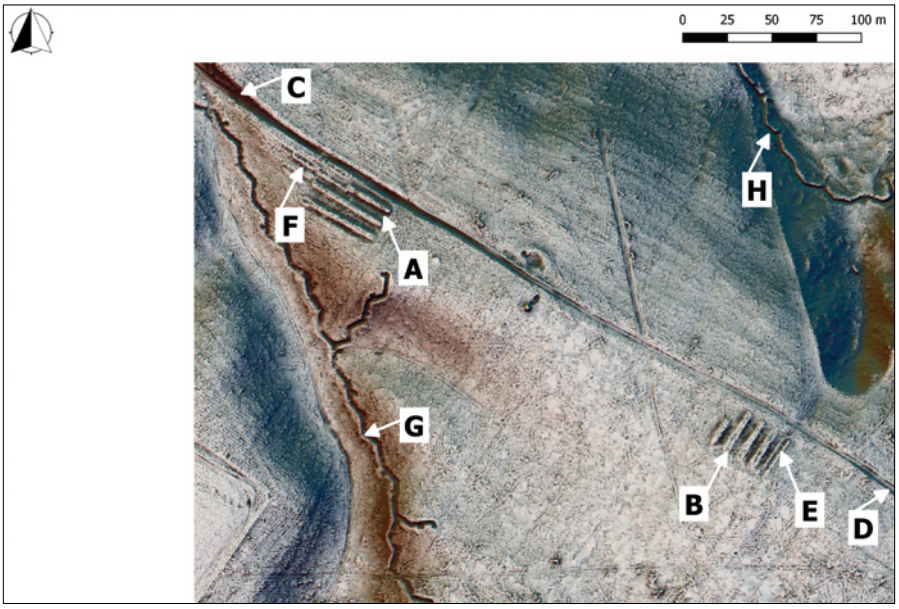

Figure 50. Road construction material (A-B) stored next to the road (C-D) connecting Racibórz Polanowski (*Heinrichshorst*) and the part of the forest called *Natzlaffer Holzkafel* on both editions of the *Messtischblatt* map (cf. Figure 18). Some mounds have already been used (E-F). A World War II trench system (G-H) encloses the area. ALS-derived DTM visualization: sky-view factor superimposed on hill-shading from multiple directions (Red – channel 14; Blue – channel 1; Green – channel 3).

a hollow-way in Stary Żelibórz (Figure 46). The latter provides evidence of an extensive usage of this track, which happened at the expense of the old road on the western bank of the Grabowa River. Thus, the once important road through the Polanów Town Forest was forgotten and partially disused, while the (southern) crossing in *Raderang* still links the east with the west, but falls outside the most important transportation corridors in the area, facilitating only local movement.

In addition, through the interpretation of ALS derivatives the process of road improvements can also be recognized. In some parts of the study area, construction materials were stored. Mounds of gravel and sand (Figure 50), which were to be used for the modernization of older roads, are easy to detect. Most of these are located in the area which enjoyed rapid growth in population during the late 19th and early 20th centuries. As a result, improved roads were required and some additional material was piled next to the roads to allow for maintenance.

Finally, the remains of a narrow-gauge railway, which used to connect Polanów, Żydowo, and further south, Gołogóra, are also clearly visible in ALS-derived visualisations (Figure 51). Opened in 1897 (Malczewski, 2000), the railway was used to transport passengers to Polanów, which at the time was developing as a spa town. It also served to transport various commodities, including grain and wood. A side-track in the forest between Chocimino and Łokwica, where a few barns are shown on the 2nd edition

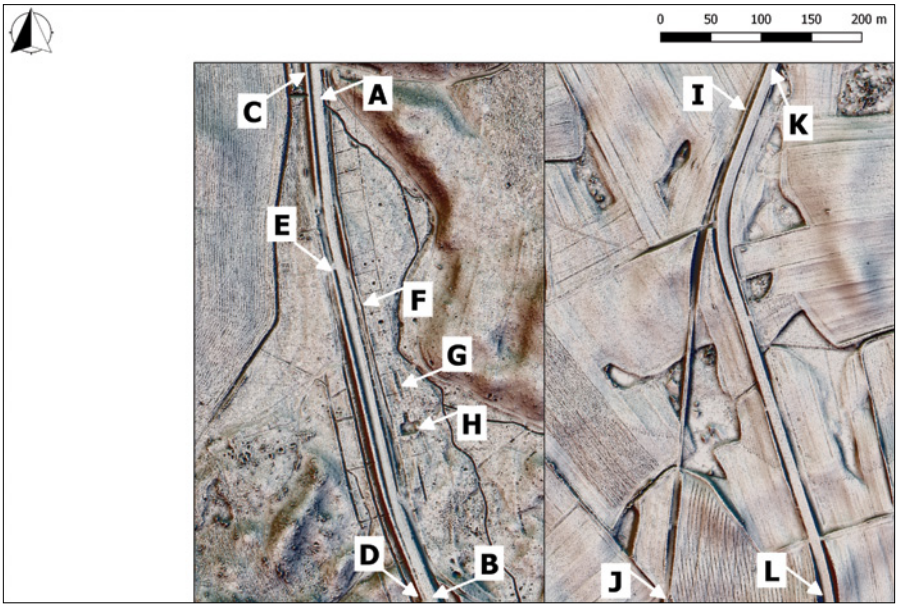

Figure 51. The remains of a narrow-gauge railway between Chocimino and Łokwica (left), and to the north of Żydowo (right). The track (C-D & I-J), is almost entirely adjacent to the Polanów-Żydowo road (A-B & K-L). A side-track used to cross the road (E-F) and continue (G) to barns located around a point of embarkation (H).

of the *Messtischblatt* map, suggests that wood was transported by rail to the saw-mill in Polanów, which itself was situated next to the railway station. The narrow-gauge railway survived intact through World War II, though it was later dismantled by the Red Army or fell into ruin in the post-war period (Rydz & Mencel, 2007). Throughout most of its course the rail track followed the course of the Polanów-Żydowo road, leaving it a few hundred metres north of Żydowo and bypassing the village to the west. What remains of the railway today are the causeways and cuttings through the moraine upland, which intertwine with the post-glacial landscape.

3.2.4. Animal husbandry

By the end of the 18th century, animal husbandry, and sheep in particular, were a well-established tradition throughout Pomerania (Szultka, 2003b). In fact, a sheep house in Chocimino, which is recorded on the late 18th century map as well as on the other, later, cartographic sources, might have already been in use for nearly two centuries, as Lubinus also mapped a sheep house in the area (Figure 14:*Scheferei*; Figure 16:*Schäff*). The abundance of flock in Pomerania gained the region the nickname of the 'sheep homeland' of Prussia (Stępiński, 2000). At the same time, numbers of cattle per capita were similar to other regions of Prussia, and poor field and meadow management as well as minimal use of forage crops that would be appropriate for cattle, made it difficult to keep large numbers of livestock. Land improvements which started in the late 18th century and continued throughout 1800s, produced

Figure 52. The steep, small, and narrow, rolling hills in the area south of Pomeranian Urstromtal, east of Przybrodzie, which were afforested after the *Urmesstischblatt* map was produced, offer great conditions for sheep grazing, but are considerably less attractive to cultivation.

better conditions for cattle grazing, and their numbers increased gradually. Nonetheless, sheep dominated husbandry until the early 20th century, while in the post-World War II period they have been almost entirely wiped out from the landscape.

Although no detailed statistics are available for the study area (since it includes various parts of a few historic administrative units), land-use estimates for Pomerania offer insights in how the land adjacent to Polanów might have looked prior to the mass afforestation of the 19th and 20th centuries. At the start of the 1800s, 28% of Pomerania comprised arable land, which included fields, pastures, gardens and derelict areas. Only 8.1% of the Prussian province was covered with fields, and given that the three-field system was still dominating crop husbandry, only 29% of fields were sowed at the same time (Szultka, 2003a). In addition, in 1802/5 there were nearly 1.3 million sheep, 0.25 million cattle, and 0.27 million pigs in Pomerania, while by 1867 these numbers increased, 241%, 152%, and 112% respectively (Wachowiak, 1993).

Large numbers of sheep, flocks of which often numbered more than 1000 animals, require extensive pasture. Although the percentage of land used for grazing differed from region to region throughout Pomerania, it is very likely that pasture was omnipresent in the study area. The degree of afforestation in the late 18th century and early 1800s was approximately 36% and 46% respectively (Figure 22), while only a fraction of the remaining land was cultivated. A well-established sheep house in Chocimino, and another in Uniesław (*Felixhof*), a few kilometres north of Rzeczyca Mała, suggest the presence of extensive pasture around. It is likely that pasture

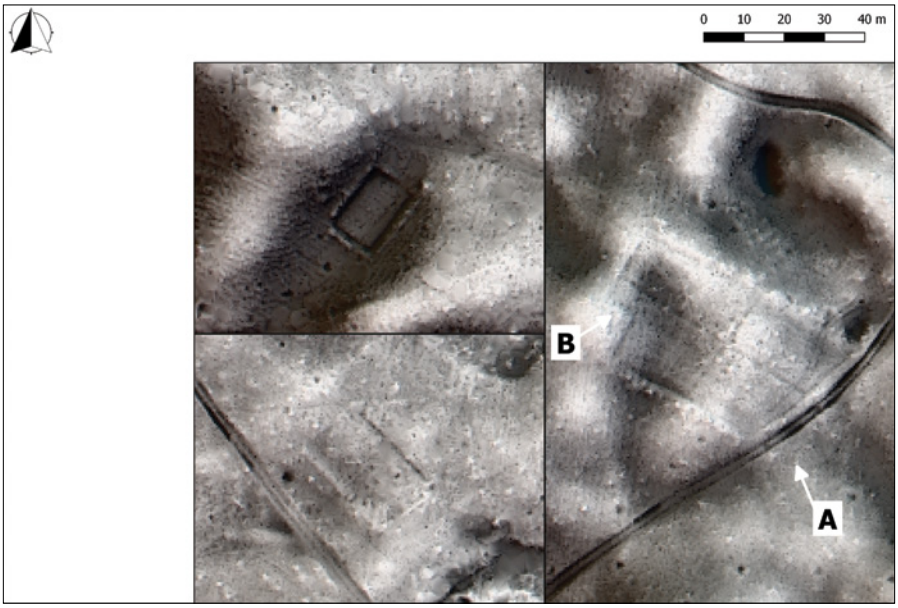

Figure 53. The remains of rectangular enclosures (pig/sheep pens) in the study area, constructed with an internal ditch and external bank. A – the faint south-eastern corner is overlaid by late 19th century road; B – a dent in the south-western corner to avoid a hillock. ALS-derived DTM visualization: local dominance superimposed on hill-shading from multiple directions (Red – channel 14; Blue – channel 1; Green – channel 3).

covered the rolling hills (Figure 52) rather than flat grounds of the Pomeranian Urstromtal or the moraine plateaus, including *Stein Berg*, where cultivation remains survived under forest (cf. section 3.2.1). Such hills, which are cut by small post-glacial valleys, concentrate in the north-eastern and western part of the study area (Figure 2). While the sheep house at Uniesław was not far from the hilly area south of Rzeczyca Mała, the facility in Chocimino was surrounded by hills.

At the same time, pigs, which were often kept also by town citizens, foraged in the forest. Deciduous woodland, dominated by oak and beech, which have been a feature of the study area for centuries (cf. section 3.1), provided an abundance of forage for these animals, and surely was extensively exploited. In fact, a substantial part of the late 1700s-early 1900s forest in the study area was owned by the town of Polanów (cf. Figures 16-19). As a result of agrarian reforms in the late 18th century and the first half of 19th century, along with the abolishment of serfdom, common pastures were defunct, with a new organization of land introduced, and cadastre updated. At the same time, land where pigs were allowed to forage was limited with foraging in forest prohibited (Wachowiak, 1993). Although the numbers of pigs in Pomerania increased throughout the 1800s, it is clear that when compared with sheep and cattle the growth in pig numbers was limited.

Although animal husbandry was an important element of early and late modern land-use, and flocks were grazed throughout the study area, both

beyond and within woodland, archaeological remains of pastoral practice are sparse. In a postglacial landscape without any rock outcrops, no drystone walls were constructed that could be used to enclose the animals and leave them unattended. Instead, herders kept the flock together and drove them through pasture, barren lands, and forest.

In this context a few unusual enclosures scattered throughout the forest west of the Grabowa River seem to be related to animal husbandry (Figure 53). Although these rectangular features are in a way similar to forestry related enclosures (cf. section 3.2.5 & Figure 60), they differ in their detailed morphology. They comprise an internal ditch, with an external earthen bank, occasionally reinforced with stones. This suggest that more attention was paid to the keeping the livestock in, rather than preventing the animals from entering the pen (Figure 54). While the smallest enclosure is about 300 square metres, the largest is about six times larger, and is divided in four parts by two shallow ditches. In addition, no pits that are characteristic of forestry related activity were identified in these animal enclosures (cf. section 3.2.5).

While these two features, the smallest and the largest examples, are situated on the edge of the late 18th century forest in areas which were afforested immediately before the *Urmesstischblatt* map was produced, the third enclosure lies inside an area that has been constantly afforested at least from the late 1700s (Figure 59). Also, the south-eastern corner of the largest feature is traversed by a road that was not mapped until the 1st edition of the *Messtischblatt* map was produced. In addition, all enclosures are within the beech and oak dominated (both in the past and today) part of the woods. Therefore, the enclosures were presumably used to keep pigs foraging in the deciduous forest before this practice was banned in the mid-19th century. Otherwise, an earlier use is possible, however, given the modern appearance of these features, this seems less likely. Thus, the enclosures situated between the forest and open land (pastures?) could have served to manage other livestock (sheep?) in the area. The early and late modern earthworks related to animal husbandry are little studied in the archaeology of Pomerania and other lowland areas of Poland, which makes the understanding of this type of features difficult.

Finally, the remains of a pond were identified on the floor of a small dry valley surrounded by moraine hills, south of Rzeczyca Wielka (Figure 55). An oval pit, seven metres across and nine metres long, was cut into a slope, with the pond retained by a stone dam, the remains of which comprise a scatter of boulders some 0.3-0.4 metres high and six metres long, infilled with mud/soil.

Unlike the south-eastern corner of the study area where landlocked lakes and pools are abundant amongst the moraine upland, the hilly area adjacent to the Pomeranian Urstromtal east of Przybrodzie, lacks bodies of standing water. Light soils and steep slopes (Figure 52) make the area well drained. If the hills were turned into pastures, sheep, which might have been

Figure 54. The faint remains of a stone/earthen bank and a ditch (to the left of the bank) forming an animal enclosure in beech dominated forest.

grazing in the area, required water, and the pond described above provided it. There is no evidence of other activity in the area, except from two charcoal burning platforms situated in another small valley, 80 metres from the pond. Nonetheless, throughout the study area there is no clear pattern showing that platforms were constructed in areas adjacent to water bodies or running water (cf. section 3.2.5), and thus, it is unlikely that the pond was built for the purposes of charcoal production. Hence, the pond in the forest south of Rzeczyca Wielka was probably constructed to provide water for grazing livestock. Given the steepness of the hills in the area, it is expected that sheep rather than pigs were pastured here.

Figure 55. The remains of a pond cut into a slope and retained by a stone dam in Rzeczyca Wielka.

3.2.5. Forestry, resource exploitation, and production sites

Modern afforestation, the history of which can be understood from historic maps (cf. section 3.1), left its mark on the landscape. Forestry-related tracks and roads were established throughout the last 250 years and while some are still in use, other minor tracks were abandoned and were subject to intentional afforestation or secondary regeneration. A regular grid of forestry-related tracks covered the Polanów Town Forest in the mid/late 1800s as a result of developments in forest management with other areas following in the early 20th century (Figures 18-19). Nonetheless, the roads are not the only evidence of historic forest management. In fact, the change in land-use that has been evident for the modern landscape can also be detected.

Extensive areas adjacent to Chocimino are covered with long, curvilinear strips, which cut the area irrespectively of landforms (Figure 56). These lines are formed by positive and negative lynchets, and partially by aligned stones. The lines extend over 1500 metres in length and cover U-shaped valleys, slopes, edges, and plateaus which were afforested shortly after the Schmettau & Schulenburg's map was produced. Regardless of cluster orientation and general topography, lines are set about 24-32 metres apart. These lines often cover difficult slopes immediately beyond the edge of the later cultivation, and this explains their survival. Interestingly, the northern slopes of the cluster located to the north of Chocimino were already partially afforested on the late 18th century map (Figure 57).

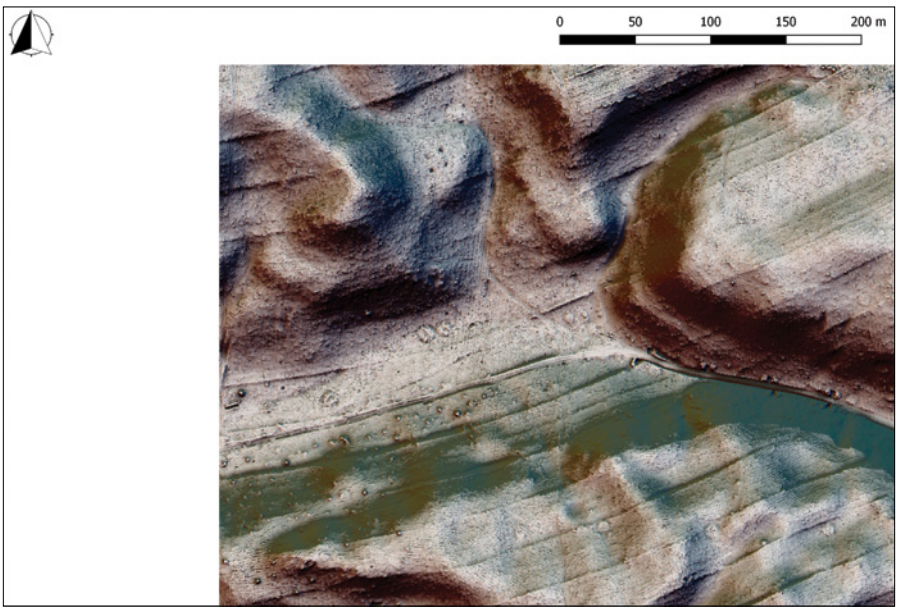

Figure 56. The curvilinear strips south of Chocimino cover the area without any regard to general topography and thus, are observable on valley bottoms, slopes and higher grounds, while circular remains of charcoal burning platforms are scattered throughout the area. ALS-derived DTM visualization: sky-view factor superimposed on hill-shading from multiple directions (Red – channel 14; Blue – channel 1; Green – channel 3).

The strips are not located in the immediate surroundings of any known settlement. This is in contrast to the long and modern strip fields in Pomerania (for instance in Nowe Worowo, Złocieniec *Gmina*) and beyond, that are spatially closely related with the settlements. Thus, the linear features in Chocimino seem to result from the 18th and early 19th century afforestation rather than provide the evidence of an early modern agriculture. While observing the ALS derivatives for other parts of Pomerania, similar linear features were identified in Jeleń (Borne Sulinowo *Gmina*) and Dziki (Szczecinek *Gmina*). In all these cases the area covered with the strips is far too extensive to result from agriculture which would be later abandoned and at the same time left unrecorded by the late modern cartographers. In this sense, the element of scale, the lack of any planned relationships with the recorded settlement, and the evidence of two historic maps altogether provide arguments for recognizing these strips as a result of planned afforestation that took place before the *Urmesstischblatt* map was produced. It seems that a large area was reworked before the trees were planted, though the function of the discussed strips is unclear. Although the evidence is indirect and such features have not been studied elsewhere in Pomerania and beyond, the strips should not be understood as earlier (due to their extensive scale without any traces of settlement) or later cultivation remains (the area has been continuously afforested since the late 18th-early 19th centuries). This makes them the oldest evidence of forestry-related activity in the study area, while the later afforestation techniques are less evident. It has been noticed in other parts of Pomerania that ploughing techniques that produce narrow and linear ridge and furrow like features was used during 19th and 20th century afforestation (Rączkowski & Banaszek, 2013). This, however, is not evident in the study area. While some of the early 20th century plough marks are scattered throughout the area, a more recent, post-war, deep ploughing is more common (Figure 26) and proportionate to the scale of the post-war afforestation (Figure 22).

The late modern forest has been turned into a production site on an industrial scale, where various resources have been exploited (Samojlik *et al*., 2013). Charcoal was produced on site leaving the remains of platforms and kilns that cluster in areas which have been long afforested, and which were not under cultivation in the early 20th century. In fact, the greatest number of charcoal kilns and platforms is to the south of Chocimino, in the area where the late 18th-early 19th century afforestation that was discussed above took place leading to the creation of the long and curvilinear strips. Here, different types of production features are situated, which might represent various charcoal production processes or a variety of output. All form flat-top, round, platforms, and while some are surrounded by a narrow ditch, others are defined by four small pits enclosing the platform (Figure 56). Features of the former type are either about 9-10 or 5-6 metres in diameter, whereas the diameter of the latter is slightly bigger at 11-12 metres. Most of the platforms are faint and no more than about 0.1-0.2 metres in height,

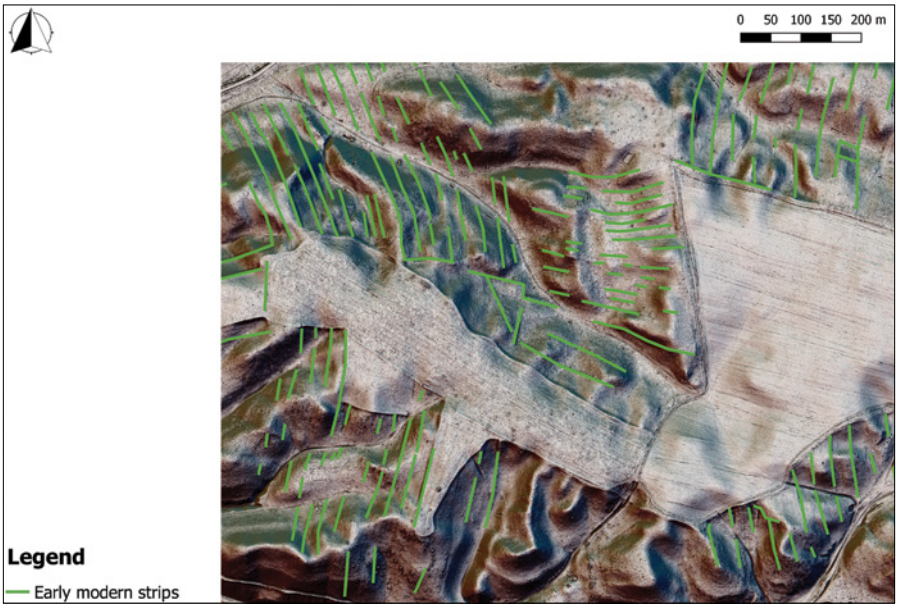

Figure 57. The curvilinear strips north of Chocimino are located outside smoothed and even grounds cultivated in 19th and 20th century. ALS-derived DTM visualization: sky-view factor superimposed on hill-shading from multiple directions (Red – channel 14; Blue – channel 1; Green – channel 3).

although more prominent features, 0.4 metres high, can also be recorded. Ditches and pits are usually 0.1-0.2 metres deep.

In addition, both types of charcoal burning platforms overlay the curvilinear strips surrounding Chocimino discussed above (Figure 58). Accepting that the strips were created while the area was afforested shortly before the *Urmesstischblatt* map was produced, the platforms are not earlier than the late 18th-early 19th centuries. Shortly after the newly planted trees reached an appropriate age, some, if not all, were felled and processed into charcoal. Although the historic sources demonstrate that charcoal was commonly produced in Pomerania throughout the early modern period (Szultka, 2003b), there is no clear evidence that any of the charcoal burning platforms in the study area are earlier than the late 18th century. Some kilns are located in the areas that have been constantly afforested throughout the last 250 years (Figure 59). However, it is impossible to establish their chronology solely on the basis of interpreting ALS derivatives, as these features do not intertwine with any monument of known date.

It is notable that a cluster of charcoal burning platforms in the north-eastern part of the study area is located in a region that was afforested in the mid/late 19th century. The 1st edition of the *Messtischblatt* map shows the area as covered with mixed forest which was planted extensively in the north-eastern corner of the study area after the *Urmesstischblatt* map was produced (cf. section 3.1.4). Hence, the charcoal production in this area was relatively late, unless the platforms were constructed earlier, in the late

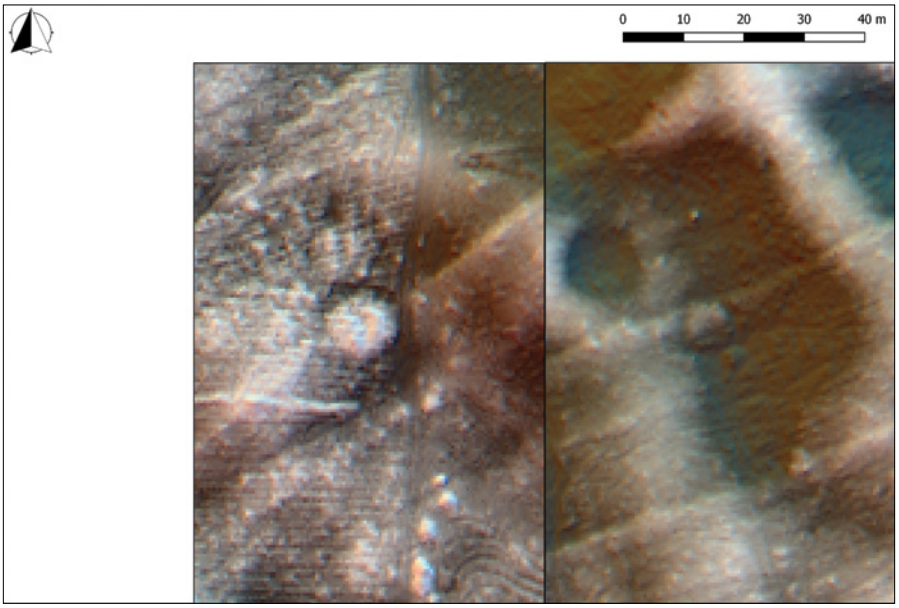

Figure 58. The remains of charcoal burning platforms overlaying diagonally orientated curvilinear strips near Chocimino. ALS-derived DTM visualization: local dominance superimposed on hill-shading from multiple directions (Red – channel 14; Blue – channel 1; Green – channel 3).

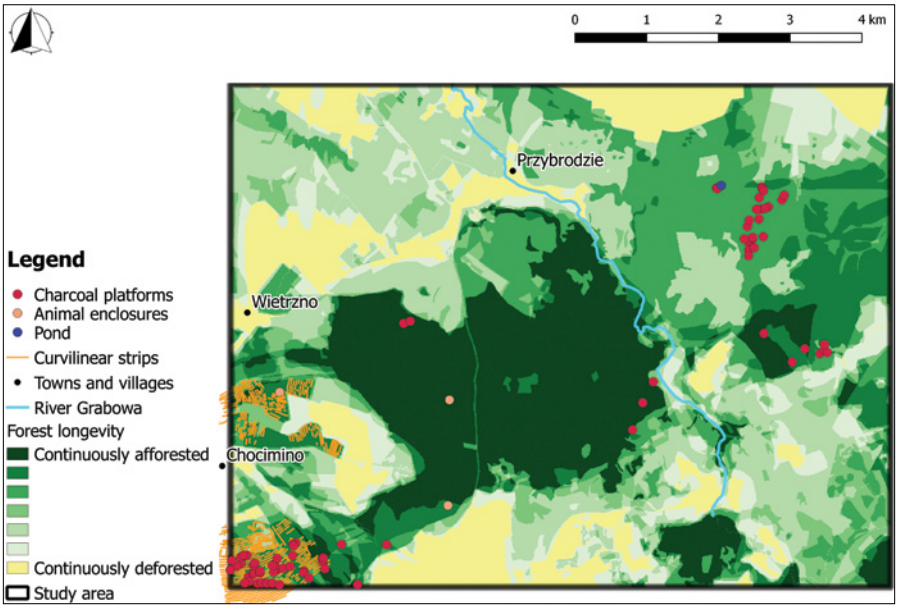

Figure 59. The location of charcoal burning platforms, curvilinear strips, animal enclosures, and a pond against a forest longevity map.

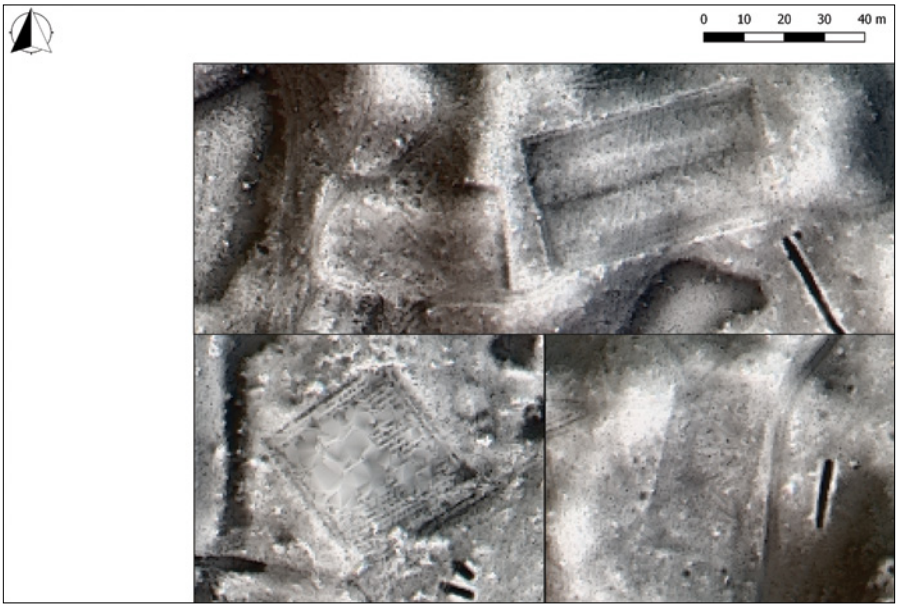

Figure 60. The forestry-related enclosures identified in the study area always occur with deep pitfalls, linear ditches, which in this case are located east/southeast of the rectangular features (cf. Figure 61). ALS-derived DTM visualization: local dominance superimposed on sky-view factor and hill-shading from multiple directions (Red – channel 14; Blue – channel 1; Green – channel 3).

medieval/early modern period, when a brickyard operated nearby (see below), and before the area was deforested to the extent shown on the late 18th century map. However, while there is no clear evidence to support this theory, the morphology of charcoal platforms in the north-eastern corner of the study area is similar to those south of Chocimino – basically rounded platforms, some 9-10 metres in diameter enclosed by narrow ditch.

In addition, several rectangular enclosures of recent date are also found in the forest (Figure 60). These are forestry related and result from planting trees on small plots of land for testing purposes. The enclosures differ in shape and size but cover about 0.1-0.2 hectares. Although similar to the pig/sheep pens discussed above (cf. section 3.2.4), neither a surrounding bank nor a ditch was identified in any of these features. Rather, the enclosures were constructed by ploughing and levelling of a small plot of land within the forest for planting young trees amongst the old (Figure 61). As a result, faint cuts (negative lynchets) define the edges of the enclosures, while there is often a furrow down the centre. In addition, deep pitfalls, short linear ditches, are always located next to these features. According to local foresters, these were dug for the protection against insects, which can threaten the newly planted trees – to lure and trap them inside the ditch. These ditches are not adjacent to any of the supposed pig/sheep pens in the study area (cf. section 3.2.4).

Although wood and its derivatives have been one of the most important commodities exploited in the modern age, there is also abundant evidence of other goods produced within the study area. Both the *Urmesstischblatt* and the *Messtischblatt* maps demonstrate extensive peat cutting in the area north of Żydowo along the Żydowo-Świerzno road. Located in the south-eastern corner of the study area, numerous peat-filled depressions were drained in the 18th and 19th centuries to allow exploitation. The use of peat as a local source of fuel stopped after World War II. As a result, sites which had been exploited saw new layers of peat forming. This created levelled surfaces, partially filled with water, and in most cases left no trace of peat cutting. Nonetheless, some sites are still observable in ALS derivatives.

The irregular surface of the once cut peat is clearly visible in Myszyna (Figure 62). Here, an area of about 5.8 hectares was drained and extensively exploited. In places strips of peat were cut, whereas in other areas the material was exploited in an irregular way creating a chaotic pattern. A layer of at least 1.5 metres deep was removed, and such substantial change in the elevation required a rearrangement of the drainage system. Thus, the old drainage (Figure 62:A-B) was replaced by a new, deeper channel (Figure 62:C).

Peat cutting remains demonstrate substantial transformation of the modern landscape, and its extensive use at least over the last three centuries. Nonetheless, there is more evidence of resource exploitation in the study area. Small and localized clay, sand, and gravel extraction pits are abundant throughout the area. These are often situated next to isolated farmsteads, suggesting individual use, while others cluster next to main roads and the railway track, and were presumably exploited during the construction of the transportation networks. In addition, at two sites, in Kania and Czarnowiec, sand and gravel have been exploited on an industrial

Figure 61. A stand covered with young mixed trees amongst old beech produces modern enclosure-like feature in ALS derivatives (cf. Figure 60).

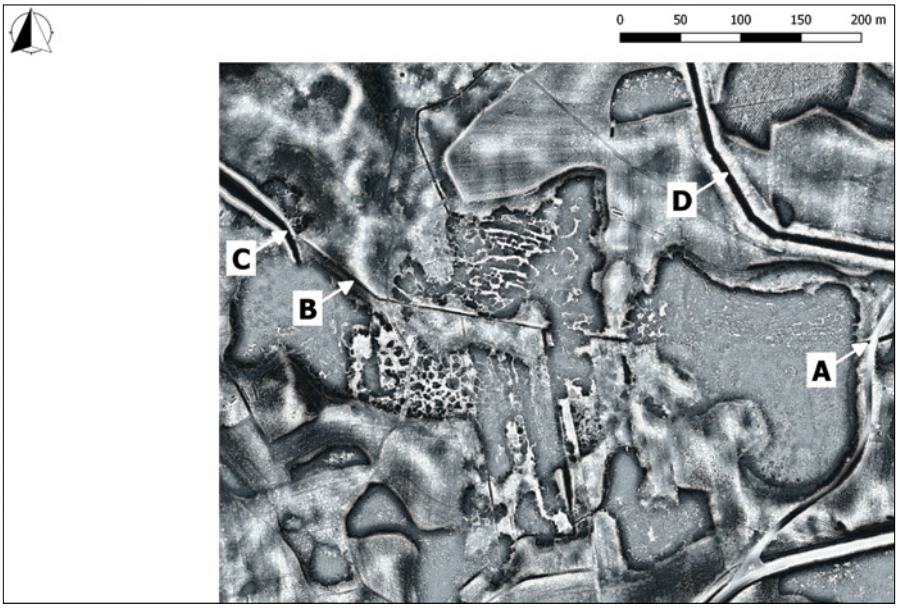

Figure 62. Peat cutting remains and a drainage system in Myszyna. The irregular surface and sharp edges represent areas which were exploited, while the drainage was rearranged through time (A-B was replaced by deeper C). A World War II anti-tank ditch (D) is located in the north-eastern part of the area and its morphology is similar to drain C. ALS-derived DTM visualization: local dominance superimposed on sky-view factor and positive openness.

scale leading to extensive transformation of the landscape. While resources in the former location were used to a minor extent even before World War II, and have been continuously extracted, in the latter case, the gravel extraction started after the war, and ceased a few decades later.

In addition, the remains of lime production sites were identified east of Przybrodzie (Figure 63). A lime kiln (German *Kalkofen*) that was only recorded on the *Urmesstischblatt* map (Figure 17) is located on the north bank of an unnamed gully (which is crossed by the road that used to connect Przybrodzie and Stary Żelibórz) shortly before its water supply the Grabowa River. Bog lime is recorded to cover this section of the valley floor, and the irregular surface of the area south of the two-chamber kiln shows where the resources were exploited. Given the postglacial geology of the region, bog lime was the only available source of lime, and the *Urmesstischblatt* map provides evidence of borrow pits in the area. In addition, there is another extraction area about a kilometre to the west of the former, on the opposite bank of the Grabowa River. The kiln is about 16 metres long with a single chamber 8 metres in diameter. This section of the Grabowa River valley is the only place in the study area, where a kiln is present, while additional lime production sites are located to the southwest of Żydowo.

Finally, the remains of two brickyards were identified in the study area. While traces of the 19th to 20th century production site have been recognized to the southeast of *Raderang*, on the shores of the Żeliborskie Lake (*Wocknin See*),

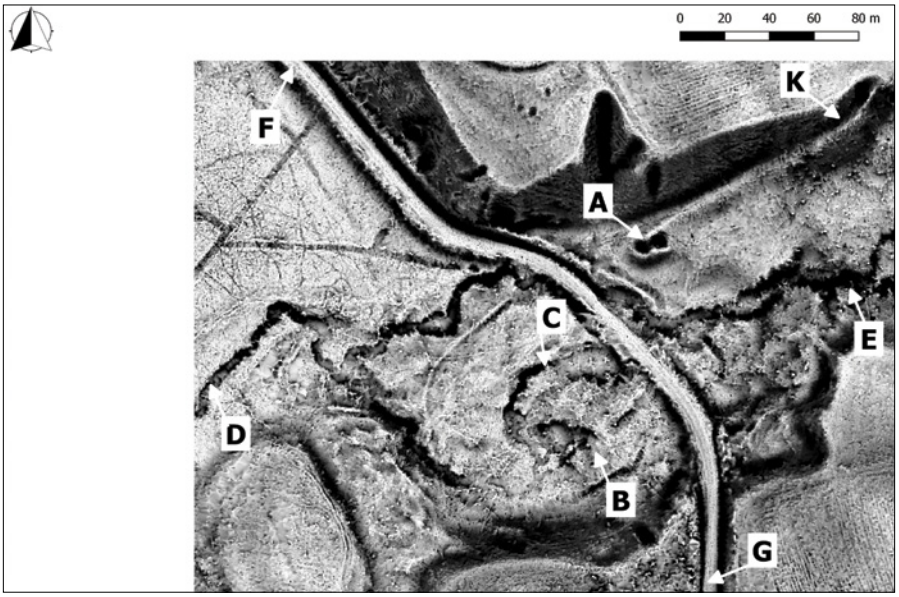

Figure 63. A lime kiln (A) and exploitation site (B-C) located on both sides of the Przybrodzie-Stary Żelibórz road (F-G) and separated by a short gully (D-E), which flows westwards and meets the Grabowa River 200 metres to the west of the illustrated area. Another road (K), now disused, once provided access to the kiln from Rzeczyca Wielka. ALS-derived DTM visualization: sky-view factor superimposed on positive openness.

the other brickyard, which most likely operated in the early modern period, was recorded in Rzeczyca Mała. Located about 1600 metres to the south of the village, there are several borrow pits, as well as remains of a kiln, ponds, and other structures. The main cluster of the remains lies on a small knoll separated from other moraine hills by two burns, one on the western side of the hill with another on the eastern side (Figure 64:J). The small knoll rises only seven and ten metres above western and eastern valleys respectively, and is dominated by other hills in the area, which are 20-40 metres higher. Nonetheless, due to the presence of the brickyard, this topographically insignificant knoll acquired a name, identified as *Ziegelofen Berg* (Brick Kiln Hill) on the *Urmesstischblatt* map. While various place names, including the names of hills, rivers, and meadows, were registered on the Schmettau & Schulenburg's map, not a single feature was named within the large area between Rzeczyca Wielka, Rzeczyca Mała, Przybrodzie, and Stary Żelibórz. Thus, the *Urmesstischblatt* is the oldest map that mentions names of the hills in the area, and *Ziegelofen Berg* does not occur on any other, later, map.

While the early 19th century map does not show any structure on the knoll, other operating brickyards, for instance the one located about 2400 metres to the west of Polanów, are illustrated. None of the discussed brickyards is shown on the Schmettau & Schulenburg's map though. It is likely that by the time of the *Urmesstichblatt* map, the brickyard in Rzeczyca Mała was already abandoned for some time. However, the memory of the production site was still active in the local inhabitants, and for this reason the name

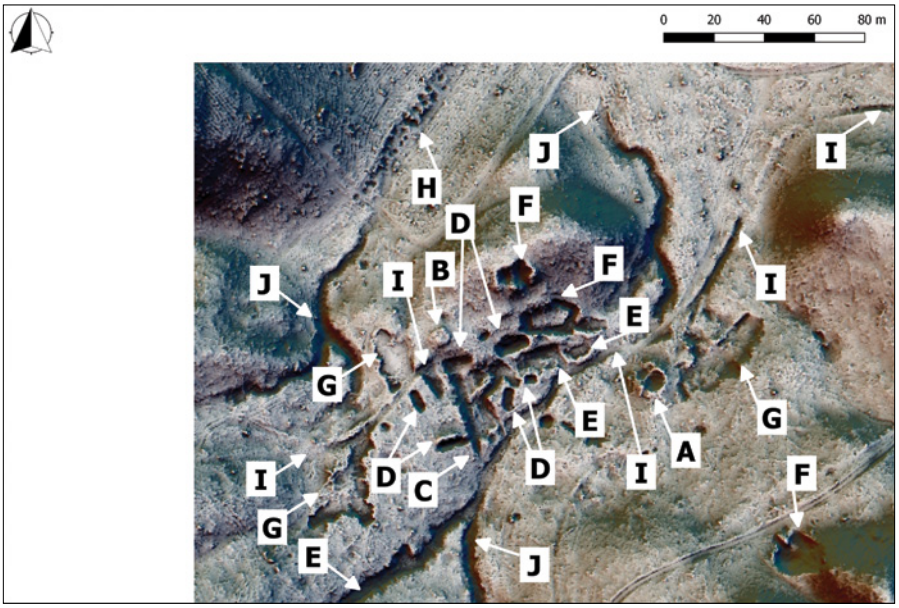

Figure 64. The remains of an early modern brickyard in Rzeczyca Mała. ALS-derived DTM visualization: sky-view factor superimposed on hill-shading from multiple directions (Red – channel 14; Blue – channel 1; Green – channel 3).

of the knoll was registered on the map. It faded away soon afterwards though. In addition, a dead-end road connects the village with *Ziegelofen Berg*. The fact that the road was not completely forgotten, yet included on the early 19th century map, suggests that the abandonment of the brickyard did not happen long before 1830s though.

While most of the observable relief features related to the brick production cluster on the western bank of the eastern stream, the remains of a kiln (Figure 64:A) and a few borrow pits are situated on the other side. A few artificial ponds (Figure 64:E) lie adjacent to the stream with other deep pits nearby (Figure 64:D). The remains of a linear ditch (Figure 64:C) are located between the stream and a rectangular building, measuring about 8 by 7.5 metres, (Figure 64:B) on the west slopes of the knoll. The alignment of the ditch might suggest that this was a lade, though no traces of a dam were identified in the area. Remains of a road approach the site from the east, with another road from the west (Figure 64:I). The borrow pits either consumed parts of the hills nearby (in this case they are surrounded by upcast (Figure 64:F)) or are located on the valley floor where no upcast is recorded (Figure 64:G). In addition, there are numerous small pits aligned with the disappearing western burn creating a line about 60 metres long (Figure 64:H).

The remains of the late modern brickyard located on the shore of the Żeliborskie Lake (Figure 65:G) look almost sterile when compared with the production site in Rzeczyca Mała. This small brickyard, which was connected by road with *Raderang* (Figure 65:F) and Nowy Żelibórz (*Selberg B*)

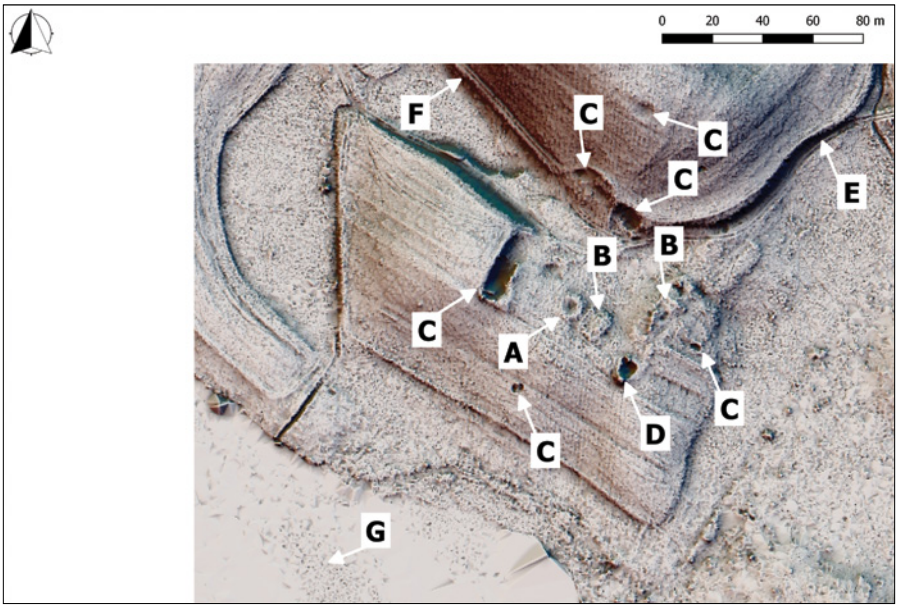

Figure 65. The remains of a late modern brickyard on the shore of the Żeliborskie Lake. ALS-derived DTM visualization: sky-view factor superimposed on hill-shading from multiple directions (Red – channel 14; Blue – channel 1; Green – channel 3).

(Figure 65:E) operated only for a short period. It is shown on the 1st edition of the *Messtischblatt* map, and although two buildings (Figure 65:B) in its area are also illustrated on the updated version of the map, the brickyard must have been shut by 1930s, as no production function is marked on the 2nd edition of the map. The circular remains of a kiln (Figure 65:A) are surrounded by a few borrow pits (Figure 65:C) with only one pit where clay could have been mixed with water (Figure 65:D).

Both brickyards, located about 5.5 kilometres apart, offer a great opportunity to compare the spatial organisation of production sites throughout the modern period, and study developments in kiln construction as well as other aspects of brick production. In addition, given the extensive transformation of the landscape, the brickyard in Rzeczyca Mała was most likely operating over a long time, perhaps a few centuries. Thus, it is likely that this production site might have its roots in the early modern period or even before, as the use of bricks in Pomeranian architecture was common already in the late middle ages.

3.2.6. The World War II landscape

The aftermath of World War II and its impact on the landscape of Polanów has been extensively discussed above, however, the war itself also left significant marks in the landscape of the study area. A system of trenches and bunkers comprising the *Pommerstellung* (Pomeranian Wall) was already designed in the 1930s and extended from the Baltic coast to the Toruń-Eberswalde Urstromtal near Piła (Miniewicz & Perzyk, 1997). Thereafter,

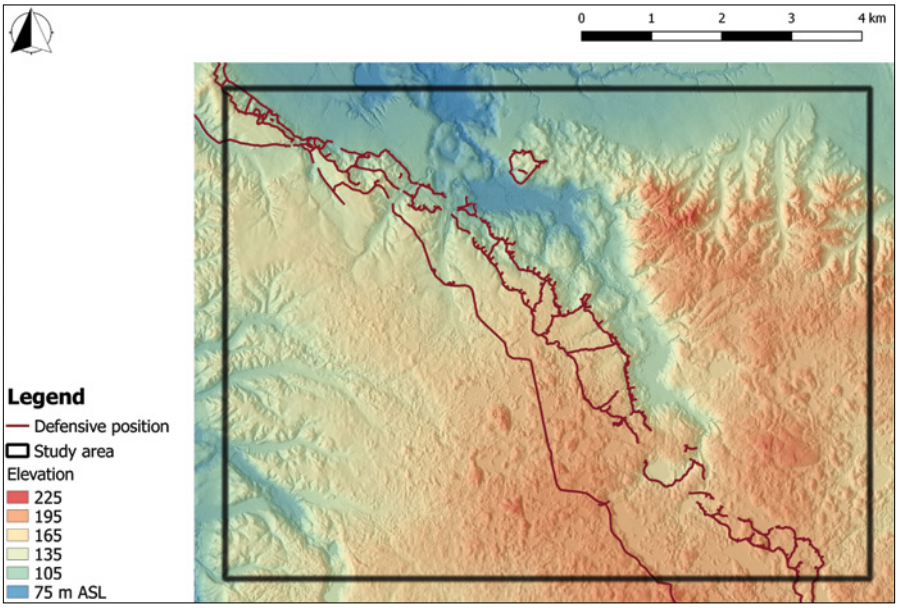

Figure 66. The remains of the Pomeranian Wall (*Pommerstellung*) fortifications. ALS-derived DTM visualization: elevation superimposed on hill-shading. Data outside the extent of the bespoke ALS survey commissioned by IA AMU was provided by Polanów Forest District.

this defensive position followed the course of the valley westwards, crossing it to the east of Gorzów Wielkopolski before joining the *Ostwall* (East Wall) and continuing southwards, eventually reaching the Odra River valley before heading towards Wrocław.

In total, the system was hundreds of kilometres long, though it was not developed to the same degree throughout its course. Indeed, the northernmost section was never finished, though it includes the trenches in the study area, and extends from the Bobięcińskie Wielkie Lake and the coastal town of Bukowo Morskie, about 35 kilometres to the northwest of Polanów. When the Red Army and the Polish People's Army marched through the region of Polanów in the early 1945, only a few bunkers, Ringstand 58c, were fully developed and operational, while in other cases only the pits were dug out and foundations laid (Miniewicz, 1988).

Two infantry trenches cut diagonally across the study area, connected by short communication sections. This fortification follows the western slopes of the Grabowa River valley and continues towards the northern shores of the Bobięcińskie Wielkie Lake in the south, and the Holy Hill in the north (Figure 66). From there, the defensive position cuts across the Pomeranian Urstromtal, to the west of Polanów, with the town lying between the entrenched German units and the enemy army marching from the east. In addition, an anti-tank ditch, flanked by two banks, and up to three metres deep, was constructed to the west of the infantry trenches. The distance between these two types of fortification varies between 30 and 1200 metres. The ditch respected the roads that were in use in the 1940s and joined them

obliquely, often by creating triangle-like junctions (Figure 68). In addition, a hill adjacent to Przybrodzie, on the eastern bank of the Grabowa River, was also enclosed with zig-zag trenches, and there are four deep holes that mark the locations of the unfinished bunkers on the hill (Figure 67). In total, the trench system in the study area is about 55 kilometres long.

Although the observed trenches within the study area are today situated solely in the woodland, these were constructed both within the woods and beyond. Whenever a trench cut through arable land, it is no longer visible as an earthwork unless the area was covered with trees in the post-war period (Banaszek, 2015a). Hence, some of the observed gaps in the course of the shallower infantry trenches are a result of later ploughing, which led to the levelling of these relatively slight features.

Figure 67. Steel reinforced bars at the bottom of a deep pit dug for a bunker near Przybrodzie.

No cropmarks have been identified in the fields where trenches are expected, though some cropmarking is evident to the north of the study area where the defensive line crossed the Pomeranian Urstromtal. Nonetheless, fields to the south of Polanów were cultivated also throughout World War II and were fortunately documented by United States Air Force photographs taken in July 1944 (cf. section 2.4). While analysing the declassified aerial imagery no line of fortifications was recognized in the unforested areas (Figure 68). Neither the infantry trenches, nor the anti-tank ditch were constructed at the date of the photography. This provides evidence of a very late start of the construction, of which the unfinished bunkers are silent witness.

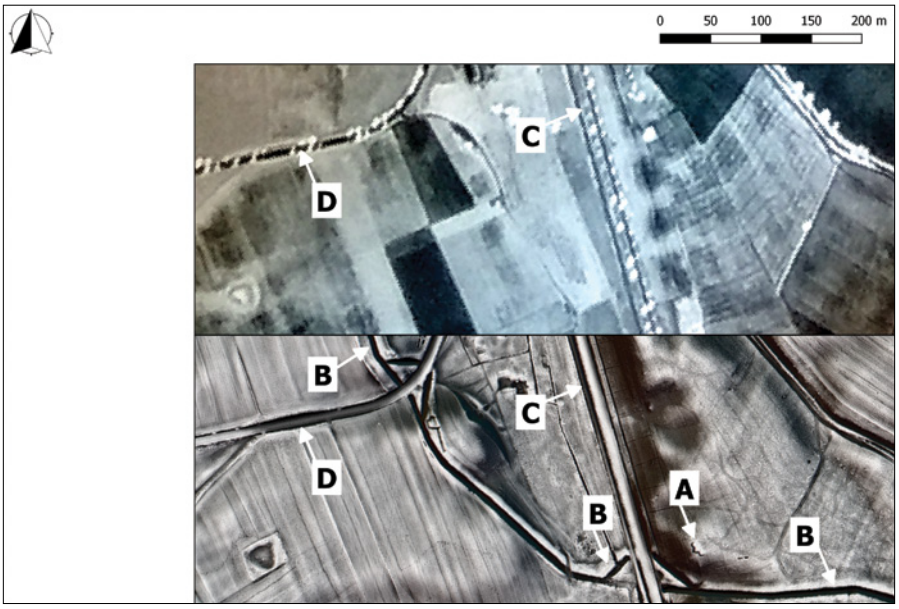

Figure 68. While infantry trenches (A) and the anti-tank ditch (B) are clearly visible next to the roads connecting Polanów with Żydowo (C) and with Łokwica (D) in the ALS-derived DTM visualization (bottom), there is no trace of the fortification on the reconnaissance photograph taken by United States Air Force in 1944 (top). National Archives and Records Administration: photograph no. 4349, roll D13971-D13973. ALS-derived DTM visualization: local dominance superimposed on sky-view factor and hill-shading from multiple directions (Red – channel 14; Blue – channel 1; Green – channel 3).

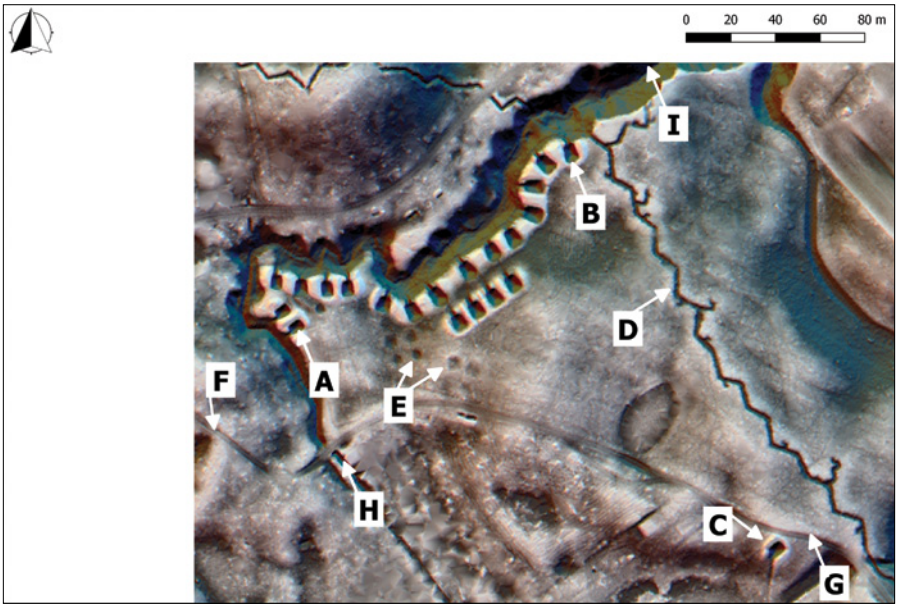

Figure 69. The remains of a group of 21 sunken houses (A-B, C) lying next to an infantry trench (D), the Polanów-*Raderang* road (F-G), and a gully (H-I). In addition, two charcoal burning platforms (E), each defined by four pits, are situated close to the houses. ALS-derived DTM visualization: local dominance superimposed on hill-shading from multiple directions (Red – channel 14; Blue – channel 1; Green – channel 3).

It is very likely that the builders of the defensive position between Polanów and the Bobięcińskie Wielkie Lake were camped in sunken houses located north of Bartlewo. Here, a group of 21 such houses has been identified (Figure 69) next to the road that cuts across the Polanów Town Forest and connects *Raderang* with the Polanów-Żydowo road, close to Łokwica. While one house lies about 170 metres to the southeast of the main cluster, other buildings were laid out in two rows. The shorter row comprises four houses with entrances located on the north-western side. The second, longer row takes account of the course of a small, unnamed gully and the entrance to each house is on the gully side of the structure. The remains of the buildings are about seven metres across, and about 11.5 metres long, including a 'corridor' about three metres long (Figure 70). The interior of the sunken houses is 1.5-2.5 metres below the top of the surrounding bank. Adjacent to the camp is a zig-zag military trench, and two charcoal burning platforms, each defined by four pits (cf. section 3.2.5).

The camp seems to have been used for a short period of time without thoroughly organized space and other infrastructure that was characteristic of the war-time camps elsewhere in Central Europe (Banaszek & Ratajczak, 2011; Kobiałka *et al*., 2017). Like other war-time camps and infrastructure in Poland these remains have already been plundered by metal detectorists, who have discarded many of the metal objects they find (Frąckowiak & Michalski, 2011). These include spade blades, barbered wire and stove elements (Figure 71). Perhaps charcoal that was produced nearby was used to heat the buildings or prepare food on site. It is likely that prisoners-of-war or forced labourers were forced to construct the Pomeranian defensive position and hence, based in the camp in Bartlewo.

The case of the World War II trenches demonstrates that one of the most significant features in the study area was created in a short time. This makes

Figure 70. The north-westernmost sunken building in the camp at Bartlewo with the entrance facing north.

it quite different from the other modern landscape transformations discussed above. Nonetheless, the survival of the afforested sections of the defensive position is quite astonishing. Although the zig-zag pattern of the infantry trenches is characteristic and easily recognized in the ALS derivatives, the anti-tank ditch is to a certain degree more challenging. While observing ALS-derived visualisations, this substantial structure (Figure 72) is similar to the drainage system (Figure 62) and might be easily misinterpreted, unless its large-scale is acknowledged. In addition, the ditch, unlike the drainage networks, does not follow the slope, and traverses varied topographic features, climbing and descending again.

In fact, when a team led by Michał Pawleta and Rafał Zapłata was undertaking archaeological survey of the region immediately south of the study area (Pawleta & Zapłata, 2015) using ALS derivatives to interpret the earthworks (Zapłata & Ptak, 2015) with field survey (Borkowski *et al*., 2015; Kaźmierczak & Zapłata, 2015), and other methods following (Rączkowski, 2015), they did not recognize the ditch, which is also present there. Having mapped the infantry trenches in the east part of their study area, the team did not identify the anti-tank fortification that ends in the waters of the Bobięcińskie Wielkie Lake, next to Czyżewo. The ditch begins again at the southern bank of the lake, about five kilometres away from the northern shores.

Although the ditch is clearly marked on the 1:10 000 scale topographic maps, the relationships with the zig-zag trenches that intersect the anti-tank fortification, made it less obvious and more difficult to recognize. Nonetheless, this case study demonstrates that while interpreting ALS derivatives not only the small-scale and faint features can be left unrecorded, but also large and extensive earthworks can be omitted due to their similarity to the modern, often archaeologically irrelevant features and/or as a result, of limited experience in interpreting remote sensing data and derivatives (Palmer, 2005, 2011, 2013; Palmer & Cowley, 2010).

Finally, there is another earthwork in parts related to 20th century warfare, which was also used for civil purposes. This is a shooting range (Figure 73) situated in the area between Żydowo and Chocimino, about 500 metres to the northwest of where the narrow-gauge railway diverges from the Polanów-Żydowo road (cf. section 3.2.3). The range, about 100 metres long, was constructed shortly before the 2nd edition of the *Messtischblatt* map was produced. It is cut into a small moraine knoll, and comprises a straight ditch flanked by a small bank, about 0.3-0.4 metres high on its north-west, and a steep slope, 0.8-2 metres high, on the south-east. A bullet trap was constructed at the north-eastern end.

The odd location and morphology of the range is a product of the redevelopment of an older ditch that traversed the area. In fact, the range was constructed over a section of a dry ditch that defined the boundary between the two villages of Żydowo and Chocimino. The course of the boundary, recorded already on the 1st edition of the *Messtichblatt*

Figure 71. Metal objects left behind by detectorists in the area of the camp in Bartlewo.

map, was defined either by water bodies, rivers, and gullies, as well as by some anthropogenic structures (i.e. the drainage system and dry ditches). The remains of the boundary ditches are about 0.3-0.8 metres deep. Given that the study area was drained in the late 18th-early 19th century, this ditch was most likely constructed at the same time, as in some places there is a clear continuity between the dry ditch traversing a moraine hill, and the drainage cutting the peat-filled depressions.

Figure 72. The anti-tank fortification in the forest near Polanów. A deep ditch, partially submerged, is flanked by two substantial banks.

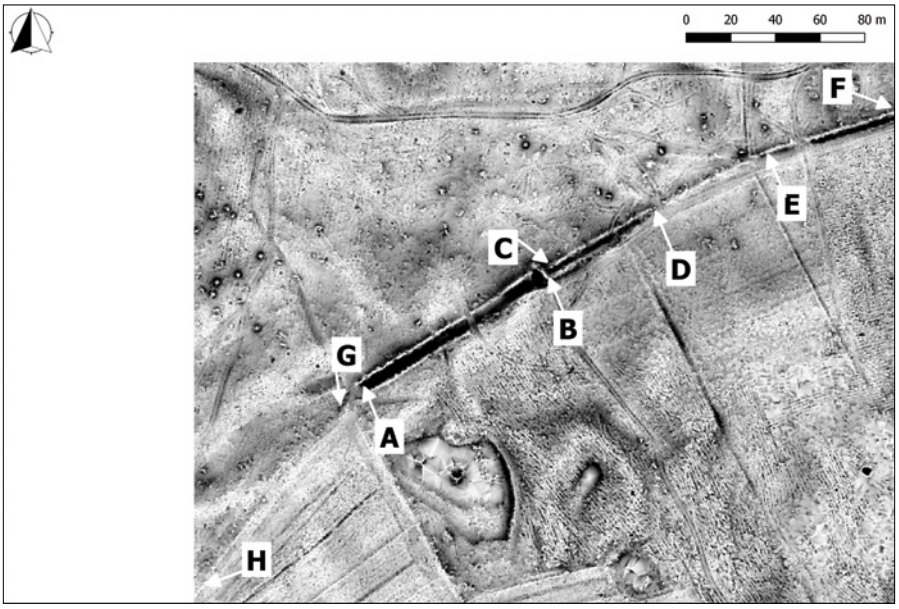

Figure 73. A shooting range (A-B) constructed over the boundary separating Chocimino and Żydowo. Two sections of the old boundary ditch survive (C-D, E-F), while headlands define other parts of it (D-E, G-H). Bullet trap (B) is the only historic feature perpendicular to the borderline. ALS-derived DTM visualization: local dominance superimposed on hill-shading from multiple directions (Red – channel 14; Blue – channel 1; Green – channel 3).

This continuity means that the dry ditch observed next to the shooting range is of the late 18th-early 19th century date, despite the fact that it might have followed earlier land divisions. With a small break close to the shooting range, it continues in the northeast, and after about 850 metres reaches the Polanów-Żydowo road, crosses it and continues eastwards. On the south-western side of the shooting range, no ditch is observed for a distance of about 1800 metres, as the boundary was marked by two different land-use types. Here, headlands separated the Chocimino Forest from the fields in Żydowo, and another section of the border ditch falls outside the study area.

3.3. Discussion

The remarkable combination of historical and archaeological sources that has been compiled during this survey has allowed the detailed exploration of the early and late modern layer of activity in the palimpsest of the landscape of Polanów. The landscape of the study area is extensively marked by the remains of human labour, produced both through repeated actions over decades and centuries, as well as during short periods of intensive activity. The understanding of change in forest cover and other modern land-use transformations means that the barely populated contemporary landscape is in stark condition to that over the preceding few centuries. In fact, an abundance of cultivation and field system remains covers almost the entire

area, which has been unforested at some point over the last 250 years (Figure 74). In this sense, both the open landscape adjacent to present-day settlement, and current woodland, except for the continuously afforested regions, are full of traces of modern cultivation and settlement (Figure 75). However, these areas contain traces representing different phases of cultivation. While the evidence is generally the strongest for the most recent phase, immediately prior to afforestation or transformation into pastures and derelict land, whether that represents the 1800s, the early 20th century or the post-war period depends on local trajectories and patterns in the pace of landscape transformation. Outside the continuously afforested land, only steep slopes, moorland, and the floor of the Grabowa River valley are patchy areas where no cultivation remains have been observed.

In addition, the evidence for early modern settlement and cultivation within the stable forest (Figure 74) proves that afforestation and deforestation was an ongoing process in the early modern period, and that such remains should be expected also within other areas with similar histories of afforestation. Nonetheless, the scale of the remains is limited. While their survival within the over 250 years old forest has not been affected by later cultivation, such remains have disappeared as a result of late modern ploughing elsewhere. The survival of a few headlands in the north-west of the study area is unique; surviving solely due to the cessation of early 20th century cultivation by World War II. The evidence of two early modern huts recognized in Zaświecze area, which was unforested until World War II,

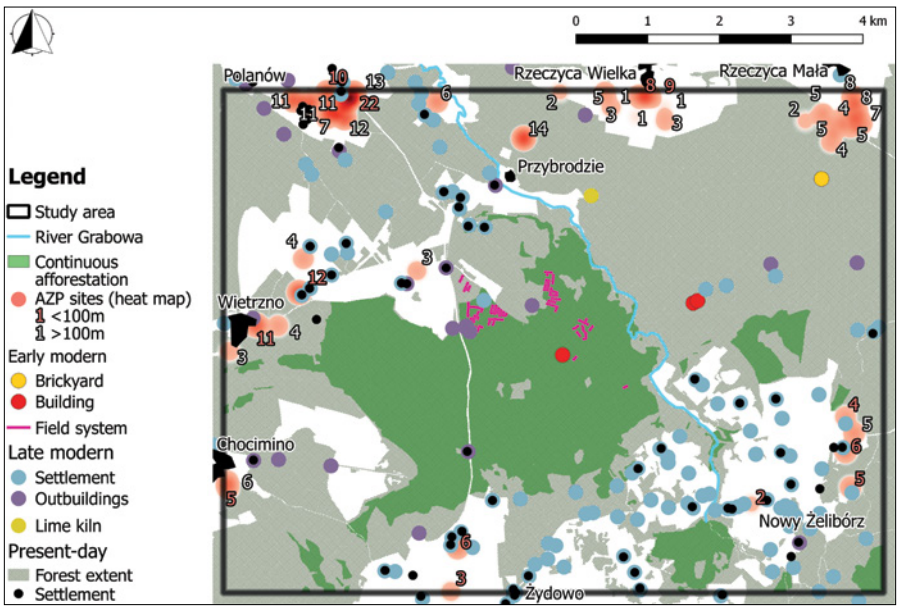

Figure 74. Elements of the early and late modern settlement, as well as currently occupied farms and townships superimposed on the extent of present-day forest, and the area that has been continuously afforested in the last 250 years.

proves that this type of earthworks might fortuitously survive late modern cultivation in areas of complex topography, where the remains can be identified on ALS derivatives. However, the identification of the remains of levelled early modern farmsteads, especially within cultivated or otherwise improved ground, requires other methods of archaeological prospection. Since aerial prospection is constrained by unfavourable land-use and poor conditions for the formation of cropmarks, field-walking in accordance with the AZP programme has shown some potential to explore these sites.

While 61 archaeological sites were identified throughout the study area (Figure 4), early and/or late modern potsherds were recorded at 43 sites (Table 2). However, the methodology of the AZP survey means that the number of recorded potsherds is not clear, and that the final record depends largely on decisions made on site, the discovery strategies, the pattern of coverage, observation conditions, resourcing, and many other factors (Jaskanis, 1996), which are individual to each site, and not easily transferable between regions. Nonetheless, generally large numbers of potsherds collected at a single site, from the field surface, suggest that a settlement in given area was more intensive, long-term or was capable to produce more archaeological material, unless other post-depositional process have interfered with local environment. Therefore, a site producing a few dozen potsherds is often regarded as more important than a site where only a handful of finds was collected. In this framework, the importance of a site does not derive from its (lost) cultural meaning and function, but is rather constructed on the basis of material recorded by archaeologists. The reductive concept and methodology of the AZP programme means that the record is notably biased and should be used with care. In addition, while recording of a dozen or so finds within a limited area seems to be adequate to acknowledge a site, whether the discovery of a single potsherd makes a site is disputable.

Nonetheless, while the median of potsherds from field-walking of early and/or late modern archaeological site locations in the study area is five, there are three sites where a single find was identified, an additional three where two potsherds were collected, with the greatest number of finds of 22 for a site near Polanów (Table 2). Given the abundance of late modern farmsteads throughout the area, the impact of pre-war settlement on the AZP record requires understanding. While the surveyors usually did not have access to historic maps, during the communist period in particular when spatial information was secret (Królewicz & Żuk, 2015), there is a clear concordance between some sites and the farmsteads deserted in late 20th century (Table 2 & Figure 74). Historic maps provide evidence that in 13 cases known settlement locations were within 100 metres of the archaeological site identified through field walking. These concentrate in the southern part of the study area where seven out of nine sites in Nowy Żelibórz, Żydowo, and Chocimino are situated next to farms established in the late 19th and early 20th century. While a handful of finds was recorded

Figure 75. Remains of headland in an area afforested in the early 20th century.

for each of these sites, the number of potsherds identified for similar sites in the north of the area is notably higher. For two sites, east of Wietrzno, 11 and 12 finds were recorded respectively. In the area to the south of Polanów two additional sites were identified within 100 metres of a modern settlement, for which 10 and 22 potsherds were recorded respectively, while eight and nine finds were collected for another two sites adjacent to Rzeczyca Wielka. While in the case of Polanów, there are other sites located farther from modern settlement, for which a dozen or so potsherds were identified. In the case of Wietrzno and Rzeczyca Wielka, numbers of finds collected for sites near the settlement are notably higher when compared with other sites in the area.

Thus, it is very likely that the material identified through the AZP relates to the farms recorded on historic maps. In addition, given that ploughing transports potsherds throughout a field, sites nearby Wietrzno and Rzeczyca Wielka, which are characterised by only a few finds, might be a product of continuous cultivation. Archaeological material related to the historically mapped farms was more frequently noticed in the immediate vicinity of the settlement, while lesser numbers of potsherds were transported farther away from the village. In this sense, rather than representing other, unknown, early or late modern settlements, the finds derive from long-term activity of the mapped settlement, and while the well-established townships in the northern part of the area 'produced' more archaeological finds, the isolated and late farmsteads in the southern part generated notably less material.

Indeed, the cluster of archaeological sites to the south of Polanów demonstrates a notably different character. Although in two cases numerous potsherds were identified near the settlement recorded by historic map makers, the number of finds identified beyond the immediate locality of the settlement known from the maps is also notable. This suggests that in the area, for which only a fairly limited number of farms was recorded since the late 18th century, early modern settlement was present. Similarly, the cluster of sites between Rzeczyca Mała and the remains of an early modern brickyard (cf. section 3.2.5), and a single site, to the northeast of Przybrodzie, for which 14 potsherds were recorded, should be understood as remains of early modern settlement. These sites are at least 250 metres away from any known settlement, while in a few cases the closest township recorded on late modern maps is 500-600 metres away. The evidence of the late modern maps suggests that townships, which are represented today only by potsherds identified through field-walking, were deserted and cleared before late 18th century. Therefore, a single archaeological site is not to be understood as an individual early modern farm. It is the clustering of the AZP sites adjacent to Polanów and Rzeczyca Mała, and the high number of finds for the site to the northeast of Przybrodzie that provide traces of settlement. Regardless of whether this process occurred due to the great agrarian reform, which started in Prussia in the mid-1700s, or as a result of the Thirty Years' War, which decimated the Pomeranian population, or any other lesser historic event, the importance of this discovery is that there are sites in the northern part of the study area. Here not a single farmstead was recorded by the map makers amongst the well-established town of Polanów and other large villages until the late 19th century, while the area remained largely deforested until the decades after the *Urmesstischblatt* map was produced.

In fact, the area was presumably deforested also in the early 17th century (cf. section 3.1.1). While it is very likely that Lubinus mapped all well-established and important townships, it is also probable that he omitted isolated farmsteads, given the scale of *Nova Illustrissimi Principatus Pomeraniae Descriptio…* Therefore, he might have decided not to include the levelled farms discussed above, which are represented by potsherds from field walking or earthworks identified through ALS interpretation. However, there is no evidence that these were inhabited in early 1600s. In the same manner, the farms might have been occupied after Thirty Years' War and deserted before the late 18th century, though additional information is needed to establish detailed dating.

Finally, the presence of the Catholic sanctuary on the Holy Hill, which was demolished in the early 17th century needs to be acknowledged while discussing early modern landscape (Bastowska, 2011; Siemiński, 2010). Although the location of the church falls just beyond the north-western corner of the study area, land which was cultivated for the purposes of the sanctuary might have included areas discussed in this volume. Although

no early modern field system remains have been identified in the area, as these, if they existed, would have been levelled and transformed by later ploughing (cf. section 3.2.1), the surroundings of the church were presumably cultivated while the sanctuary was operating. With its demolition, the arable land was transferred to other owners and it is likely that the cultivation progressed. The late 18th century map demonstrates that extensive land between Wietrzno and Polanów was deforested (cf. section 3.1.2), although no farms were recorded in the area.

IV

CONCLUSIONS

The forest is a complex entity with significant impacts on archaeological discovery strategies, and the survival of earthworks. It is a dynamic environment, subject to multi-temporal transformations – in the short-term, in accordance with the changing seasons, or over several decades as regards wood production, for which both young and mature trees are selected, depending on purpose. Finally, patterns of afforestation and deforestation can define woodland for centuries, opening or enclosing the landscape. The dynamics of the forest environment must be acknowledged to allow for thoughtful data acquisition, fieldwork, analysis of historic and contemporary resources, and to improve understanding of the landscape. This multi-temporality of the forest is an omnipresent theme in this volume, providing a demystification of the longevity of extensive woodland in Polanów. While change in levels of afforestation and its patterning opened up once afforested land E-SE of *Raderang*, extensive planting elsewhere took in large areas of former fields and pastures. The latter process accelerated exponentially in the post-World War II reality and historic maps offer a means to expose the myth of unchanged natural woodland in Western Pomerania.

This evidence presented in this volume demonstrates that under the canopy there are remains of a world which came to a rapid halt in 1940s, however, it was under continuous transformation over the centuries prior to World War II. Newcomers, unaware of the traditions of the region responded to the local environmental and settlement conditions with new energy but also in a way that led to extensive abandonment of isolated farms. However, these farms, scattered across the study area, were not well-established. Indeed, most of these isolated farmsteads were occupied only for several decades before World War II, and fell into ruin after the war. There are, however, some settlements that survived the turmoil of mid-20th century migration, and are still occupied, while newly constructed buildings are rare. In between these late modern structures, enclosed by the accompanying remains of field system, there are also traces of older settlements. Integrated methods of archaeological prospection allow for the identification of early

modern farmsteads, cultivation remains, production sites, and transportation networks. These are situated both within present-day woodland and beyond it. Most of the features identified during the survey project reported on here were previously unrecorded, and often lay beyond the scope of traditional Polish archaeology. This volume hopes to increase awareness of such features, responding to the lack of interpretative frameworks by presenting a model that can be used to explore the landscape history of forests across Pomerania and beyond.

The work reported on here demonstrates that the woodland, which covers a third of Poland is poorly understood and underrepresented archaeologically but is nonetheless abundant with modern earthworks, amongst which late modern features dominate. Nevertheless, areas of continuous afforestation do indeed represent lower numbers of modern monuments. However, if there are any archaeological features within well-established woodland, these are often well-preserved as they lie beyond the reach of late modern cultivation. This brings with it the higher probability that older earthworks also survive within such forest in comparison with other unforested areas. Indeed, prehistoric and early medieval earthworks, identified through interpretation of ALS derivatives generally concentrate within the continuously afforested central part of the study area (Banaszek, 2015a). Nonetheless, clusters of substantial, prehistoric and early medieval barrows have also survived within fields that were cultivated throughout the late modern period and were turned into woodland only recently (Figure 76). While the pattern of their survival is interesting, it lies beyond the scope of this survey.

The ongoing afforestation of once arable land creates additional problems for archaeological prospection and landscape research. Identification of earlier earthworks in marginal zones of late modern cultivation and settlement offers only a limited view on the past landscape that is now forested. Although the numbers and variety of monuments are quite high both within the well-established forest, and within the areas that were afforested in early 20th century as well as immediately after World War II, archaeological evidence within new forest stands is significantly lower and uniform. Within land afforested during the last 20-30 years the remains of very recent cultivation dominate, while ruins of deserted farmsteads that are tucked in the corner of once arable land are still substantial (Figure 37). Here, the mechanised agriculture of the late 1900s caused almost complete levelling of earlier archaeological remains and, to a large extent, natural landforms (Banaszek, 2015b). Thus, the utility of ALS for this type of areas is limited. Although the method is extremely effective for surveying woodland, and this volume demonstrates it clearly, the levelled character of any potential features makes them invisible in this data. Since aerial reconnaissance has limited effectiveness in afforested areas and the use of geophysical survey is restricted by the density of the dominant tree species and understorey, newly-established forest stands are impenetrable. In addition, these areas

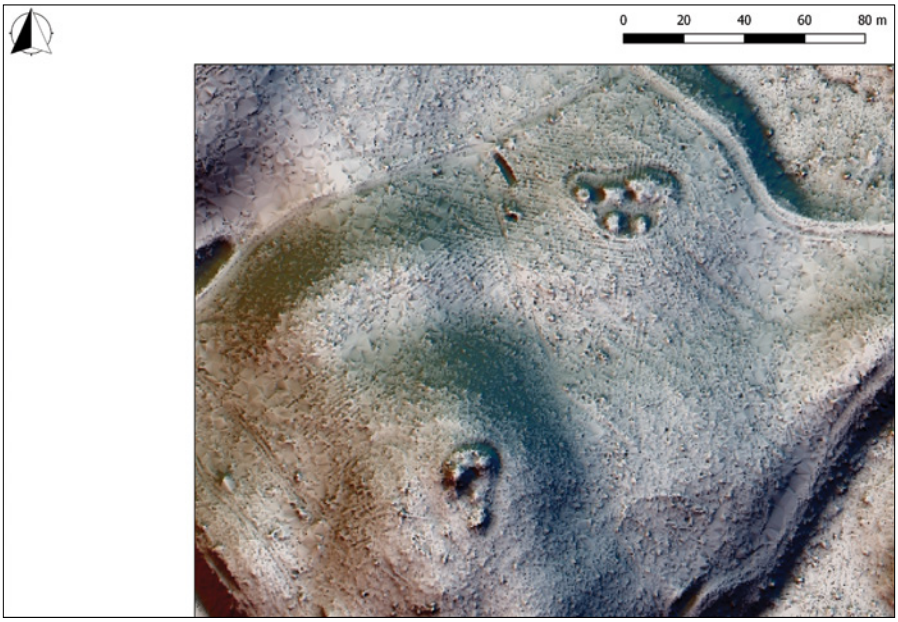

Figure 76. Two clusters of barrows survived within an area that was continuously unforested at least from the late 18th century and was only afforested in the post-war period. ALS-derived DTM visualization: sky-view factor superimposed on hill-shading from multiple directions (Red – channel 14; Blue – channel 1; Green – channel 3).

are also inaccessible for traditional field-walking, not only physically but also since there are no surface finds due to lack of ploughing. In fact, Table 7 demonstrates that several sites discovered in late 1980s and early 1990s have been afforested since. Thus, if a levelled site within arable land was not identified through field-walking survey, and the land was afforested more recently, the chances for future discovery are slim. Although the AZP programme produced results of variable quality, it allowed for identification of sites that would not be observable today due to afforestation. Hence, while integration of various datasets is required to better understand the landscape, by acknowledging advantages and disadvantages of each method bias in the record can be limited.

In a similar fashion, this volume highlights the value of multiple sources of evidence for the verification of information derived from individual datasets and estimating the quality of information. The interpretation of ALS derivatives makes it clear that the historic maps are high quality. Despite the fact that imprecise instruments used by map makers a few centuries ago led to displacement of individual features in terms of absolute location, the level of detail of the historic maps used throughout the volume is excellent, and so is the relative location of the mapped elements.

This volume offers a view of an extensive landscape, full of early and late modern features, now almost completely enclosed by the forest. In taking a landscape perspective, this approach moves beyond simply adding dots to a map, a common feature for many regional surveys in Poland.

The abundance and variety of the identified archaeological monuments is in marked contrast to the limited pre-survey picture of this area. Some of the substantial monuments produced deep scars in the land, and extend to a few dozen kilometres, while other are rather small, faint, and relate to every-day activity repeated through time. Altogether these features represent the second last layer in the palimpsest of the area, which ended in the aftermath of World War II. This volume serves as a form of guidebook to reveal the early and late modern monuments in Polanów, and provides a model to untangle similar complex landscapes elsewhere in Pomerania and beyond.

It is time for the post-war generations of West Pomerania, and other settlers of the Recovered Territories, to acknowledge the early and late modern roots of the land in which they dwell, and to which they add their own layers. Although notably altered as a result of the post-war migration, landscape transformations, which took place through the few centuries prior to the migration, are still largely responsible for the character of the land.

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This book [...] posts a benchmark methodology for future studies.
Dr Piers Dixon

Łukasz Banaszek is archaeologist and remote sensing mapping manager at Historic Environment Scotland. Born and raised in West Pomerania, Poland, he has been exploring the vast woodlands of Pomerania since he could walk. The development of airborne laser scanning has offered him additional means to engage with the afforested remains of a world that underwent dramatic population exchange in mid-20th century. He integrates remote sensing data with other, traditional, resources, and traces the modern evolution of the landscape. His work has uncovered the transformation of the area south of Polanów into sparsely populated woodland, which reflects changes observable elsewhere throughout West Pomerania.

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