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An attempt to reconstruct selected elements of the original site topography of the Teutonic castles at Unisław and Starogród (Chełmno Land, Northern Poland) based on archaeological and cartographic data

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Abstract. The article presents an attempt to reconstruct the original site topographies of 13th-century Teutonic castles at Unisław and Starogród, which have not been preserved in the surface terrain. The archaeological remains of both castles are located in the west of Chełmno Land, on the edge of a moraine plateau 30 to 50 metres above the floor of the Vistula valley. The reconstruction used a research approach known as Historical GIS (HGIS), which, besides archaeological data, employs digitised historical cartographic sources. The research showed that changes in the original site topography are associated with anthropogenic transformations in the plateau surface, mainly due to agricultural use, and with retreat of the plateau edge resulting from natural and man-made landslide processes. The authors believe that the reconstruction of the castles' original site topographies could be used to verify detailed hypotheses related to the conditions of their construction and operation.

Key words:
topographic reconstruction,
Teutonic castles,
Chełmno Land,
Historical GIS

Introduction

One characteristic feature of Chełmno Land's landscape is its Teutonic castles, built between the mid-13th and latter 14th centuries. They were erected in places of strategic significance to the State of the Teutonic Order. The first of this kind of masonry-wall buildings were typically irregular and multi-sided (such as the castle at Starogród). In the last quarter of the 13th century, alongside the irregular castles, rectangular strongholds and small fortified houses (such as the castle at Unisław) began to be built.

The state of preservation of the Teutonic castles is very varied. Some are easily observable on the ground. The layout not only of the high castles, but also of the baileys, is discernible. However, most of them have been partially or completely destroyed.

The research presented is part of a broader research project, entitled "Castra Terrae Culmensis – na rubieży chrześcijańskiego świata" ("Castra Terrae Culmensis, at the edges of the Christian world") and being undertaken in the period 2016–2019. The interdisciplinary studies relate to five Teutonic castles, namely those at Bierzgłowo, Papowo Biskupie and Lipienek, in addition to the ones at Unisław and Starogród. Their objective is to provide a comprehensive treatment of issues related to their construction, topography, layout and operation.

Among the aforementioned buildings, the castles at Unisław and Starogród are distinguished by their particular siting, which in Polish castelology is termed "wyżynno-cyplowe" (Guerquin 1984, p. 16–22) (*transl.* upland headland: this term is not used here because the Unisław and Starogród sites, although overlooking lower terrain, do not meet the criteria for definition as uplands, being markedly

lower than the Polish limit of 200 m above sea level, and are technically lowlands). They are also distinguished by their not having been preserved in the terrain surface, and their shape and layout have never previously been identified.

The objective of the present study is to attempt to reconstruct the original site topography of the castles at Unisław and Starogród. The research was undertaken as a direct result of archaeological work undertaken at their sites. These revealed, among others, that the preserved remains of the high castles, in the form of foundation walls or trenches, were damaged by landslide processes of natural and man-made origin and that their surroundings had undergone significant changes.

The research work employed the research approach known as Historical GIS (HGIS) (Rumsey and Williams 2002), which, in addition to direct archaeological data from excavations, uses digitised historical cartographic sources.

Study area

The archaeological remains of the Teutonic castles at Unisław and Starogród are located in the west of the historical Chełmno Land (Fig. 1), which is bounded to the west by the Vistula river (Biskup 1961). According to the classification of physico-geographical regions (Kondracki 1998) this lies in the Chełmno Lake District, on the border with the Lower Vistula Valley (Fig. 1A). In geomorphological terms (Fig. 1B) it is on the edge of the Chełmno Plateau (Niewiarowski 1959; Molewski and Weckwerth 2017). The moraine plateau is separated from the erosionally-widened Vistula valley floor (known as the Unisław basin) by steep slopes of between 30 and 50 metres in height. The basin floor mainly comprises biogenic plains. One characteristic feature of the valley slopes is that they are cut into by numerous small denudational-erosional valleys, which vary in length from several hundred metres to several kilometres.

Typologically, in terms of original topography and local morphography (Molewski 1994) the sites of both castles are quasi-peninsular plateau-edge sites of outstanding defensive value (Fig. 2). The quasi-peninsular sites of both castles are the result

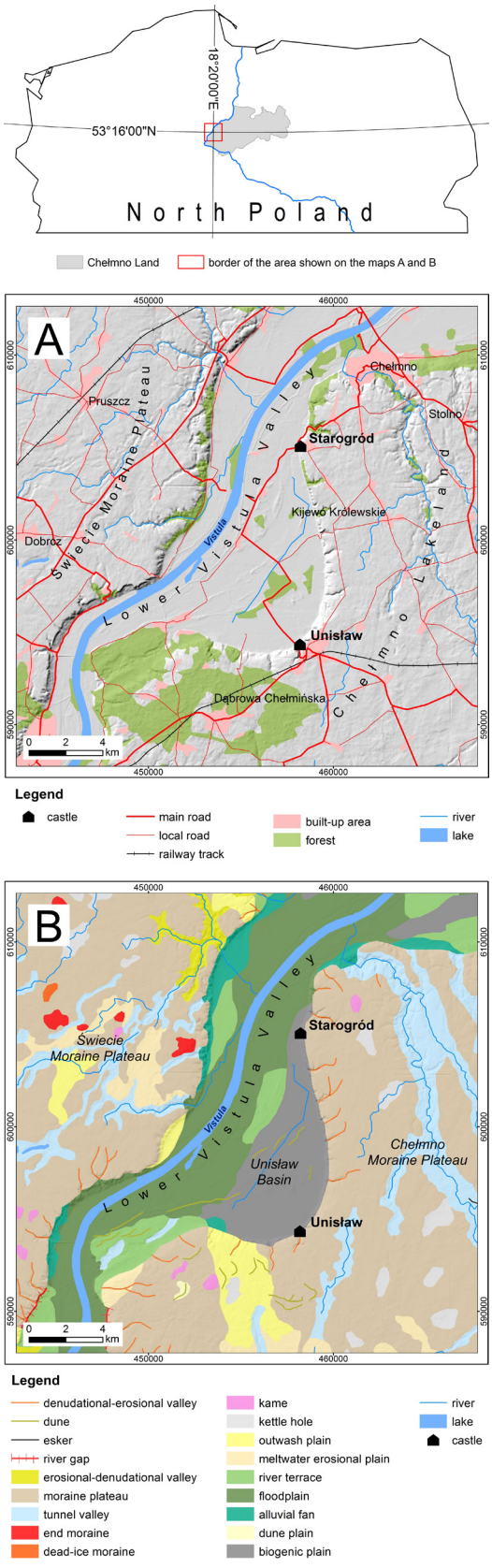

Fig. 1. Castle sites at Unisław and Starogród: A – general geographic map: B – geomorphological map (after Molewski et al. 2015)

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of the slopes of the Vistula valley being cut into by denudational-erosional valleys around the sites.

The high castle at Unisław (or, to be precise, the place where the stronghold previously stood) is located on the very western part of a WNW–ESE-lying quasi-peninsula in a denudationally-lowered, flat moraine plateau (Fig. 2A). The plateau quasi-peninsula stands 71–77 m a.s.l., i.e. around 30–35 m above the Vistula valley floor. Its slope angle is predominantly between 30° and 45°, reaching up to 70° towards the very top. The uppermost parts of the slope form an almost vertical wall in places, revealing the plateau's geological structure. The north-western slope of the quasi-peninsula has stepped terraces. To the east of the high castle and within the quasi-peninsula there were two baileys. To its northeast, at the base of another plateau quasi-peninsula, there are the remains of a fortified settlement dating to the 10th or 11th century. Today, the southern and western slopes of the quasi-pen-

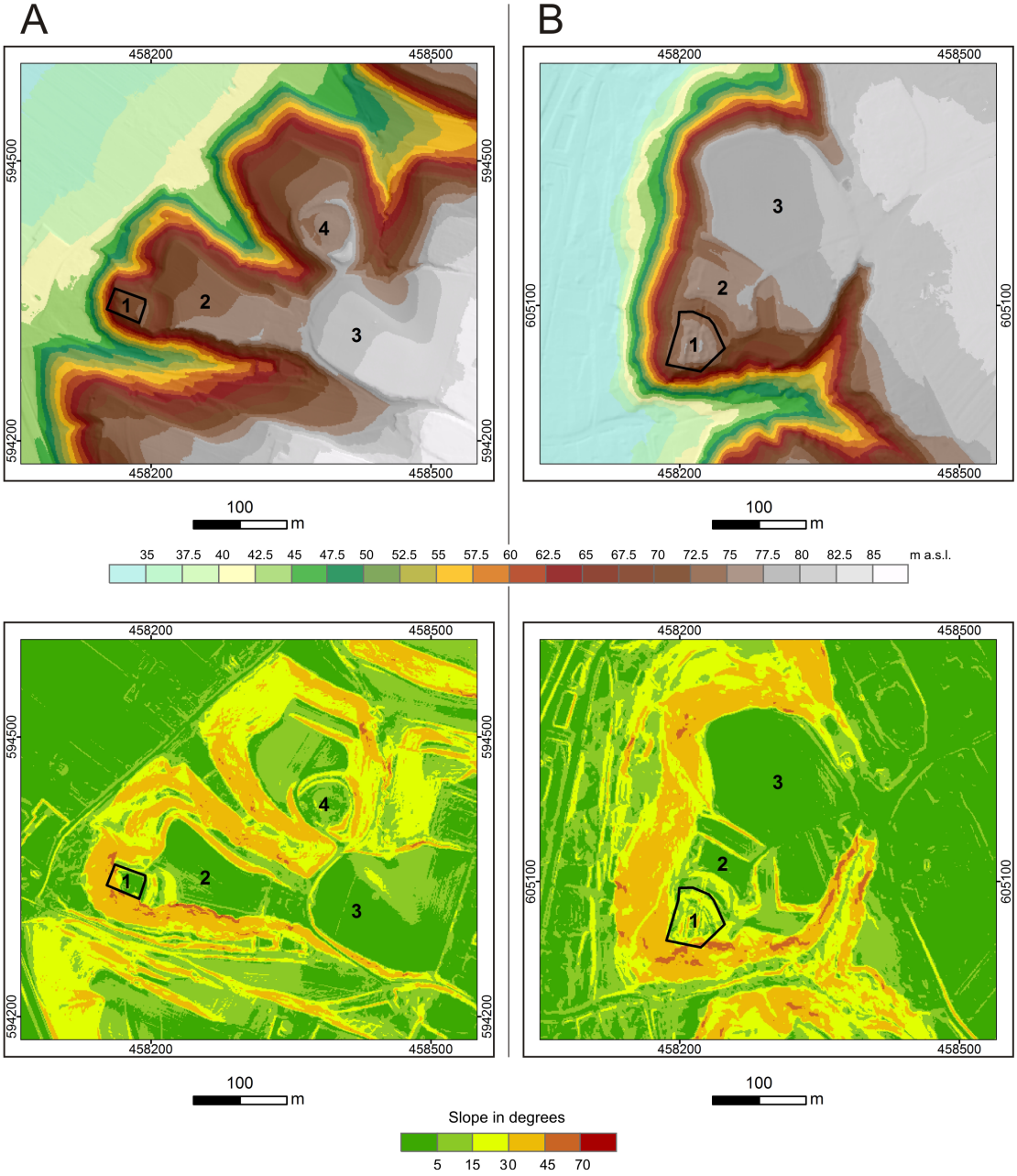

Fig. 2. Landform and slopes at the castle sites: A – Unisław: 1 – castle; 2, 3 – baileys; 4 – 10th/11th-century fortified settlement; B – Starogród: 1 – castle; 2, 3 – baileys

insula are overgrown with grasses and occasional clumps of trees or shrubs, while the northern slope is wooded.

The remains of the high castle at Starogród are located in the south-western part of a moraine plateau quasi-peninsula which stands 75–80 m a.s.l., i.e. 40 to 50 m above the Vistula valley floor (Fig. 2B). Its slopes, as at Unisław, are predominantly between 30° and 45°, reaching up to 70° in places. To the northeast of the high castle there were two baileys. Today, the northern and western slopes of the quasi-peninsula are overgrown by woods, and the south slopes by grasses and shrubs.

Materials and research methods

Digital and analogue data were obtained for the research. The digital data were: the Topographic Objects Database (BDOT – nominal scale 1:10,000), a Digital Elevation Model (DEM) from an Airborne Laser Scanning (ALS) of resolution 1×1 m (CODGiK), and geological borehole profiles from the Central Bank of Hydrogeological Data (Bank HYDRO).

In order to determine the geological structure of the vicinities of the castles the Unisław sheet (281) of the 1:50,000 *Detailed geological map of Poland* was used (Kozłowska and Kozłowski 1988, 1990).

The basic sources of data on topographic changes for the castle sites at Unisław and Starogród were the latest archaeological studies, including the results of geodesic measurements. The topographical changes identified in the archaeological studies were cross-referenced against the oldest historical maps. A query was conducted which showed that only the 1:25,000 German topographic sheet map known as the "Messtischblät" was of (limited) usefulness. This is due to its relatively large scale (which displays terrain features of five metres in length or width), and to its presentation of relief using contour lines, its clear legibility and its accuracy (Jankowski 1961). Two Messtischblät sheets issued in 1906 were used – those for Chełmno (Culm 2676) and Unisław (Unislaw 2776).

The rectification of analogue maps and the integration of all geospatial data were performed on the GIS (Geographic Information System) platform software and using Poland's national geodetic coordinate system CS92 (EPSG 2180).

The original site topography of the castles was reconstructed by modifying the digital elevation model of the analysed area using the collected data (Fig. 3). The procedure comprised several stages:

- generating a raster digital elevation model of the analysed area from airborne laser scanning data,
- superimposing on the elevation model a topographical data layer derived from cartographic materials including historical maps, archaeological studies, field observations and interviews and expert historical knowledge of the topography of the Teutonic castles,
- deleting the contemporary elevation data from those parts of the raster digital elevation model where there were changes in relief of relevance to the study,
- in parts of the elevation model where contemporary elevation data had been deleted, inputting elevation points taken from geodetic measurements gathered from: archaeological studies; selected relief features from historical maps; and hypothetical

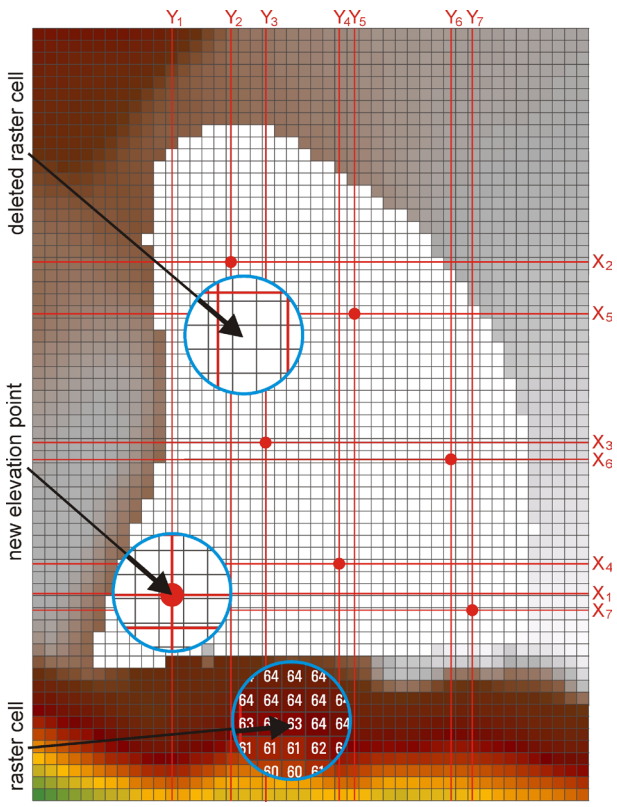

Fig. 3. Method used for modification of the digital elevation model (DEM)

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elevation points assumed for general topographical changes in the research area,

- interpolating all elevation points and creating a modified raster digital elevation model for the relief of the castle sites.

Results

The castle at Unisław

The castle complex at Unisław comprised three parts; namely, the high castle and two baileys (Fig. 4A). Bailey 1 (the inner bailey), of about 0.7 ha, is approximately trapezoid and aligned NW to SE, with approximate dimensions of 120×90×50 m. About 4 m below the north-eastern and north-western edge of the area of the bailey there is a terrace of approximately 5 to 13 m in width. The terracing is most probably associated with the bailey and part of a double line of defence which was created on the side facing the abandoned 10th/11th-century fortified settlement and elsewhere. Interviews with local inhabitants indicate that in the early 20th century the bailey was still separated from the east by a preserved earth embankment with a moat on both its internal and external sides (Fig. 4B). To the south the embankment turned westwards and ran parallel to the escarpment. Bailey 1 was effectively protected from the east (the most easily accessible side, where the entrance probably was) by a moat, a large earth embankment, a second moat, and probably a second, smaller embankment around the bailey. A small rise at the south-east edge of the bailey may be the remains of this embankment.

Bailey 2 is to the east of bailey 1. It covers about 0.8 ha and is roughly oval, with its longest axis running NW–SE. It is about 120 m in length, and 80 m at its widest. To the east and northeast it is surrounded by a single moat of approximately 30 in width, which is now only poorly discernible in the relief.

The final and main part of the castle complex is the high castle, which is built to a rectangular plan with its entrance from the southeast. To the east it is protected by the 30-m-wide moat. Its bed was originally about 1.6 m lower than today, i.e., about 6.4 m below the level of the castle entrance (Fig. 4B).

The reconstructed line of the high castle walls proves that its 26-m-long north-western wing and part of the south-western wing extended 16 m beyond the present-day edge of the plateau quasi-peninsula slope (Fig. 4A). Changes in the location of this edge in the vicinity are documented by the 1906 German topographic map (Fig. 5A). At the site of the castle, the western edge of the plateau quasi-peninsula has retreated about 25 m since the beginning of the last century, and by 15 m within the denudational-erosional valley which cuts into the plateau quasi-peninsula to the south (Fig. 5B). Nearby, the preserved location of the north-eastern edge of the plateau quasi-peninsula suggests that the rate of degradation has been moderate there. However, the lack of older detailed relief maps means that the exact position of these edges during the construction and operation of the castle in the Middle Ages remains hypothetical.

The extent of the retreat of the slopes of the plateau quasi-peninsula show that it was undoubtedly the result of landslide processes *sensu lato*, and shearing slides in particular (Kleczkowski 1955; Kowalski 1988). The tall, steep slopes of the Vistula valley are, after all, predisposed to the occurrence of such processes (Ilcewicz-Stefaniuk and Stefaniuk 2007).

Towards the end of the Pleistocene these processes were primarily associated with fluvial erosion and undercutting of the valley slopes by the waters of the Vistula. The river's lateral erosion widened the Vistula valley at that time to create the Unisław Basin. Today also, the most substantial landslides occur where the Vistula channel runs directly along the foot of the valley slope, including around Grudziądz and Świecie (Banach 1998; Tyszkowski 2014). However, in most of the smaller landslides, groundwater outflows in the slopes and precipitation and meltwater are the predominant factor. Underground waters change the structure and weight of the ground, while precipitation and meltwaters reduce cohesion (in the case of cohesive rocks) and increase the weight of sediments (Kleczkowski 1955).

The geological structure of the slope at the castle site can be observed directly only in its uppermost parts where there is exposed till, which is light

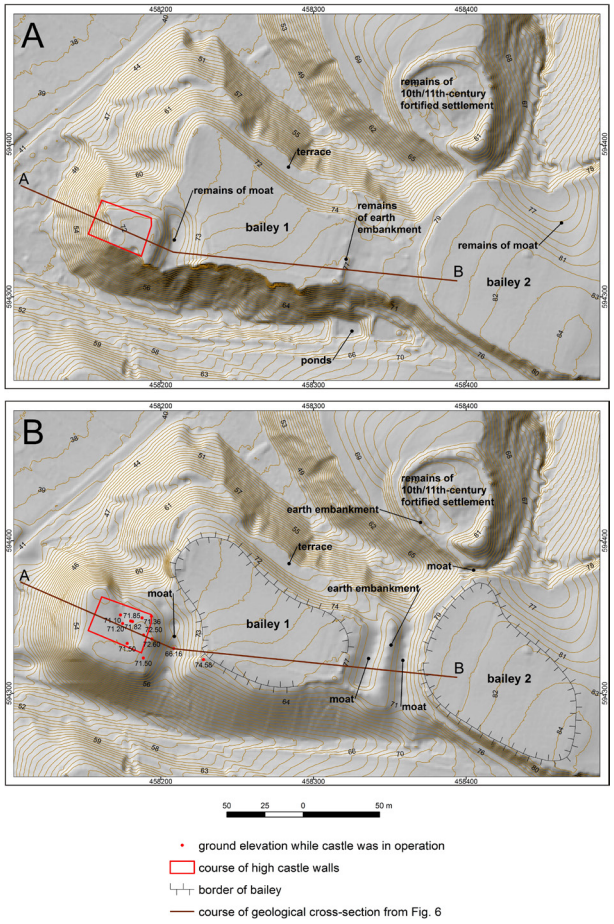

Fig. 4. Attempted reconstruction of the topography of the castle at Unisław: A – digital elevation model of the present-day surface; B – digital elevation model of the reconstructed surface

brown and weathered towards the top, and sandy in places. It forms a near-vertical wall of between 2 and 6 m high. The remainder of the slope has a one- to several-metre-thick cover of denudational deposits (predominantly colluvium). The structure of the lower slope can be deduced from geological maps (Kozłowska and Kozłowski 1988) and archival borehole profiles from the higher non-denuded moraine plateau, the lower part of which forms the plateau quasi-peninsula on which the castle is located. This plateau is at an elevation of 92 m a.s.l., i.e., 15 metres higher. At the surface it is made of Pleistocene formations, i.e. two layers of tills of a combined thickness of 25 to 36 metres, under which there are sands, and sands with gravels, of a thickness of 20 to 30 m, occasionally interlayered with clays. The roof of the sand–gravel deposits lies at between approximately 50 and 60 m a.s.l. Below

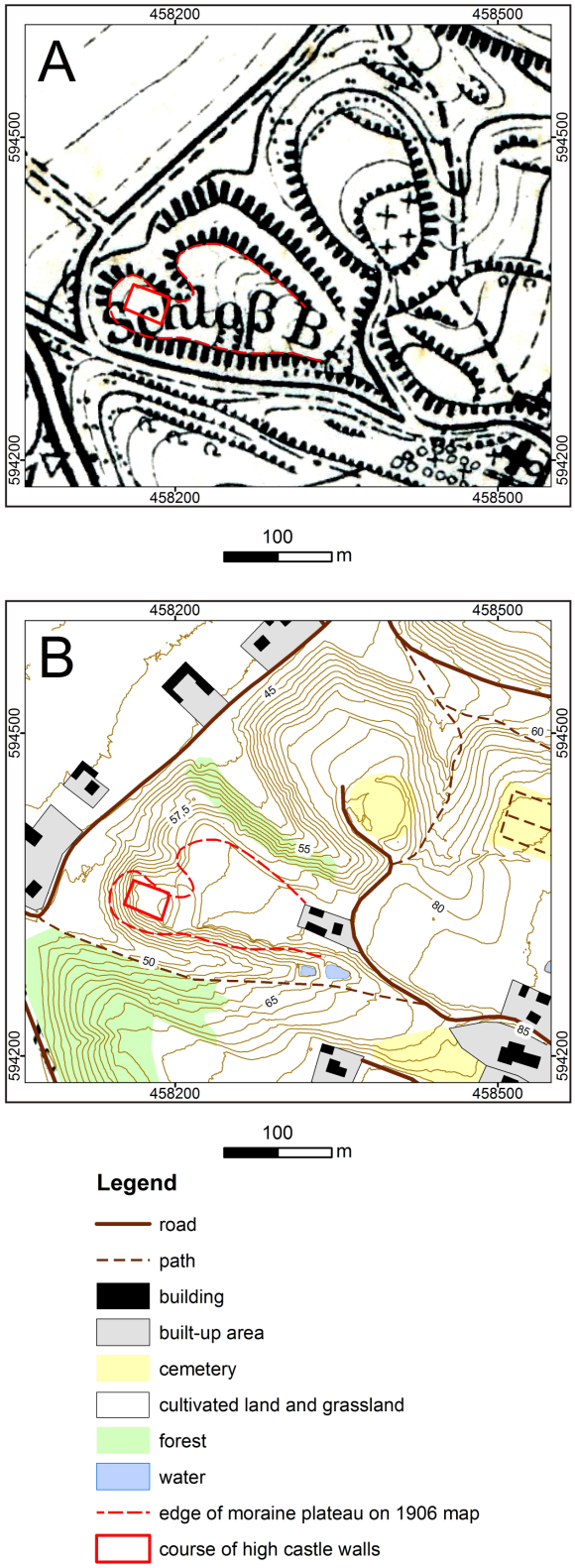

Fig. 5. Change in the reach of the morainic plateau's slope edge at the site of the castle at Unisław: A – 1906 German topographic map (known as the "Messtischblät", at original scale 1:25,000); B – contemporary topographic map

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these deposits there is a further layer of tills of several to about ten metres thick.

Other than the aforementioned natural morphogenetic processes, anthropopressure (also referred to as indirect anthropogenic effects, Galon 1979) was also responsible for an increase in landslides in the lower Vistula valley in the present case. Field observations and interviews with local inhabitants revealed that the retreat of the slope on the west of the plateau quasi-peninsula was caused by the extraction of the sand–gravel deposits underlying the till (Fig. 6). As has been established, this extraction began in the early 20th century, and the aggregate obtained was used to dry out local floodlands and for construction. As a result of the undercutting of the lower slope and undermining of its stability, successive landslides occurred until extraction was discontinued in the mid-20th century. Alongside the progressive extraction of aggregate, another fundamental cause of the landslides was also the original burden on the slope of the high castle's remains.

Landslides on the valley slope in question are still occurring, although their dynamics are limited. Comparison of contemporary cartographic material against a 1:10,000 topographic map from the 1970s shows significant changes in the location of the slope edge. However, the activity of landslide processes at the castle site is indicated by the at-times vertical walls of the upper slope and small slumps and landslide circuses in the slopes (Figs 7A and B). Landslide processes are slowed to a small extent by vegetation cover. The relative stability of the north-western slope of the quasi-peninsula is probably due to its having been terraced, which eased the load of the upper part by removing overlying deposits.

The castle at Starogród

The castle complex at Starogród, similarly to that in Unisław, comprised three parts; namely, the high castle and two baileys (Fig. 8A). Bailey 2 (the outer bailey) was separated from the plateau by a dry moat of about 35 m wide which took advantage of natural depressions in the form of small denudational-erosional valleys. These were shielded by an earth embankment which is preserved as a slight rise in the ground along the eastern edge of the bailey. The bailey, which is partially oval, lies on a NW–SE axis. It is about 225 m long and 140 m at its widest point and covers an area of around 2.3 ha.

Bailey 1 (the inner bailey) was significantly smaller (about 0.3 ha) and was polygonal, running along a NW–SE axis. It was about 90 m long and about 35 m wide. It was separated from bailey 2 by an approximately 25-m-wide dry moat which is still visible in the terrain. To the south, the moat connects to a terrace of maximum width around 25 m lying 5 m below the ground level of the bailey (Fig. 8A). Historical sources (Inwentarz dóbr biskupstwa... 1927) show that at the end of the 17th century a garden was established in the moat between the baileys and on the southern slope. It was an Ital-

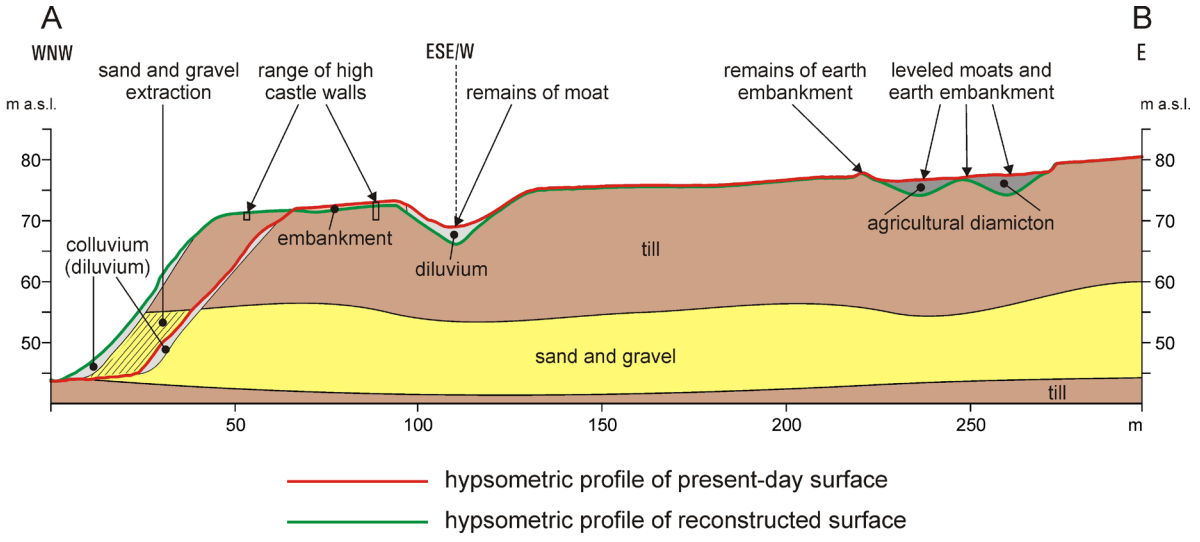

Fig. 6. Model of geological structure and main transformations of the quasi-peninsular plateau site of the castle at Unisław

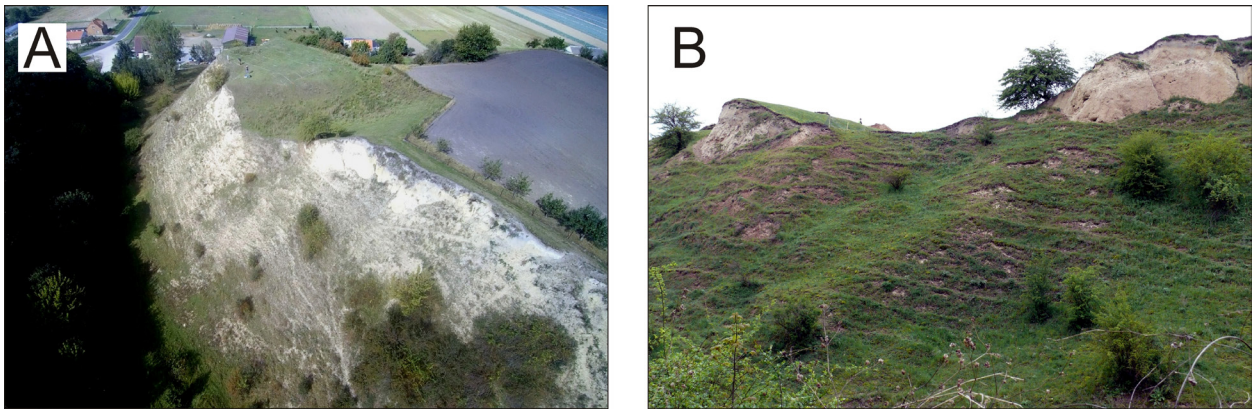

Fig. 7. Plateau quasi-peninsula in Unisław: A – castle site with denuded south-western slope; B – natural uncovering of tills and small slumps in the slope

ian-style garden, and so created on level ground. It is probable that the creation of the garden was the impetus for building the terrace, which was further extended as a result of the later agricultural use of the land. And so the terrace did not exist in the original topography of the castle, and the edge of the quasi-peninsula's slope approximately coincided with the southern edge of the baileys (Fig. 8B).

The final part of the castle complex was the high castle. It was separated from bailey 1 by a dry moat of about 15–20 m wide which is still discernible in the ground relief. The original stronghold was built to a pentagonal plan, with an entrance leading from the northeast.

The reconstructed line of the high castle walls in Starogród indicates, that its south wing and part of the south-east wing, of a combined length of 60

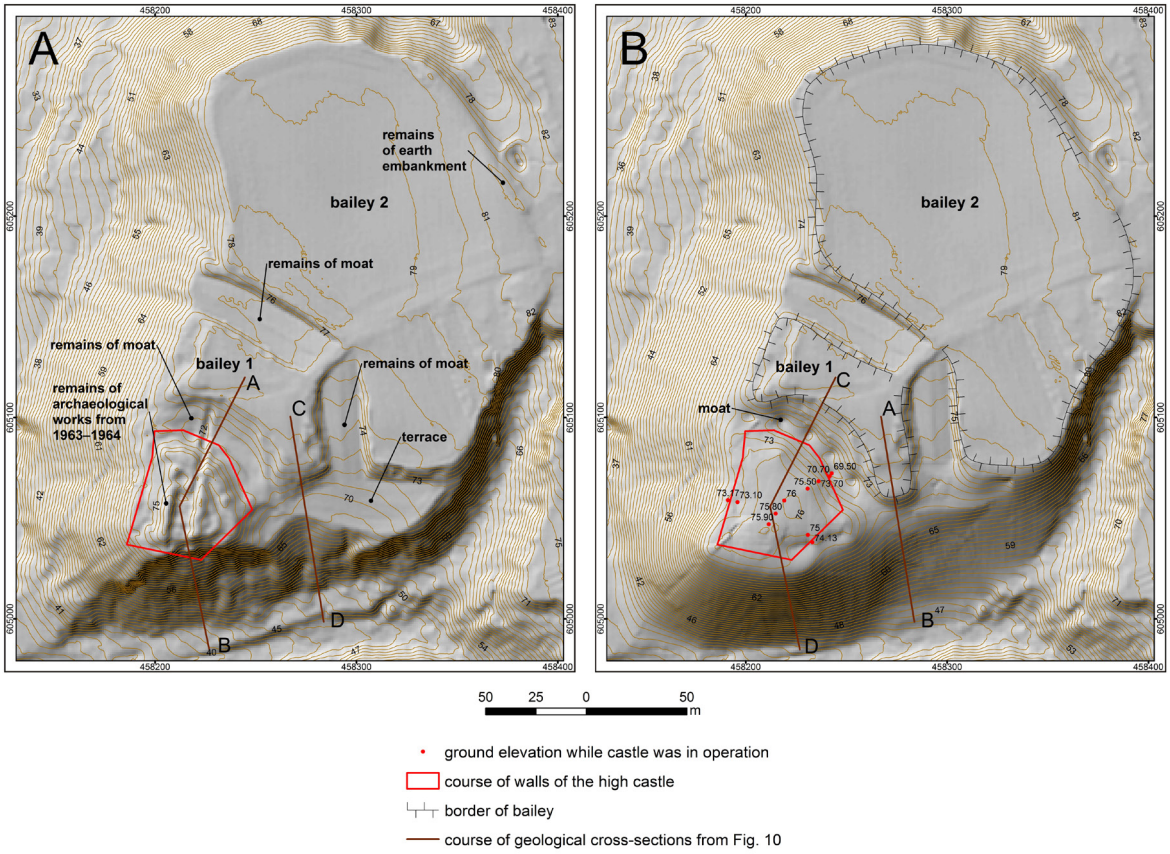

Fig. 8. Attempted reconstruction of the topography of the castle at Starogród: A – digital elevation model of the present-day surface; B – digital elevation model of the reconstructed surface

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m, extended beyond the present-day edge of the plateau quasi-peninsula slope. Analyses of the early-20th-century German maps show that since then most of the changes which have occurred in the reach of the quasi-peninsula's edge have been in its southern part (Fig. 9). However, these changes create significant problems of interpretation. At the castle site, the edge on the 1906 map is 10 m from its current location and cuts across the documented reconstructed line of the castle (Fig. 9A). The slope below this edge is labelled on the map as a "long slope", and so of a shallower and probably variable angle. At the same time, the contemporary ground surface where the castle was sited has been heavily re-shaped by earlier archaeological works from 1963–1964. Traces of them can be seen in trenches and embankments which significantly change the topography from what it was at the beginning of last century (Fig. 8A). As already stated, the latest archaeological studies show unambiguously that the original edge of the quasi-peninsula must have been to the south of the southern wing of the castle. Nevertheless, the lack of data makes it impossible to determine what its exact location was in the period of the castle's operation. The inconsistency which has been identified in the location of the edge is probably due to the upper edge of the slope having been marked subjectively and to the accuracy of the historical map, as well as to anthropogenic transformations in the contemporary ground surface.

A probable retreat of the quasi-peninsula's edge is also visible to the east of the castle's location (Fig. 9B). The slope edge on the historical map is, contrary to what natural denudational processes would suggest, up to about 30 m back from its current location. The cited historical sources and field observations confirm that the original slope was terraced in this location in order to make arable land area. As part of creating the garden the original terrace was created by manually transferring material from further up the slope to an adjacent lower part (Fig. 10) (Frederick and Krahtopoulou 2000), and it was later expanded as a result of ploughing (lynchet-row, Spencer and Hale 1961).

In the rest of the plateau quasi-peninsula, changes in the location of the slope edge were mainly caused by natural processes. Since the beginning of last century, the quasi-peninsula's western slope has probably retreated by a maximum of about 10 m.

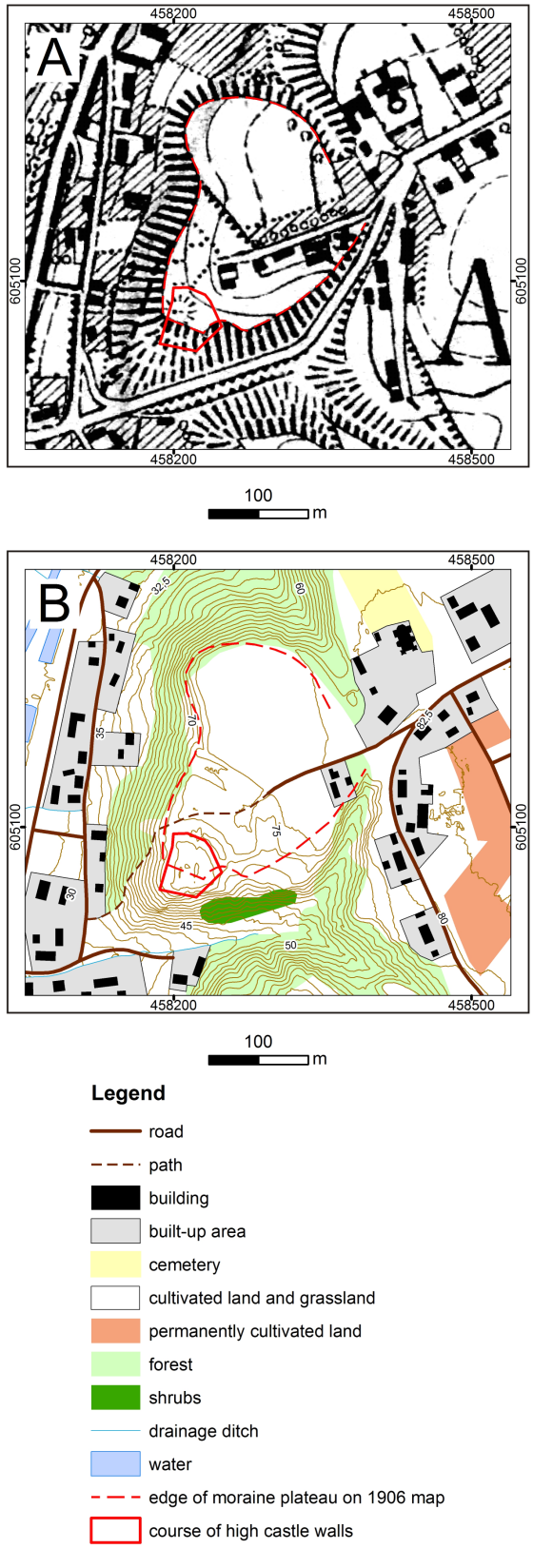

Fig. 9. Changes in the reach of the morainic plateau slope edge at the site of the castle at Starogród: A – 1906 German topographic map (known as the "Messtischblät", at original scale 1:25,000); B – contemporary topographic map

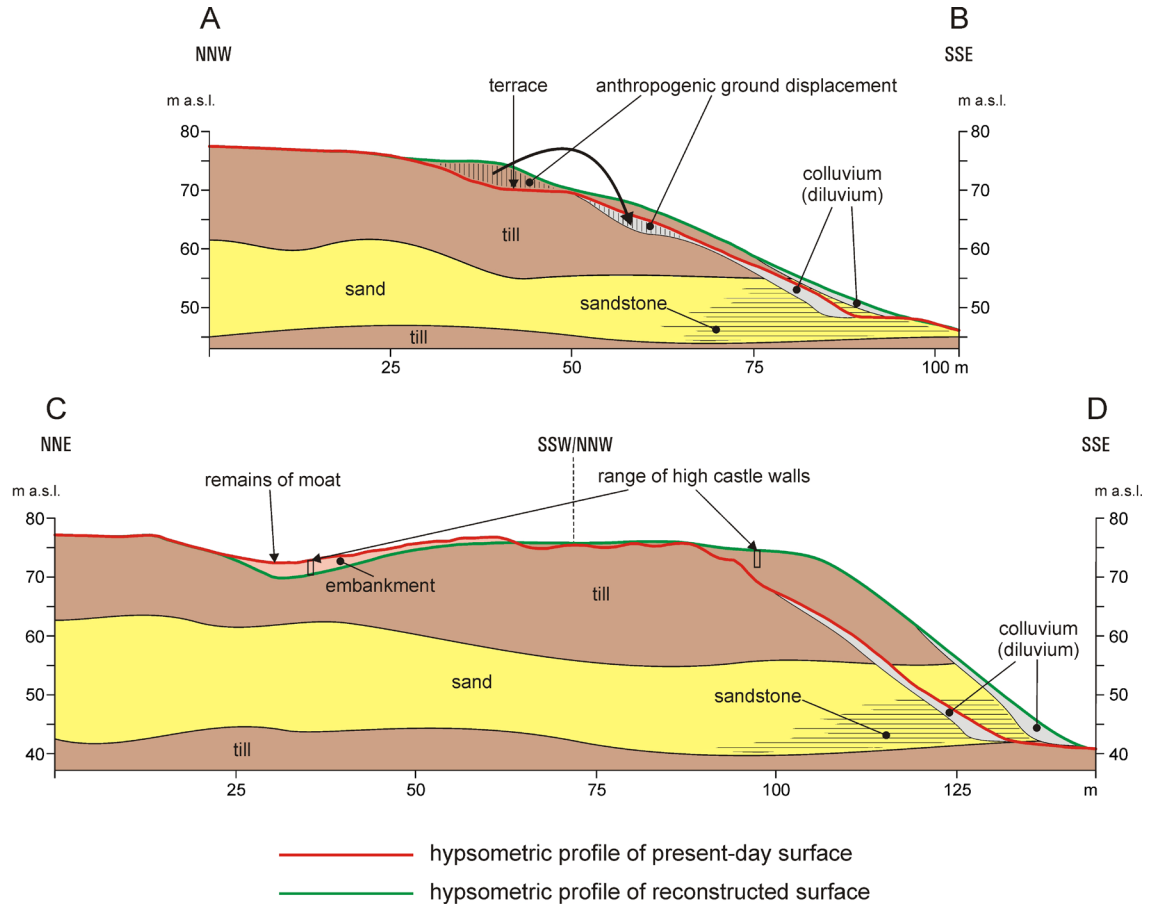

Fig. 10. Model of geological structure and the occurrence of terracing on the south slope of the quasi-peninsular plateau site of the castle at Starogród

Similarly to Unisław, the still-active landslide processes are conditioned by the height and steepness of the slopes, and by their geological structure (Fig. 10 and Fig. 11A). The moraine plateau around Starogród is made of two surface till layers overlying sandy deposits (Kozłowska and Kozłowski 1990). The combined thickness of the tills is nearly 40 m, and of the sandy deposits is 20–30 m. The top of the sands is at 55 m a.s.l. Below these there is another layer of till of about 10 m thick.

The sediments under the till are uncovered in several places in the lower slopes of the plateau quasi-peninsula (Fig. 11B) as fine sands, strongly cemented with calcium carbonate (calcium carbonate

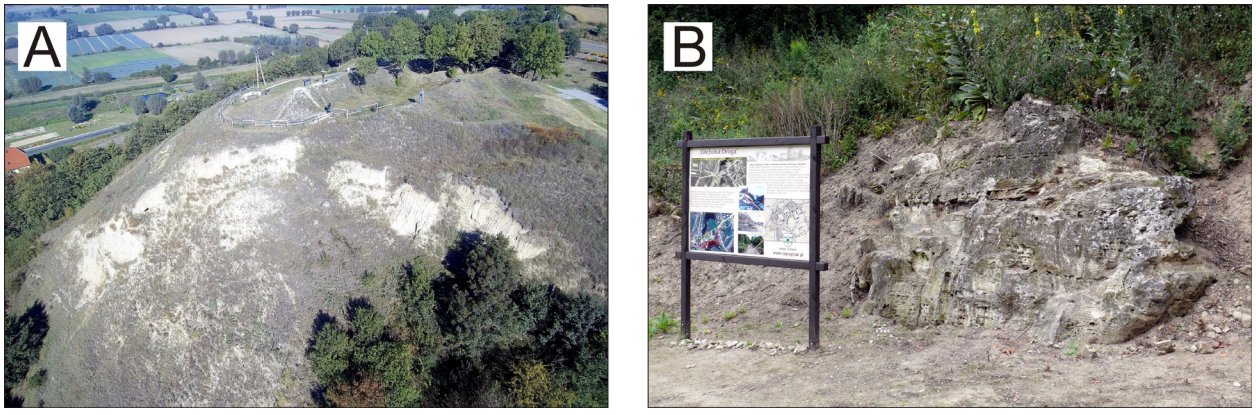

Fig. 11. Plateau quasi-peninsula in Starogród: A – castle site with landslide slumps on the south slope; B – uncovering of Pleistocene sandstones at the foot of the south slope

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contents reach 50%). These are Pleistocene sandstones, which are known in the lower Vistula valley (Drozdowski and Krażewski 1978) but also in other places in the Polish Lowlands (Urban 2000) and so, in this case, they are fluvioglacial deposits cemented with calcite. Therefore, in the case of Starogród, the undermining of the slope's stability and the occurrence of landslides may be the result of chemical suffosion (Kowalski 1988) by the calcareous binding being washed from the Pleistocene sandstones. Additionally, the natural retreat of the slope edge, combined with landslide processes to the south of the southern wing of the high castle, may have been a catalyst to the remains of the castle walls burdening the slope.

Conclusion

The contemporary cultural landscapes of the castle sites at Unisław and Starogród lack their earlier basic features, i.e., the castle complex buildings, including the high castles. However, traces of anthropogenic transformations related to their construction and operation have been, to a greater or lesser degree, visibly preserved in the surface relief. The topographical reconstructions presented here are approximate in nature – especially the topographies of the parts of the castle sites which have disappeared from their original landscape due to natural and anthropogenic morphogenetic processes. The procedure employed, despite its many limitations, represents a first attempt at quantitative reconstruction and is the foundation for the 3D digital visualisation of the castle sites' topography (Fig. 12).

For researchers of architecture and archaeology, observation of the layout of wall remains and their accompanying sedimentary layers alone provides enough information from which to reconstruct topography. Detailed geographic and geomorphological analysis verifies the trustworthiness of such observations and provides significantly greater opportunities to reconstruct the castles and to verify hypotheses regarding the conditions of their construction and any later transformations. In the case of the castle at Unisław, where about one quarter of the terrain has been destroyed, the presented reconstruction shows that the topography on which the

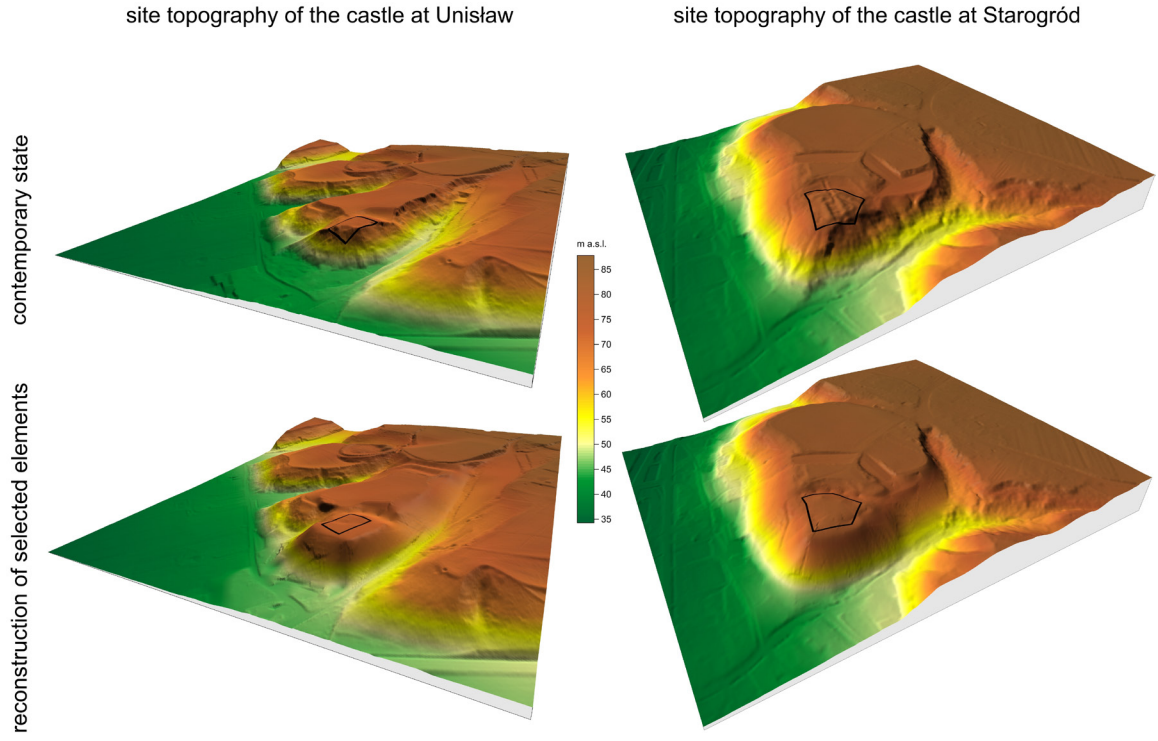

Fig. 12. 3D models of site topography of the castles (black line – course of high castle walls)

Teutonic built their fortress was significantly different from that of today. In Starogród, too, where the destruction was lesser, specialist analyses indicate anthropogenic transformations associated with, among others, the castle owners' modern-day activities. For both the castles, the knowledge of the ongoing destructive geological processes will contribute to a better understanding of the threats to both archaeological sites, and may be a foundation for interventions by heritage protection agencies.

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