REFINING THE LOCATION OF THE BATTLE OF MOHÁCS FOUGHT 500 YEARS AGO AT THE GATEWAY OF THE BALKANS (USING GEOGRAPHICAL METHODS)

DOI: https://doi.org/10.18509/GBP26249g
UDC: 910.2:355.422(439.127-81)"1526"

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ABSTRACT

The collapse of the medieval Hungarian Kingdom was caused by the expansion of the Ottoman Empire in Central Europe. The most important and symbolic event in this series of historical events was the Battle of Mohács in 1526. The battlefield was located on the plain near the River Danube and the town of Mohács; however, the exact central location of the battle has not yet been precisely identified and remains the subject of ongoing scholarly debate. We examine the Mohács Plain using GIS software, historical and modern maps, satellite imagery, hydrological data, and digital elevation models. Based on contemporary descriptions and recent literature we identified various landmarks, geographical objects and measured distances from them. Our results indicate that the centre of the battle arena was located south and east of the village of Sátorhely.

Keywords: Battle of Mohács; battlefield geography; environmental reconstruction; GIS

INTRODUCTION AND OBJECTIVES

On 29 August 1526, the armies of the Kingdom of Hungary led by King Louis II suffered a decisive defeat against the Ottoman forces of Sultan Suleiman I on the Mohács Plain. Descriptions of the structure and movements of the opposing armies are more or less known, but the plain is relatively large and the exact location of the battle has not yet been determined. While in the 18th and 19th centuries the battle was still placed near today's Sátorhely (in the middle and eastern part of the plain), in the 20th century a new location emerged, the village of Majs and the foothills bordering the Mohács Plain to the west [1]. On the 500th anniversary of the Battle of Mohács (in 2026), investigations that clarify the location of the fights are of particular importance.
Research objectives:

- We collected numerous contemporary descriptions and documents relating to the battle, which contain information about the geographical environment. We examined maps from the 16th to 20th centuries.
- We familiarized ourselves with the physical geography of the Mohács Plain by studying geographical literature and conducting field surveys.
- We used cartographic and GIS methods to analyze old maps, digital elevation models, aerial photographs, and satellite images.

- We identified the geographical objects mentioned in the descriptions of the battle and used them to determine the more precise location of the Battle of Mohács.

BRIEF HISTORICAL OVERVIEW

On August 29, 1526, the Ottoman army led by Suleiman I destroyed the Christian army of King Louis II and Archbishop Pál Tomori.
During his long reign, Sultan Suleiman I personally led 13 campaigns, seven of which were against Hungary. He achieved his first significant success with the capture of Belgrade in August 1521. His greatest triumph came on August 29, 1526, on the plains of Mohács, when he dealt a decisive defeat to the Christian forces.
Louis II, King of Hungary and Bohemia, was 20 years old in the year of the battle. He fielded the largest army in Central Europe at the time, but even so, it numbered only 30,000 men against the Ottoman forces of approximately 80,000. He fought bravely in the battle, but at the end of the battle, the king and a significant part of the nobility were killed, and the Ottoman troops ravaged Buda and Pest.
According to eyewitnesses, the battle lasted only one and a half or two hours. The Christian army suffered huge losses, with at least 16,000-18,000 soldiers dying on the battlefield. The Ottoman army lost only 300 soldiers on the site and further 1000 in the next 10 days. [2]
The Ottoman victory broke the Kingdom of Hungary. By 1529, Suleiman was already besieging Vienna.

THE LOCATION AND PHYSICAL GEOGRAPHY OF THE MOHÁCS PLAIN

The investigated area – the Mohács Plain microregion – is located in Central Europe, in the Pannonian Basin, on the Great Plain, next to the Danube River. The study area lies mainly in Hungary, but a smaller part extends into Croatia as well.
During our physico-geographical investigations, we mainly focus on this microregion, but this area has been in constant contact with the surrounding microregions. The boundaries of the investigated area are as follows:

- the edge of the Baranya Hills in the north and northwest;
- in the east, the line of the Mohács-Danube and the Mohács Island;
- in the south, the Karasica Stream and the Bán Hills (Baranyahát);
- in the southwest and west, the transition is gradual towards the Lower Drava Plain.

In the Mohács Plain and its immediate environs, four surface levels can be distinguished by elevation. The geomorphological properties are markedly different from each other:

- lower and higher floodplain levels (Fig. 1 number 1);
- flood-free terrace (Fig. 1 number 2);
- the hilly area bordering the Mohács Plain from the north and west (Fig. 1, number 3).

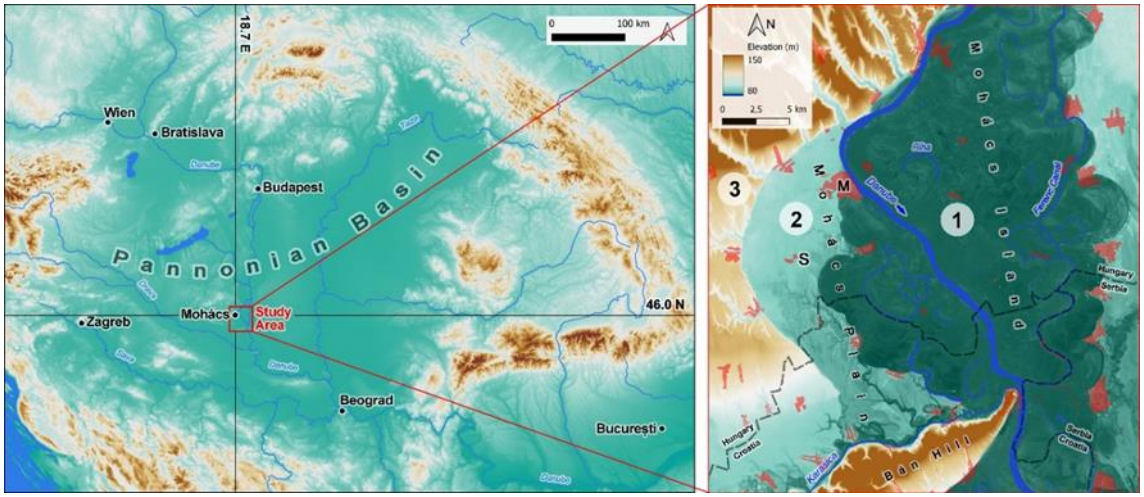


Figure 1. The location of the study area within the Carpathian-Pannonian Basin (A) and its vertical geomorphological levels (B). Legend: 1 = Lower and higher floodplain levels (dark green); 2 = Flood-free terraces (light green); 3 = Hilly areas (brown); M = Mohács; S = Sátorhely

Lower and higher floodplain surfaces

Areas located 5-6 m above the zero level of the Danube (79.195 m above sea level at the Mohács gauge[12]), i.e. at around 84-85 m elevation, are called lower floodplain surfaces. Before river regulations they had been inundated by the Danube even at a slightly higher than mean water level; therefore, they remained dry at low water levels. Such surfaces are of Late Holocene age. Recent backwaters (permanent or temporary oxbow lakes) are characteristic of the surface, which are partly of natural origin and partly formed as a result of river regulations.

From the evidence of the maps drawn in the past centuries, the low floodplain was mostly covered by swamps, waterlogged areas with reed-beds. Fishing and gathering related to the traditional 'notch' economy was typical. The higher ground was used as pasture in the summer. Before the regulations, humans did not settle in these low-lying areas.

The higher floodplain surfaces rise 8-9 m above the 0 zero level of the Danube (i.e. 87-88 m elevation above sea level). Water could only reach them during major floods. The higher floodplain surface can be observed in patches of various size south of Mohács on the inner banks of oxbows, where extensive floodplain forests stand. [3]

The bank stabilization and river regulation works carried out in the 19th century have very significantly transformed the surface of the floodplain. In the area protected by dykes and drainage canals (between the edge of the geomorphological floodplain and the flood-control dykes, in the protected floodplain), since the construction of the protection structures, geomorphic action has been taken over from the river by agrotechnology and today the latter governs landscape evolution.

During our research, we used maps from the 17th and 19th centuries to reconstruct the pre-regulation course of the Danube and other waterways. (Fig. 2A) To reconstruct the course of the Mohács-Danube in 1526 with absolute precision is now almost impossible since fluvial geomorphic action has completely reshaped the floodplain topography since then. Few accurate descriptions and maps of the Danube section between Mohács and Kiskőszeg (Batina) have survived from the period before regulation and flood-control

[12] https://www.vizugy.hu

works. In the course of the research, we performed a comparative investigation of some early map representations in order to locate the course and dimensions of the Mohács Danube around 1685. It can be concluded that the current bed of the Danube between Mohács and Kiskőszeg has little to do with that solely formed by the river before the regulations. When researching the Battle of Mohács, you have to reckon with a narrower, but much longer and more sinuous river bed. [4]

Flood-free terrace

The flood-free terrace is located at an altitude of 90-100 m above sea level, bordered by the floodplain to the east and the hilly area to the west. The flood-free terrace is separated from the floodplain by a steep 4-6 meter high slope on the eastern side. On the western side, a 15-30 meter high steep slope separates it from the hills.

The terrace, covered with fertile soil, is now mainly used for farming. However, we can observe on maps from the previous centuries that in the shallow valleys of the smaller watercourses crossing the loess-mantled terrace, there occurred waterlogged areas, which were predominantly used as pastures. Due to river regulations, the extent of wetlands has been significantly reduced. The major routes ran on the free terrace, such as the thousand-year-old military road along the Danube, on which traffic was only disrupted by streambeds.

Largely due to the work of waters, and to a lesser extent to the wind as geomorphic agents, microforms with a relief of a few meters have been formed on the flood-free terrace. They are either negative or positive features. In its central section the free terrace is ca. 10 km wide, with the Sátorhely ridge in the middle, but other elevations can also be observed in the area.

Today, it is more difficult to detect the differences in microtopography. The excellent, chernozem-type soils formed on the terrace surface are intensively cultivated. As a consequence, the smoothing effect of tillage and rainwater is enhanced. The large-scale field cultivation of the 20th century planated the terrace surface, reducing and eliminating the differences in microtopography, which were extremely important in previous centuries, through tillage operations.

Today the most easily noticeable and most contrasting negative forms can be associated with regulated, channelized streams: the Csele, Jeny, Lánycsók, Lajmér and Borza Streams, which now flow in artificial channels bordered by dykes on the terrace surface. However, their meandering beds active before the regulations can also be observed on contemporary maps or on current satellite images. The beds of the streams crossing the terrace are the widest and deepest along the eastern edge.

Aerial and satellite images taken in times of proper soil moisture content, vegetation cover, and irradiation angle also show microtopography which is hardly noticeable in the field. These include the traces of ancient watercourses, some of which may once drained to the Danube or to other major watercourses. They have been inactive for a long time.

The former, deeper Danube riverbed lying in front of the western hills is also a marshy area. Streams flowing down from the hills have built flat alluvial fans across it. This has transformed it into a series of separate marshy patches of varying sizes, covered with reed vegetation.

We digitized the water levels surfaces? on the Mohács terrace, marshy, wet, inland water areas and wet meadows from maps and satellite images (Fig. 2B). Having surveyed and mapped the swamps, wetlands, and inland water spots, a more differentiated picture of Mohács terrace was achieved. South of Mohács the following areas of larger extension

needed for the Battle of Mohács, and those which remained sufficiently dry even after a prolonged rainy period could be identified at the eastern side of terrace:

- the interfluve between the Bég and Lajmér streams,
- the area east of Sátorhely,
- the area between Udvar and Dályok,
- the area between Izsép and Hercegmárok and
- the area between the Karasica ditch and the Kisfalud (Branjina) Stream.

The western section of the terrace, close to the hills, from Lánycsók to Buziglica, especially the environment of the Majs alluvial fan, was regarded unsuitable for warfare.

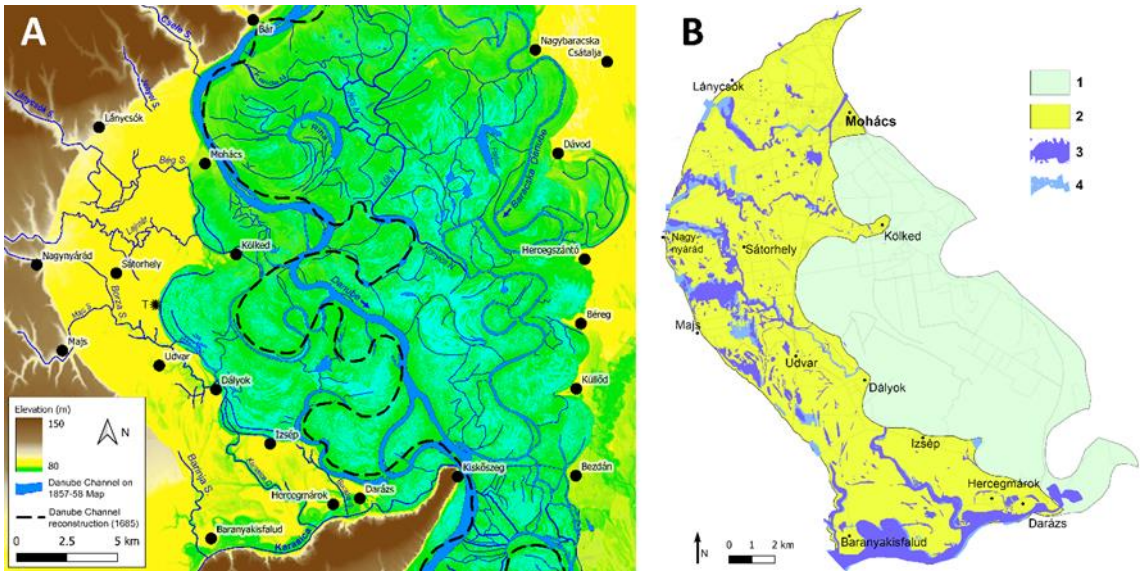


Figure 2. The reconstructed 17th and 19th centuries pre-regulation course of the Danube and other waterways (A). The digitized marshy, wet, inland water areas and meadows from maps and satellite images (B). Legend: C = Canal; N = "Notch"; S = Stream; T = Turkish Hill; 1 = lower and higher floodplain surfaces (in the 16th century mainly swamps); 2 = flood-free terrace; 3 = inland and stagnant water spots, wet areas; 4 = wet meadows

Hilly areas

The hilly area bordering the flood-free terrace to the west and north are genuine hills in the north, while the southern part can be considered more of an alluvial fan plain. This area is covered with thick loess and is mainly used for agriculture. The steep slope between the hilly area and the plains has a height difference of 40 meters in the north and only 10 meters in the south. This steep slope was created by paleo-Danube erosion in the late Pleistocene. Streams flow from the hills to the flood-free terrace, dividing the edge of the hilly area with valleys and forming alluvial fans at the mouths of the valleys. [3]

GEOGRAPHICAL OBJECTS AND SPATIAL DATA THAT ARE IMPORTANT FOR DETERMINING THE LOCATION OF THE BATTLE

The Danube and the transport routes

The main watercourse in the area is the Western or Mohács branch of the Danube. The presence of the watercourse, its water level and its floods have determined the life of Mohács and its surroundings for centuries. The armies marched along the Danube and its floodplains, and the configuration of flood-free and marshy lands, and above all the defensive aspects, were of fundamental significance in their camping. Transport and

warships also used the river. The armies also needed large quantities of drinking water, and the Danube was the best source for this.
In the past, the main branch of the river was the Baracska Danube, which flows along the eastern side of Mohács Island. The eyewitness of the fights, István Brodarics [5] also mentions this in his account of the battle. The Danube splits into two channels just above Báta village. The larger channel splits the Trans-Hungarian region into flat fields, the smaller one washes the banks of Báta and Mohács, and both arms merge below Mohács, forming an island.
The relative dimensions were reversed by the end of the 18th century with the widening of the western branch due to certain tectonic and morphological reasons. The process, which eventually resulted in the Mohács branch becoming wider and the Baracska branch (Ferenc Chanal) narrower, can be traced on maps. During the regulations, the Hungarian section of the Danube downstream Budapest became shorter by more than 100 km (as a result of meander cutoffs). In the study area numerous bends were cut off in the 19th centuries. [6]
Both the Christian and Ottoman armies used the river and the old military route running alongside it for marching and transport.
Suleiman left Constantinople on 23 April. The journey was along the old military route and the troops were accompanied by a considerable flotilla on the Danube after Beograd. The Ottoman army crossed the Karasica Stream, which borders the plain from the south, on August 28, and reached the middle of the Mohács Plain on August 29.
The army of King Louis II left Buda on 20 July 1526 and his troops were stationed in dozens of places before reaching Mohács. The king arrived in Mohács on 25 August. [7]
The Ottoman campaign diary reports several instances of extreme weather conditions (rain, hail) during the journey. Due to the rainy weather, it can be assumed that there were muddy, swampy areas along the streams on the western side of the flood-free terrace. (Fig. 2B) It can be assumed that the Hungarian military leadership therefore designated the eastern side of the flood-free terrace as the battlefield. This choice was reinforced by the military route that had been used here for thousands of years.

Floodplain and swamps along the Danube

South of Mohács, the higher and lower surfaces of the floodplains widen considerably between the Danube and the flood-free terrace. This area was not suitable for battle, but it appears as a landmark in descriptions.
Brodarics described the location of the battle as follows: "As we have said above, this place is a vast, wide plain, not broken by woods, shrubs, water or hills, but on the left, between it and the Danube, there was muddy, marshy water, covered with dense sedge and reeds where many people later perished." [5]
Miklós Istvánffy called it a swampy lake. [8] A Czech source also reported that a deep swamp lay directly next to the battlefield: *"*Many sank in the swamp, one after the other fell into it." [9] Among the Ottoman Turkish chroniclers, Kemalpaşazade also notes [10] that the battle took place west of the Danube marshes. Brodarics, the Czech source and Kemalpaşazade all mention that many Christians perished in this swamp after the battle.
These features fit the marshland on the right bank of the Danube, the so-called Vizslak Meadow.
On the western side of the Mohács plain, there are only muddy, waterlogged areas, but there are no deep swamp where many people could have drowned during the battle.

“Large ditch”

The Ottoman Turkish chronicler Lutfi Pasha also reported on a ditch that started from the marsh and crossed the plain: “… a spy has reported that the unbelievers, besides being so numerous, have dug a large ditch, one end of which stretches up to a hill and the other to the Danube, and it is impossible to pass through it.” [11]

Miklós Istvánffy also stressed the importance of the ‘ditch’ or ‘valley’: “Some of our horsemen retreated into the valley between the hill and a nearby marshy lake…” [8]

Using satellite images and free terrain models, we discovered an ancient river valley. This abandoned, now partially buried river valley, as described above, starts at the marsh and crosses the flood-free terrace in a southeast-northwest direction. Our recent studies, based on a digital elevation model derived from LIDAR data and color-infrared (CIR) aerial photographs, have also revealed this landform, as well as other important landmarks (Fig. 3)

The ditch or valley in question is very different from the meandering valleys of the active watercourses of the plain. The former riverbed, which is nearly 5 kilometres long and 50–70 meters wide, runs in gentle curves of a kilometer scale, may have appeared man-made to those observing the site from a distance. Moreover, in its immediate vicinity, Christian armies did carry out earthwork. This is evidenced by the fact that the mass graves excavated in the 1960s and 1970s may originally have been depressions designed for military purposes. Together, these may explain why the scouts believed the ditch to be artificial. The former riverbed is now only 1 meter deep. In our opinion, the level differences have been evened out mainly due to large-scale agricultural cultivation in the 20th and 21st centuries.

The “large ditch” should not be confused with the traces of 20th-century military trenches that can be seen in the area.

On the western side of the Mohács plain, near the village of Majs, there is no large ditch that matches the descriptions.

The Sátorhely Ridge

In his description, István Brodarics mentioned two other important geographical places in connection with the battlefield, a hill and a village: “In front of us there was a long hill, like a stage, behind which there was the camp of the Turkish emperor; at the bottom of the hill, there was a small village with a church, named Földvár. This was where the enemy set up their canons.” [5] The low, curved hill was the Sátorhelyi-hát (Sátorhely Ridge).

The Sátorhely Ridge played an interesting role in the battle. According to Brodarics, an Ottoman cavalry regiment tried to outflank the Christian army from the west: “… the enemy’s armies in the valley that spread out to our right, under the hills, were moving silently, betrayed only by their spearheads.” [5]

He claims that the soldiers themselves could not be seen, the movement of the Ottoman warriors was revealed by the spearheads and the light reflected by them. The regiment moved to the north behind a low elevation. This low hill was the Sátorhely Ridge, which is only a few meters higher than the plain.

We made a visibility analysis using the QGIS software tool. Using modeling, we determined that if the Ottoman cavalry advanced in the Borza stream valley and under the cover of the Sátorhely ridge, only the tips of their spearheads would have been visible, as the terrain provided 3–4 meters of cover. [12]

The hills around the village of Majs correspond in some respects to the eyewitness description, but they do not meet all the criteria.

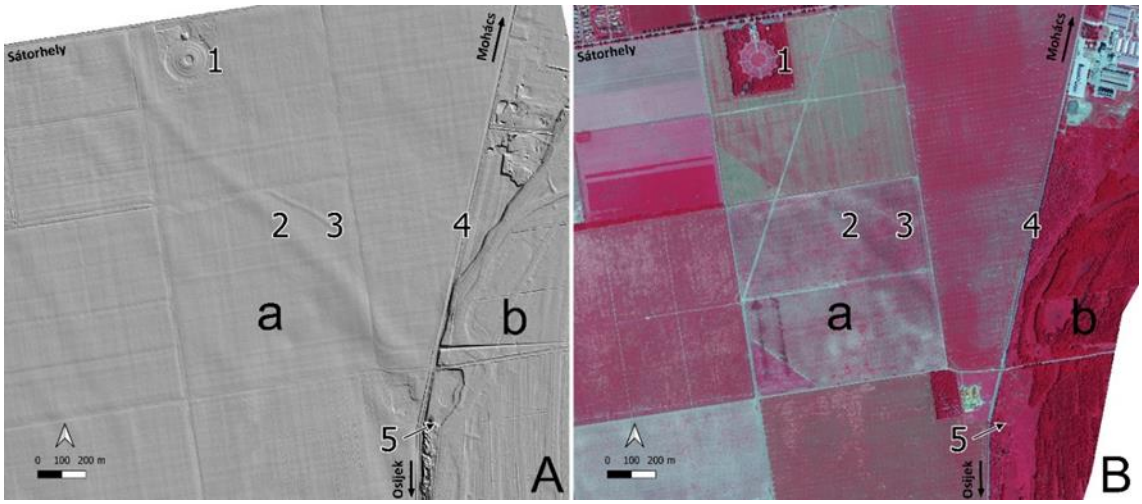


Figure 3. Landmarks located east of the Sátorhely village, as well as their appearance on a digital elevation model created from LIDAR data (A) and a color-infrared aerial photograph (B). Legend: a = Floodplain; b = Flood-free terrace; 1 = Mohács National Memorial; 2 = "Large Ditch"; 3 = 20th-century military trenches; 4 = Former path of the old military route; 5 = Turkish Hill (Törökdomb)

The spatial characteristics of the battlefield, the Christian and the Ottoman camps

On the Hungarian king's orders, the troops were united in a larger camp near Mohács on 27 August. According to contemporary descriptions the Christian military camp situated about half Hungarian mile (ca. 4 km) south of Mohács, in the immediate vicinity of the marshy floodplain below Mohács. Brodarics mentioned: "So the next day, around half a mile below Mohács, our army met theirs…" [5] Brodarics's mile has already been the subject of debate among researchers. We worked with an approximate mileage of 8 kilometres. However, it should be pointed out that Brodarics had neither an instrument, nor an accurate map, so his data can only be considered estimates, with a tolerance of a few hundred metres.

Ursinus Velius wrote: "The location of the royal camp was marked out on the flat and open fields near the marsh." [13]

The bulk of the Ottoman army crossed the Karasica stream, which bordered the plain from the south, on August 28, the day before the battle, and camped near the crossing point near Baranyavár, about two Hungarian miles (about 16 km) from the Christians. [5] On the morning of 29 August, from the camp near Karasica, the Rumalian troops reached the Borza Valley and began to make camp in the early afternoon.

Brodarics reported: "In front of us was a long hill in the shape of a theatre auditorium, beyond which the Turkish emperor was setting up his camp."[5]

Velius' report confirms this: "… The gently rising hill prevented the enemy's camp from being seen. … The camp of the Turks was pitched opposite, at the foot of the Mount." [13] The location of the camp is clearly identifiable as the flat area of the Majs alluvial fan that remained dry in front of the basin margin.

The Hungarian army had time to settle on the chosen battlefield, south of the camp, on August 29th.

According to Brodarics, they moved from the camp to the battlefield, one mile (ca. 8 km) from Mohács, and half a mile from the river. "The place where the army was stationed was a mile from Mohács, and half a mile from the Danube River, which flows by it." [5]

According to Jacomo Zaratino, who served in the regiment of the Croatian ban in the battle, the two armies were positioned about an Italian mile (about 1.6–1.8 kilometers) apart before the battle. “Thus, at the said place, at one o’clock in the afternoon, skirmishes began between armies only an Italian mile apart”. [14]
East of today's Sátorhely village, next to the large ditch, five mass graves were found in 1960, 1975, and 1976, containing the remains of approximately 1,700 dead. These are the most important archaeological remains of the battle. The Mohács National Memorial (or Historical Memorial Park of Mohacs) was established around the mass graves in 1976. [15]

Földvár village

From István Brodarics’ account of the Battle of Mohács, we know that a village called Földvár played an important role in determining the scene of the battle.
Brodarics reported: “In front of us was a long hill in the shape of a theatre auditorium, beyond which the Turkish emperor was camped, and from the hill a small village with a church, called Földvár, descended, and there the enemy guns were positioned.” [5]
The location of the village has been the subject of debate for nearly 100 years. There are several medieval village ruins in the central part of the Mohács Plain. Near the present-day village of Majs (on the western side of the Mohács plain) there is an archaeological site of a medieval village, but based on our research, this is not the remains of the medieval Földvár village, but rather traces of the medieval Nagymajsa village. [16] In our opinion, the archaeological site next to Borza manor is the most likely candidate (but this debate has not yet been definitively settled). An excavation carried out by László Papp in 1967 on a village/settlement remains east of the Borza manor suggests that a settlement existed there in the Middle Ages, the location of which corresponds to the descriptions of Földvár. [17]

Turkish Hill (Törökdomb)

Turkish Hill is a prominent, man-made feature of the military landscape of Mohács and is more than 1,500 years old. During the Roman period, watchtowers (burgi) were erected at selected points along the frontier road to control and supervise traffic along the Danube Limes. The present-day Turkish Hill marks the location of one of these towers. The associated military road (via militaris) continued to be used after the end of Roman rule and remained in operation roughly a thousand years later. In 1526 the Ottoman army led by Suleiman the Magnificent approached the battlefield along this route before the Battle of Mohács.
Local tradition attributes an important role to the hill during the battle. Various legends associated with the site propose different interpretations. According to these accounts, it may have been the place where the sultan prayed for victory, where he pitched his tent, or even a cemetery for Ottoman Muslim soldiers who fell in the battle. However, there is no reliable evidence for these claims, and recent research indicates that the hill could not have functioned either as an Ottoman cemetery or as the site of the sultan’s tent.
In 1630–1631, the governor-general of Buda, Hasan Pasha of Buda, had a well dug on the hill and a wooden structure erected above it. After the reconquest of the region, the building at this commemorative site was converted into a Christian chapel in 1687. It is not known how long the chapel remained in use or what functions it served. Nevertheless, it still appeared on maps from the late eighteenth century, before finally disappearing from cartographic records in the 1780s. [18]

RESULTS AND CONCLUSIONS

We collected and analyzed the most important terrain features and distance data. Based on an analysis of the landscape and a summary of data on landmarks and distances, we have placed the important elements of the battle on the Mohács plain (Fig. 4).

- the flood-free terrace was suitable for battle, while the marshy floodplain was not,
- in rainy weather, there is more waterlogged, muddy terrain on the western side of the flood-free terrace than on the eastern side, so the eastern half is more suitable for a battle fought with heavy cavalry (the location of the battle was chosen by the leaders of the Christian army),
- the ancient military road runs along the eastern edge of the terrace,
- The Christian camp was located about 4 kilometers (half a mile) from Mohács at the time of the battle.
- The Ottoman camp and part of the Ottoman army were hidden from the Christian troops by a low ridge (Sátorhely Ridge).
- on the day of the battle, the Ottoman camp was located between a low ridge and a higher hill,
- the central part of the battlefield was about 8 kilometers (1 mile) from Mohács and about 4 kilometers (half a mile) from the western branch of the Danube,
- there was a deep swamp (Vizslak Meadow) next to the left wing of the Christian army, in which many drowned at the end of the battle,
- there was a large ditch between the Christian army and the battlefield, which we believe to be the remains of an ancient riverbed,
- Before the battle, the two armies lined up about 1.6-1.8 kilometers (1 Italian mile) apart on the northern and southern sides of the battlefield.
- Part of the Ottoman army was located among the houses of the village of Földvár.
- The most important archaeological finds from the battle are the mass graves, which lie east of today's Sátorhely, along the large ditch.
- The most important Ottoman monument of the battle (Törökdomb) lies on the border between the flood-free terrace and the marshy floodplain.

We believe that most of the geographical and historical data does not fit with the western half of the Mohács Plain, around the village of Majs.
In our opinion, the central events of the Battle of Mohács took place east and south of the present-day village of Sátorhely.
Geographical and archaeological research will continue even after the 500th anniversary. We hope that future discoveries and research results will confirm our battle reconstruction.

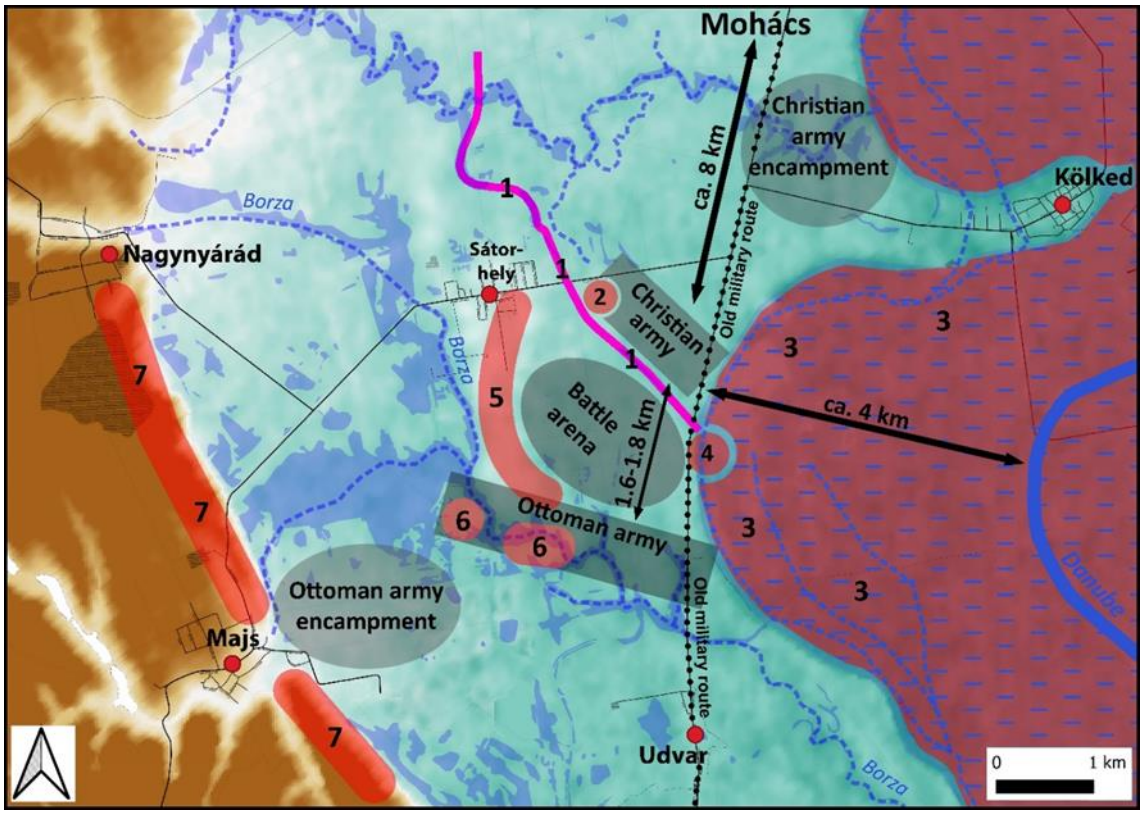


Figure 4. The main scenes of the battle. Legend: 1 = "Large Ditch"; 2 = Massgraves (Mohács National Memorial); 3 = Vizslak Meadow; 4 = Turkish Hill; 5 = Sátorhely Ridge that obscured the Ottoman camp and part of the army from Christian observers; 6 = The remains of the medieval Földvár village; 7 = The "mountain" in front of which the Ottomans set up their camp

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