RESULTS OF INTEGRATED ARCHAEOLOGICAL-ENVIRONMENT HISTORICAL RESEARCH OF SZIGETVÁR – TURBÉK VINEYARD HILL

INTEGRÁLT RÉGÉSZETI-KÖRNYEZETTÖRTÉNETI VIZSGÁLATOK EREDMÉNYEI A SZIGETVÁRI TURBÉK SZŐLŐHEGYEN•

TORMA, Andrea[1]; GULYÁS, Sándor[1]; PAP, Norbert[3,4]; FODOR, Pál[4]; KITANICS Máté[2]; GYENIZSE, Péter[2]; HANCZ, Erika[5]; TUGYA, Beáta[1,6]; NÁFRÁDI, Katalin[1*] & SÜMEGI, Pál[1,2]

[1]University of Szeged, Department of Geology and Paleontology, H-6722 Szeged, Egyetem Str. 2-6, Hungary

[2]Eötvös Loránd Research Network, Institute for Nuclear Research, H-4026 Debrecen, Bem Square 18/c

[3]University of Pécs, Szentágothai János Research Center, Historical and Political Geography Research Centre, H-7624 Pécs, Ifjúság útja 20, Hungary

[4] HUN-REN Research Centre for the Humanities H-1097 Budapest, Tóth Kálmán Str. 4, Hungary

[5]University of Pécs, Faculties of Humanities and Social Sciences, Department of Archaeology, H-7624 Pécs, Rókus Str. 2

[6]Thúry György Museum, H-8800 Nagykanizsa, Zrínyi Str. 62, Hungary

*Corresponding author e-mail: nafradi@geo.u-szeged.hu

Abstract

Suleiman I died during the Ottoman siege of Szigetvár on 6th September 1566 in the vineyard hill of Szigetvár–Turbék, Hungary. At the location of his death and temporary burial site, a memorial place (türbe) was established in the 16th century. According to written sources it was built in the 1570s, and the tomb complex was protected by a fortification (palisade) and a moat system from the north in the 17th century. The 250 cm deep moat was revealed by geological boreholes, and excavated by archaeologists for, among others, archaeobotanical, anthracological, malacological, pollen analytical and archaeozoological analysis. During the formation of the archaeological profile, Ottoman and Habsburg coins having dating importance and archaeological findings were found from the filling of the moat. 30 litres of sediment samples were taken at 15 cm intervals for archaeobotanical analysis, and four radiocarbon (AMS) dating were carried out on Hordeum *seeds. The cleaned surface of the profile was sampled at 10 cm intervals for sedimentological, geochemical and archaeozoological analysis. Based on some tens of thousands plant and some hundreds of animal, mainly domestic animal, remains we were able to reconstruct ploughed lands, orchards, kitchen gardens and vineyards, pasture lands, forest patches, gallery forest, as well as settlements. We were able to detect the land-economic zones (horticulture, forestry, cropfield, grazing zones) that closely followed the Thünen circles.*

*Based on the malacological remains, the climate deterioration of the Little Ice Age (LIA) could also be demonstrated in the first two thirds of the 17th century. At the same time, it was clearly established that the extreme effects of climate change on agriculture was not so drastic in the vineyards hill site due to its exposure situation, exogenous geological and geological conditions. Thus, the negative effects of the Little Ice Age were modified on the dry south facing, lower altitude slopes, covered with loess and human-influenced soil (*anthrasol*). At least, extremes like those detected in the North Atlantic did not occur here. So, we can conclude that the mosaic nature of the Carpathian Basin could buffer the negative effects of the Little Ice Age through the microregions characterized by a milder and drier microclimate. The memorial place and the destroyed town (Ottoman name: Türbe kasabası) may have become depopulated between 1692 and 1693, when the area was divided into agricultural zones and new gardens, arable and pasturelands were established. The memorial place*

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and the town were covered by the demolished material and soil. The site was re-identified and excavated as a part of an archaeological, historical and geoarcheological research work that started in 2015.

Kivonat

I. Szulejmán oszmán szultán, Szigetvár 1566-os ostroma ideje alatt szeptember 6-án hajnalban halt meg a mai Szigetvár–Turbék szőlőhegyen, ahol sátrának, halálának és a csatatér közelében történt ideiglenes eltemetésének helyszínén, egy emléktürbét (sírkápolnát) alakítottak ki még a 16. században, az írott források alapján 1575-ben. A korabeli forrásokból tudjuk, hogy a sírkomplexumot erődítmény (palánk), valamint északi irányból egy árokrendszer védte a 17. században. A 250 cm mély árkot régészeti geológiai fúrásokkal sikerült azonosítani, majd kutatóárokkal feltárni archeobotanikai, anthrakológiai, malakológiai, pollenanalitikai és archeozoológiai vizsgálatokhoz. A több tízezer feltárt növényi és több százra tehető állati, döntően haszonállat maradvány alapján gabonatermesztésen alapuló szántóföldeket, veteményes és virágkerteket, gyümölcsös kerteket és szőlőket, legelőket, erdőfoltokat, ligeteket és emberi megtelepedéseket, lakóhelyeket, Thünen köröket megközelítőleg követő földhasznosítási–gazdasági övezeteket rekonstruálhattunk.

*Az árok szelvényének malakológiai anyaga alapján a 17. század első kétharmadában sikerült kimutatni a kisjégkorszak (Little Ice Age = LIA) klímarontó hatását is. Viszont az egyértelműen megállapítható volt, hogy a déli irányba néző, alacsony dombsági száraz területhez tartozó, lösszel és emberi hatású talajjal (*anthrasol-*lal) fedett Turbék szőlőhegy expozíciós helyzete, exogén geológiai, geológiai adottságai miatt a klímaromlás gazdálkodást negatívan befolyásoló szélsőséges hatásai nem érvényesültek. Legalábbis olyan szélsőségek, mint amelyeket az Atlantikum északi részén kimutattak, itt nem jelentkeztek. Ennek nyomán arra következtethettünk, hogy a Kárpát-medence mozaikossága révén kifejlődött enyhébb és szárazabb mikroklímával jellemezhető mikrorégiók révén pufferelni tudta a kisjégkorszak negatív hatásait. A türbe és a hozzá kapcsolódó elpusztított városka (oszmán neve: Türbe kasabası) 1692/1693 között néptelenedhetett el, mikor a területet agrárövezetekre osztották és új kerteket, szántókat, legelőket alakítottak ki. Az emlékhely és a kisváros romjait törmelékkel és talajjal fedték el. Így a helyet egy 2015-ben indult régészeti, régészeti geológiai és történelmi kutatómunka keretében újra meg kellett találni, majd fel kellett tárni.*

KEYWORDS: INTEGRATED ECOLOGICAL HISTORICAL ANALYSES, MEMORIAL PLACE OF SULEIMAN I, LITTLE ICE AGE, 17TH CENTURY

KULCSSZAVAK: INTEGRÁLT KÖRNYEZETTÖRTÉNETI ELEMZÉS, I. SZULEJMÁN EMLÉKHELYE, KIS JÉGKORSZAK, 17. SZÁZAD

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Introduction

Suleiman I, sultan died during the siege of Szigetvár on 6th September 1566 in the vineyard hill of Szigetvár–Turbék, Hungary. At the location of his death and temporary burial site, an Ottoman memorial place (türbe) was established according to written sources (Fodor 2020; Pap 2020; Fodor & Pap 2018) in the 1570s. We know from sources that the tomb complex was protected by a fortification (palisade) and a moat system from the north in the 17th century. The creation and filling up of a moat of the memorial place (türbe) is clearly linked to human activity; i.e. the history of the moat is entirely the evolution of an anthropogenic sediment basin that spans the history of the 17th century. Environment historical analysis was supplemented by geochronological analysis, taking into account the archaeological findings and radiocarbon data (Gulyás et al. 2018, 2022). The study area (Szigetvár–Turbék vineyard hill) is located on a south facing low altitude slope (**Fig. 1.**), rising from the Great Hungarian Plain region, from the floodplain of river Drava, at an altitude of 200–230 m above sea level. So, the study site is located at the border of two regional units, the Great Hungarian Plain and Transdanubia (Marosi & Somogyi 1999; Dövényi 2012) (Pap et al. 2023: fig. 1.). This paper presents the summary results of the environmental historical analyses of the moat filling (anthropogenic catchment basin) of the Ottoman memorial place (türbe).

Materials and methods

Based on Pál Eszterházy's map-like drawing (Pap et al. 2023: fig. 2.) of the memorial place from 1664 (Eszterházy 1989), a profile was created in the moat that was established by geoarcheological boreholes (Gulyás et al. 2022). The filling of the moat was sampled at 10 cm intervals for archaeozoological (Tugya 2023) analysis and at 15 cm intervals for archaeobotanical, pollen analytical, anthracological (Torma et al. 2023a) and malacological (Sümegi 2023) analysis.

Environment historical analysis was supplemented by sedimentological, geochemical and geochronological investigations earlier (Gulyás et al. 2022). Based on this, the formation of the moat began at the beginning of the 17th century, after 1613/1619

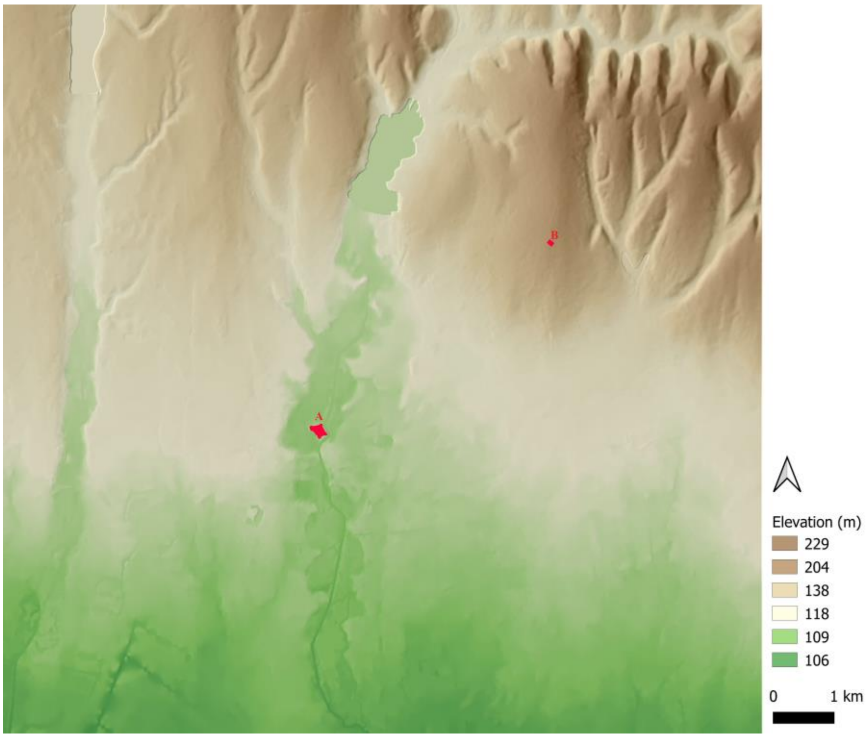

Fig. 1.:
Digital elevation model of the study site (work of Péter Gyenizse) with Szigetvár (A) and the memorial place with the Ottoman town, Türbe kasabası (B).

1. ábra:
A vizsgált terület és környezete digitális domborzati modellje (Gyenizse Péter munkája nyomán) Szigetvárral (A) és a türbe, valamint a türbéhez kapcsolódó már elpusztult oszmán kisváros, Türbe kasabası (B).

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according to the Habsburg denarius of Mathias II, which was minted in Cremnicium (today Kremnica, Slovakia) between 1613 and 1619. The geochronological analysis was supplemented by the statistical analysis (Bayliss 2015; Gulyás et al. 2018, 2022) of radiocarbon data based on the barley (*Hordeum*) seeds that was found during the archaeobotanical analysis.

The geochronological, geochemical, and sedimentological investigations have been published earlier in Gulyás et al. 2022. During the evaluation of the environment historical results we adapted these data for the geoarchaeological investigation.

Results and discussion

Based on the chronological results (Gulyás et al. 2022) the filling up of the moat could take place *sensu lato* between 1609 and 1693, while *sensu stricto* between 1651+/-36 and 1684+/-36 AD, in the second part of the 17th century (**Fig. 2**; Gulyás et al. 2022). In other words, the creation of the moat and its filling up happened decades later than the establishment of the memorial place and the town (Ottoman name: Türbe kasabası), which can be dated to the 1570s (Pap et al. 2023). The filling up of moat was not uniform. Factor analysis of all geochemical, sedimentological data revealed the presence of four major factors controlling sediment accumulation (**Fig. 2**, Gulyás et al. 2022). Factor 1 represents lithogenic elements connected to pedogenesis (Fe, Mn, Na, Al, P, S, Ba). Factor 2 marks Mg, Ca and K, while factor 3 has high loadings on all metallic anthropogenic elements (Cu, Ni, Pb, Zn, Cr) and LOI550, magnetic susceptibility and clay-sized particles. Factor 4 has the highest loading on lead. There are two major erosion-accumulation events (EA I and EA II) based on the sedimentological, geochemical and magnetic susceptibility analysis (Gulyás et al. 2022).

The first horizon developed between 190 and 160 cm (Gulyás et al. 2022). It can be assumed that during the winter campaign in 1664 (Fodor & Pap 2018) the buildings of the memorial place and the demolished garden were cleaned up and significant amount of the removed material was simply put into the moat of the türbe.

The second erosion-accumulation horizon was detected between 130 and 50 cm (Gulyás et al. 2022), when probably, very similar events took place. However, according to written sources (Gyenizse & Bognár 2014) during the Habsburg occupation of Szigetvár and the memorial place (1688/1689) the türbe was destroyed and the construction material of the buildings were re-used (Gyenizse & Bognár 2014) between 1689 and 1693.

The upper 50 cm is the recent soil and its bedrock that contain a large amount of building debris and demolished material (Gulyás et al. 2022). After destroying the memorial place, its material was put into the remaining depressions of the former moat at the end of the 17th century, or at the beginning of the 18th century at latest.

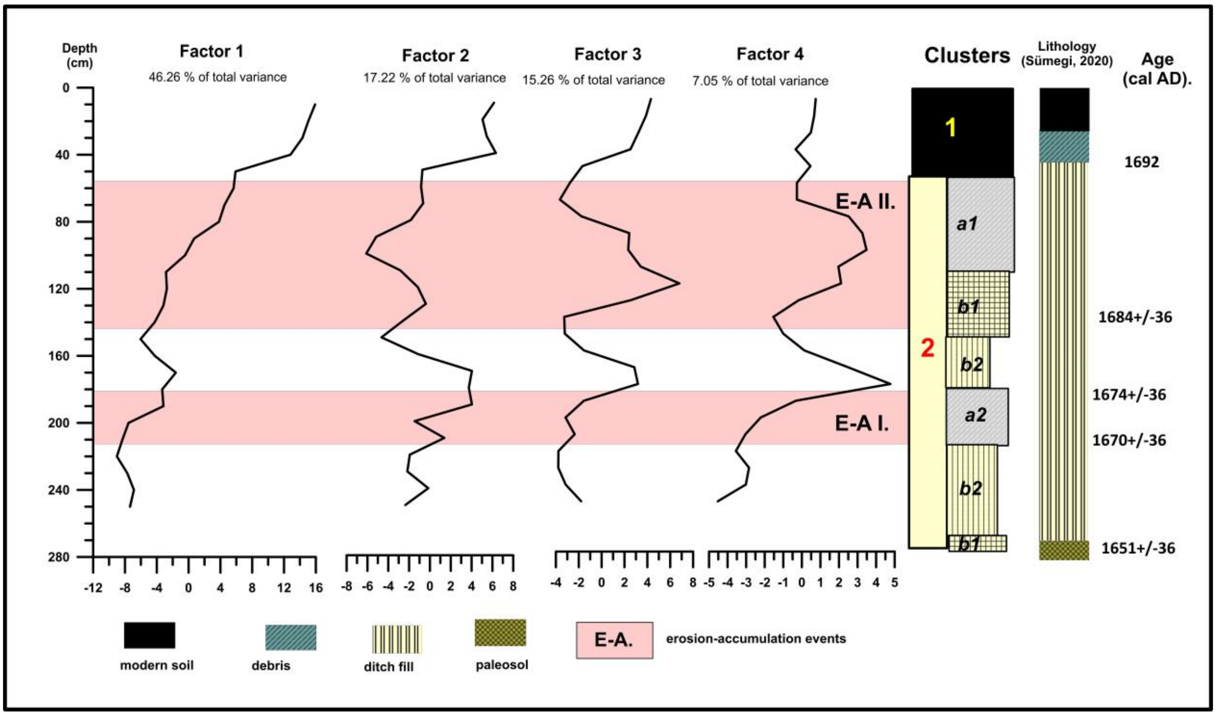

Fig. 2.: Factors influencing the erosion-accumulation events and the chronological data in the moat sequence of Szigetvár (modified after Gulyás et al. 2022)

2. ábra: Az eróziós-akkumulációs eseményeket befolyásoló tényezők és a kronológiai eredmények a szigetvári türbe árkában (Gulyás et al. 2022 után módosítva)

The surface was levelled, and an artificial surface was created (Gyenizse & Bognár 2014) where a new agricultural zone, a continuously cultivated, fertile anthrasol developed. It is very likely that the original pre-Neolithic soil may have been brown forest soil type, but during prehistoric and historical times this soil transformed into a chernozem soil and then into an anthrasol (human-influenced soil). Thus, the creation and filling up of the moat is clearly linked to human activity; i.e. the history of the moat is entirely the evolution of an anthropogenic sediment basin that spans the history of the 17th century.

The reconstruction of the filling up process of the moat in the 17th century is supported by the collected and analysed malacofauna (Sümegi 2023). The change in the composition of the mollusc fauna suggests that the moat could have a drainage function and was wet in a significant part of the year (growing season) in the first half of the 17th century. This is supported by the *Anura* (frogs, toads) bone remains (Tugya 2023) from this level of moat filling. The archaeozoological assemblage indicates that sheep/goat and cattle were the most frequent domesticated animals. The consumption of poultry meat, including hen and goose can also be observed. In addition, the remains of dog, cat and horse have also been identified. Surprisingly, a few pig bones and teeth were also found at the site, raising the question whether Christians lived in the town of Türbe kasabası or near the site. Muslim dervishes and soldiers were likely to consume sheep, goats, and beef, as well as poultry meat and fish. The Hungarian or non-Muslim ethnic groups consumed pork as well, which has become increasingly popular. The analysis of the eggshells indicates that both hatched and unhatched, but consumed eggs turned up in Szigetvár. So, the species was bred locally and some of the eggs were consumed as well.

Based on the plant residues, the surface of the wet moat was covered by weeds and shrubs during the growing season, thus creating a wet, shaded microenvironment (Torma et al. 2023). As a result of the filling up of the moat and probably the climatic change that started in the last third of the 16th century, the moat became a barren, dry habitat with herbaceous plants-weeds (Torma et al. 2023). Later, Central and Eastern European xero-thermophilous mollusca species became dominant in the habitat due to the filling up with sediment containing debris material. The malacological data (Sümegi 2023) indicate that the first two-thirds of the 17th century may have been colder and wetter in the Carpathian Basin – similar to the global climate models and the Little Ice Age (LIA, between 1560 and 1670 according to Rafferty & Jackson (2016) reconstructions (Lamb 1972; Grove 1988). However, our data require a more differentiated approach for the climate change of the 17th century and its effects on agriculture in the Carpathian Basin (Sümegi et al. 2021). It is not possible, and we should not extend the negative effects of the North Atlantic (Lamb 1972; Grove 1988) or the conclusions of studies about the deeper floodplains of the Great Hungarian Plain (Pinke et al. 2016, 2017) over other sites. Namely, in the drier habitats of south facing slopes of the mountainous region (Sümegi et al. 2021), similarly to the study area, the coldest periods of the LIA and the increase of precipitation created particularly favourable conditions for agricultural production. The evidence for this has already appeared in economic historical studies based on the latest crop yields (Rácz 2020). It seems that the mosaic environment of the Carpathian Basin (Sümegi 1995, 2004, 2005; Sümegi & Krolopp 2002; Sümegi et al. 2013, 2022) could compensate the unfavourable climatic conditions of the LIA, as it was previously revealed by malacological studies. This is supported by the botanic remains that suggest a very diverse garden and horticulture in the close vicinity of the memorial place and the Ottoman town (Torma et al. 2023). An open, human-influenced grassland dominated with gardens, smaller arable lands closer to the türbe, and patches of deciduous forest (with oak, elm, linden, hornbeam and beech trees) existed further from the moat. The number of cereal pollen grains and seeds indicate cereal cultivation of barley (*Hordeum*) – rye (*Secale*) – wheat (*Triticum*) order by quantity. The low number of wheats is probably related to climatic factors (Sümegi et al. 2016). The cooler climate in the 17th century (Grove 1988; Pfister & Brázdil 2006; Rácz 2020) favoured barley and rye production (Bonachela 1996; Sümegi et al. 2020).

We used the data series of Pécs climate stations (Bors 2013) between 1898 and nowadays, that air distance is 31 km and has identical exogenous geological (geomorphological) conditions than the study site, to prepare the Walter-Lieth diagram (**Fig. 3.**) of the site. According to the Walter-Lieth climate diagram of Pécs, there is a very strong sub-Mediterranean climate effect in the area, and in the whole territory of Mecsek Mountains (Péczeli 1979; Zólyomi et al. 1992; Skarbit et al. 2014; Ács et al. 2015). The sub-Mediterranean climate effect is mostly visible in the significant sunshine duration of 2000–2100 hours/year. However, the sub-Mediterranean climate effect is also visible in the Walter-Lieth diagram (**Fig. 3.**) in the higher autumn and spring mean temperatures and, above all, in the autumn secondary precipitation maximum Zólyomi 1958).

In the 124 years long climate data series, the fluctuation of the annual mean temperature can be estimated to 3.0–3.5°C (between 9 and 12.5°C) (Bors 2013). However, during the coldest years, only an annual mean temperature of 6.5°C occurred (Bors 2013). In the years with the coldest annual mean temperatures, winter cooling was extremely significant and minimum temperatures developed between –20 and –25°C in January (Bors 2013). However, during the most significant cooling period of the LIA the global annual mean temperature decrease was only 2°C (Lanchester 2019; Bloom 2019). On the other hand, in the internal, continental areas of Eurasia, including the Carpathian Basin, a temperature drop of 0.5°C can be realized (**Fig. 3.**) for this period of time, especially for the summer season and the growing period (Lamb 1965; Jones et al. 1998; Mann et al. 1999; Ge et al. 2013; Lee & Zhang 2015; Rafferty & Jackson 2016). Unfortunately, we do not have measured climatic data from the Carpathian Basin for the 17th century, especially from the study site, and the local microclimate was not reconstructed either for the coldest period of the LIA in the first two-thirds of the 17th century (Sümegi et al. 2009).

Similarities in the trends in the Carpathian Basin during the LIA (**Fig. 4.**) to the global one and to the internal regions of Eurasia can be deduced on the basis of the stalagmite analysis in the Sub-Carpathian region (Siklósi et al. 2009) and other ecoregions (Sümegi 1996, 2004, 2005; Sümegi et al. 2022).

A reconstruction model was made (**Fig. 5.**) taking into account the global and regional data (Lamb 1965; Jones et al. 1998; Mann et al. 1999; Siklósi et al. 2009; Ge et al. 2013; Lee & Zhang 2015; Rafferty & Jackson 2016), as well as the local data of the 20th century (Bors 2013). During creating the model, a maximum monthly mean temperature decreases of 2°C was expected (**Fig. 3.**) but taking into account +/-1°C temperature change due to the uncertainty.

Thus, the trends were similar to the global and regional reconstructions, and it became clear that the local annual mean temperature was 9.7+/-1°C. We obtained a data set for the minimum monthly mean temperature by the average of the last 124 years (**Fig. 5.**). Probably, in the winter season lower, while in the summer season higher mean temperatures occurred, however, our natural scientific data did not allow a more accurate estimation at the moment.

The malaco-thermometer (Sümegi 1989, 1996, 2005, 2019) based on the malacofauna composition of the moat (Sümegi 2023: fig. 1) correlated well with the climatic data, although only the former mean July temperature can be reconstructed for sure (Sümegi 1989, 1996, 2005, 2019).

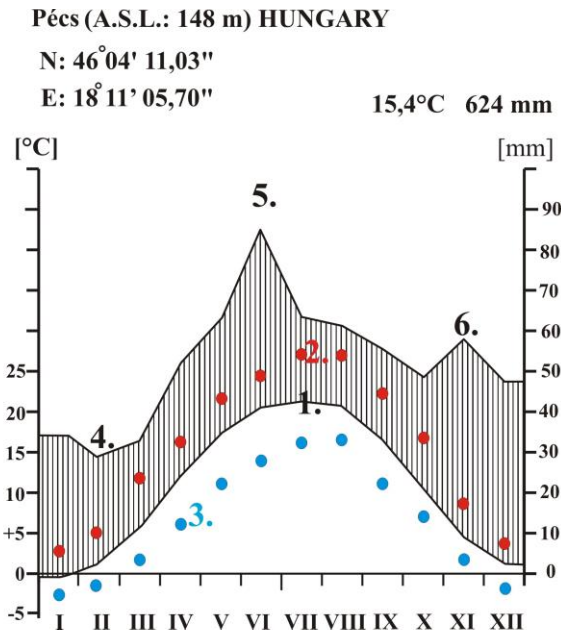

Fig. 3.: Recent climatic parameters at Szigetvár – Turbék vineyard hill based on the Walter-Lieth diagram of the climatic station in Pécs town. (Data measured from 1898 to present day) (new, original figure).

1. Monthly average temperature 2. Monthly averages (red dots) of the hottest months (multi-year average) 3. Monthly averages (blue dots) of the coldest months (multi-year average) 4. Monthly average precipitation 5. Precipitation maximum at the beginning of summer 6. Secondary autumn precipitation maximum (sub-mediterranean climatic effect).

3. ábra: Szigetvár – Turbék szőlőhegyen kifejlődött éghajlati paraméterek (Bors, 2013), a pécsi klímaállomás 1898 és napjaink között mért paraméterei alapján felállított Walter-Lieth diagram alapján (új és eredeti ábra).

1. Havi átlagos hőmérséklet 2. A legmelegebb hónapok (több évi átlag) havi átlagai (piros pontok) 3. A leghidegebb hónapok (több évi átlag) havi átlagai (kék pontok) 4. Átlagos havi csapadék 5. Nyár eleji csapadék maximum 6. Őszi másodlagos csapadék maximum (szub-mediterrán éghajlati hatás).

The annual mean temperature values (Kageyama et al. 2006; Schatz et al. 2014; Strandberg et al. 2014) of the warmest months reconstructed by the malaco-thermometer gave completely similar results. Based on the global and regional precipitation reconstruction models for the 17th century (Stahle & Cleaveland 1994; Cullen & Grierson 2009; Pinke et al. 2016, 2021; Rácz et al. 2020), there was an unambiguous increase in precipitation income in the early 17th century, but its value may have fluctuated due to regional water balance (Kiss, 2009). Based on the reconstructions, we can expect annually 100–150 mm increase in precipitation in the first half of the 17th century, therefore we indicated 10 mm monthly and 120 mm annual increase in precipitation in our model. Naturally, this is an average approach; changes may have arisen on a much wider scale. Unfortunately, we do not have an adequate data set on this issue yet. On the other hand, based on the malacological data of the moat, it is clear if there was an increase in temperature and a decrease in precipitation and humidity in the study area and in the Carpathian Basin, as well as in the wider Carpathian Basin, at the end of the 17th and the beginning of the 18th century. The existing economic, social and climatic data suggest that the climate change at the end of the LIA may have played a major role in the negative economic and social changes in the Ottoman Empire (White 2011; Kulkarni et al. 2018; Mrgić 2018).

So, the cooler and wetter growing season of the LIA was especially favourable considering the horticulture, forestry and grazing zones of the study site due to the local geological factors (island-like, dry area on the Turbék vineyard hill). Most likely, this favourable condition extended only to a 10–20 km^2 area, to the island-like region emerging from the alluvium of the Drava River. As we can see, the impact of the LIA was temporal and spatial at the same time. The excavation of the moat provided an opportunity to reconstruct the vegetation and land use activities in the vicinity of the memorial place and in the town (Türbe kasabası) for the 17th century. Based on written sources (Gyenizse & Bognár 2014), a vegetation, land use and paleohydrological reconstruction (Torma et al. 2023: fig. 3.) was implemented for the 17th century.

Although, the work of Adam Smith (1723–1790), who formulated the basics of economic sciences (Smith 1776) was outstanding, but the first reconstructions and the system of agricultural land use was introduced by Johann von Thünen (1783–1850), a German farmer (Thünen 1826) (**Fig. 6.**). This outstanding medieval theoretical model was the first to interpret the spatial development of an economic structure. It was based on complex, ordinary differential equations (general equilibrium theory) and was more than 150 years ahead of modern economic models. Thünen's model is well applicable for the land use reconstruction of farming without using machines (organic production culture) in the 17th century (Torma et al. 2023: fig. 3.).

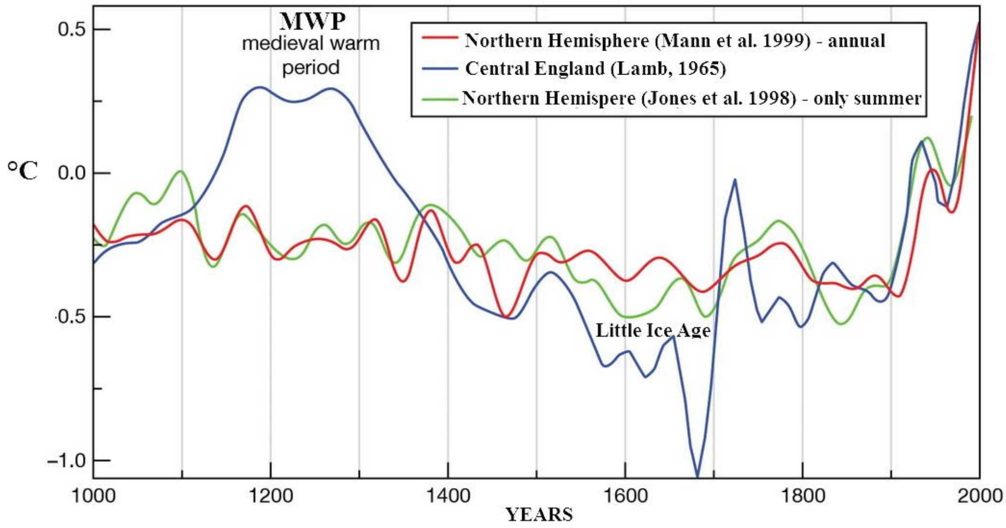

Fig. 4.: Annual and summer mean temperatures for the last 1000 years based on the data of Lamb 1965; Jones et al. 1998; Mann et al. 1999; Siklósy et al. 2009; Ge et al. 2016; Lee & Zhang 2015, and modified and completed after Rafferty & Jackson 2016.

4. ábra: Az utolsó 1000 évre vonatkozó évi, és nyári félévre vonatkozó középhőmérsékleti trend Lamb 1965; Jones et al 1998; Mann et al. 1999; Siklósy et al. 2009; Ge et al. 2016; Lee & Zhang 2015 adatainak felhasználásával Rafferty & Jackson 2016 nyomán átrajzolva és kiegészítve

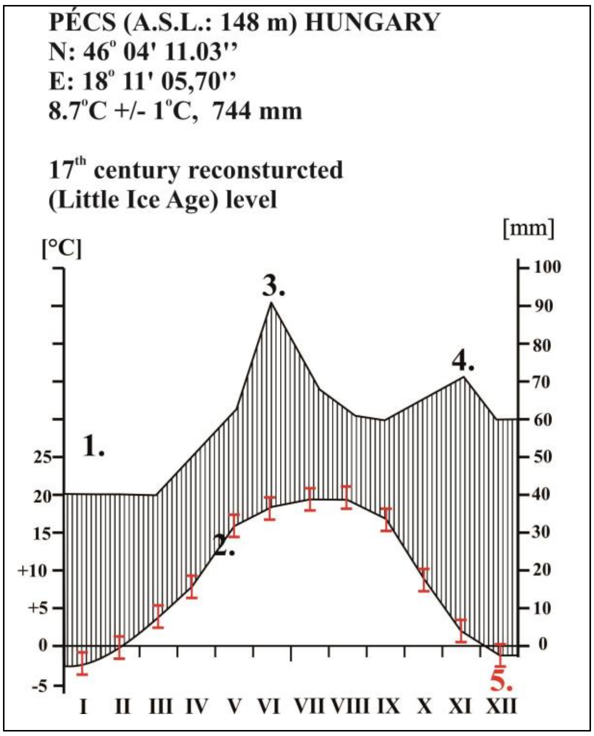

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Fig. 5.: Temperature and precipitation trend for the beginning of the 17th century, the coldest phase of the Little Ice Age (LIA). Calculated with a globally determined maximum monthly average temperature decrease of 2°C (after Lamb 1965; Jones et al. 1998; Mann et al. 1999; Siklósy et al. 2009; Ge et al. 2016; Lee & Zhang 2015) and a +/-1°C uncertainty deviation in the absence of local data (new and original figure). Precipitation amount with 10mm surplus per month.

1. Annual precipitation trend by month 2. Annual temperature trend by month 3. Early summer precipitation maximum 4. Autumn secondary precipitation maximum (sub-Mediterranean climate effect) 5. (red line) Temperature uncertainty factor.

5. ábra: A 17. század kezdetére, a kisjégkorszak (LIA) leghidegebb szakaszára vonatkozó hőmérsékleti és csapadék trend. A globálisan megállapított maximális 2°C havi átlagos hőmérséklet csökkenéssel (Lamb 1965; Jones et al. 1998; Mann et al. 1999; Siklósy et al. 2009; Ge et al. 2016; Lee & Zhang 2015 nyomán) és a lokális adatok hiányában +/- °C bizonytalansági eltéréssel számolva (új és eredeti ábra). A csapadékösszegek havi 10mm többlettel kiegészítve.

1. Évi csapadékmennyiség menete havi bontásban 2. Évi hőmérséklet menete havi bontásban 3. Nyár eleji csapadék maximum 4. Őszi másodlagos csapadék maximum (szub-mediterrán éghajlati hatás) 5. (piros vonal) Hőmérséklet bizonytalansági tényezője.

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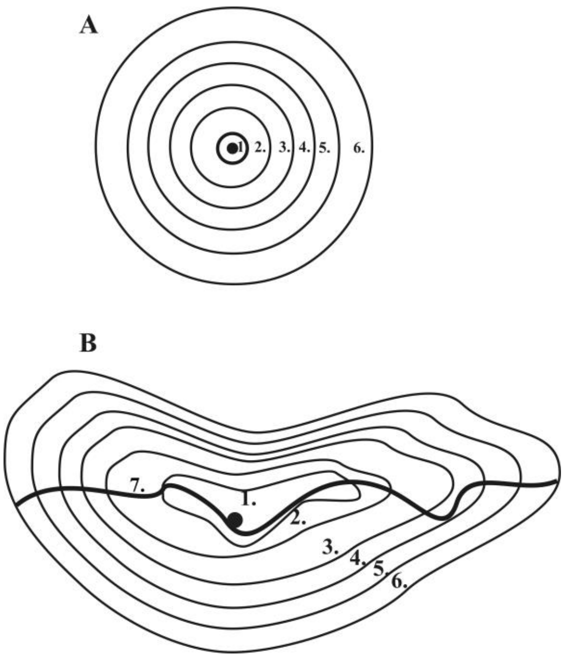

Fig. 6.: The economic model of Thünen (von Thünen 1826, redrawn and modified by Sümegi 2003).

A = original model, B = modified model, when a river valley (i.e. natural environment) is not homogenous. 1. = city centre (centrum) and fruit – vegetable – milk production zones; 2. = forest, firewood and timber production zone; 3. = crop production zone without fallow; 4. = crop production zone with fallow and pasture (livestock farming) zone; 5. = three-field system; 6. = grazing (livestock farming) zone; 7. = navigable river.

6. ábra: Thünen gazdasági modellje (Thünen 1826 nyomán átrajzolva és módosítva Sümegi 2003).

A = eredeti modell, B = módosított modell, amikor egy folyóvölgy, tehát a természetes környezet nem homogén hátteret alkot; 1. = a központi település (központ), és a gyümölcs-zöldség-tejtermelő övezet; 2. = erősült zóna, a tűzifa és építőfa övezet; 3. = a gabonatermesztési övezet; 4. = a gabonatermesztési és az állattartási övezet; 5. = a háromnyomásos gazdálkodási övezet; 6. állattartási övezet; 7. = az övezetek térbeli megjelenését módosító folyó.

In this period of time, in the city of Szigetvár and its Ottoman fortress – just as in Europe and the Ottoman Empire – local food security was the basic goal of agricultural production. On the other hand, in the religious centre established in the 1570s and the associated pilgrim town (Türbe kasabası), there were guest rooms and dining places for pilgrims, religious people and other travellers visiting the memorial place or the area (Fodor 2020; Pap 2020; Fodor & Pap 2018).

Thus, in addition to the production of agricultural goods and food that were necessary for self-sufficiency and taxation, leaders had to take care of guests arriving in the city, i.e. for the soldiers, religious persons, merchants, masters, pilgrims and travellers of the town and the memorial place. In addition, the town was a commercial centre (market place) (Fodor 2020; Pap 2020; Fodor & Pap 2018) during the 17th century, so it could be the location of money and product exchange as well. As a result, the former town can be compared to the small-town centre (**Fig. 6.**) defined by Thünen, during the late medieval – early modern times.

A horticulture zone can be assumed directly around the memorial site and the small town connected to it, and this is surrounded by (from the outside) a zone of forestry (firewood and timber production), not in a complete circular shape, according to the groundwater level (**Fig. 6.**). The forestry zone is surrounded by cereal fields from the outside, followed by periodic wetlands and meadows. At the border of the 1-day walking distance that is characteristic in organic production cultures (5 km = 1 hour on foot), Szigetvár city spatially modified the Thünen circles (**Fig. 6.**). The spatial location of the agricultural production zones roughly follows the circular structure described by Thünen (Thünen 1826); however, the circles have rather patchy development, reflecting the exogenous geological, geological and pedological features of the study area (**Fig. 6.** and Torma et al. 2023: fig. 3.). At the same time, the zones also appeared mixed, and mosaic-like, especially around the memorial place, probably due to food security. So, Thünen's economic space did not fully develop around the türbe and its small town. This may be due to the fact that the centre was only a few decades old, but it is much more likely that the natural conditions, the geological and pedological features of the area modified the developing economic space (**Fig. 6.** and Torma et al. 2023: fig. 3.). Similar development could be observed in the structure of the economic space around Marosvásárhely / Târgu Mureş from the 13th century, namely that the natural environment factor of the site led to the development of a mosaic economic spatial structure (Sümegi 2016). Thus, the development of economic space was determined by the natural conditions in the Carpathian Basin over the past millennium, and Thünen's idealized model about the homogeneous economic spatial structure have not been realized.

Summary

One of the most dominant Ottoman monarchs of the 16th century, Sultan Suleiman I died during the Ottoman siege of Szigetvár in 1566, close to the battlefield in the vineyard hill of Szigetvár–Turbék, in the Hungarian Kingdom. On the place of his death and his temporary burial site an Ottoman memorial place (türbe) and a pilgrim town (Türbe kasabası) was established in the second part of the 16th century. This site was fully demolished during the Habsburg siege of Szigetvár in 1689 and the exact location of the former memorial place and the settlement disappeared by time. In 2015, based on historical written sources, maps, geoinformatical

and geoarcheological core mapping the remains of the türbe and a moat system north of the memorial place was found. Sediment samples were taken from the filling of the 250 cm moat ditch for geological and integrated archaeobotanical analyses, as well as archaeozoological and malacological analysis.

The sedimentological and geochemical data (Gulyás et al. 2022) suggest two major changes in the analysed profile, marking the effects of site destruction, leading to the erosion of soil from the banks of the moat. Based on the pollen and macrobotanical remains (Torma et al. 2023), arable and pasture lands, orchards, gardens and vineyards, natural forest spots and park spots were able to reconstruct around the moat during the 17th century (Gulyás et al. 2022). Archaeozoological analysis (Tugya 2023) provided information about domesticated animals and meat consumption. This indicates that the most common species were sheep/goat and cattle. They accounted for more than 80% of vertebrate palaeozoological findings. The consumption of poultry meat, including hen and goose can also be observed, but dog, cat and horse bones have also been identified. Surprisingly, some pig bones were also found at the site so non-Muslims may have lived in the town of Türbe kasabası or near this Ottoman site.

The malacological analysis (Sümegi 2023) of samples indicates three major changes. According to these results, the moat may have been deeper and had double function: a drainage and protection function. In the wet and more humid microenvironment, shrubs and weeds could cover the surface of the moat during the first part of the 17th century. In the second part of the 17th century (maybe after the winter campaign of Habsburgs in 1664), the filling up of the moat became faster and gradually a dry, open vegetation covered shallow sedimentary basin developed with herbaceous plants. By this time, the moat had lost its drainage function and probably its protective role as well. Later, the depression was filled up with soil and the ruins of the memorial tomb. The demolition of the memorial place may have taken place after the successful siege of Szigetvár, after 1689/1692, at the end of the 17th century and the beginning of the 18th century, when the new land use and estate system was established.

We hope that our research will continue, and researchers will use similar or more advanced scientific approaches with natural scientific testing methods in current or future archaeological excavations.

Contribution of authors

Torma Andrea Formal analysis. **Gulyás Sándor** Data curation, Visualisation. **Pap Norbert** Spatial analysis. **Fodor Pál** Data Curation. **Kitanics Máté** Data Curation. **Gyenizse Péter** Data Curation. **Hancz Erika** Archaeology. **Tugya Beáta** Formal analysis **Náfrádi Katalin** Writing - Original Draft, Review & Editing. **Sümegi Pál** Writing - Original Draft, Supervision.

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