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ENVIRONMENTAL RECONSTRUCTION OF THE AREA OF ROMAN BRIGETIO (KOMÁROM, HUNGARY)

Abstract. The purpose of our research is the environmental reconstruction of an important part of the Ripa Pannonica (*limes*), the Roman frontier system in Pannonia province. The study area is between the present Komárom, Tata, Dunaalmás settlements in Hungary. The legionary fortress of *Brigetio* was located along the Danube, forming part of the town of Komárom, Hungary. The camp and the settlement were bordered by the Danube on the north and by an aband oned river subchannel on the south. Using this riverbed and the valley of the Fényes stream flowing into it the Romans constructed a dam and created a wetland area, which might have had a defensive role.

We prepared an environmental reconstruction based on geomorphological research, field work, GIS analysis, archive maps and historical sources and made the reconstructed digital topographic model of the study area. We also assessed the relationship between the geomorphological features and the anthropological landscape-shaping impacts.

The settlement lied on the higher level of floodplain of the Danube river. The accumulation of the higher floodplain's sediments can be dated to the end of the Atlantic and first half of the Subboreal. The higher floodplain was finally formed in the last third of the Subboreal phase. At this time, at the end of the Late Bronze Age, the riverbed (the Danube subchannel) lying south of Brigetio's island was formed. This riverbed became abandoned at the end of the Subboreal phase, in the Early Iron Age. The marsh resulting from the Roman dam construction was present up until 1747, when S. Mikoviny dismantled the flood-gates and drained the area. Its history can be followed on archive maps, such as G. G. Priorato (1672), L. F. Marsigli (1726) and S. Mikoviny (1746).

Key words: Brigetio, Roman time, geomorphology, environmental history, GIS, Danube, Komárom, Hungary

INTRODUCTION

The *limes*, the border fortification system of the Roman Empire, was mainly settled alongside the Danube River. Brigetio (actual Komárom/Szőny in Hungary) was one of the four legionary bases in the province Pannonia, controlling the Danubian border of the empire from the 1st century A.D. till the late Antiquity. The settlement consisted of three major parts: a legionary fortress, a military

town (*canabae*) and a civilian town (*municipium/colonia*). There was a smaller settlement *Azaum* east of it with an auxiliary fort and a *vicus* (civilian settlement outside the fort) and several marching camps on the territory of our research area (Fig. 1) (Barkóczi 1944–51; Visy 1989, 2000; Horváth, Viczián 2004; Borhy 2006; Borhy et al. 2011; Szabó 2011; Szabó, Visy 2011).

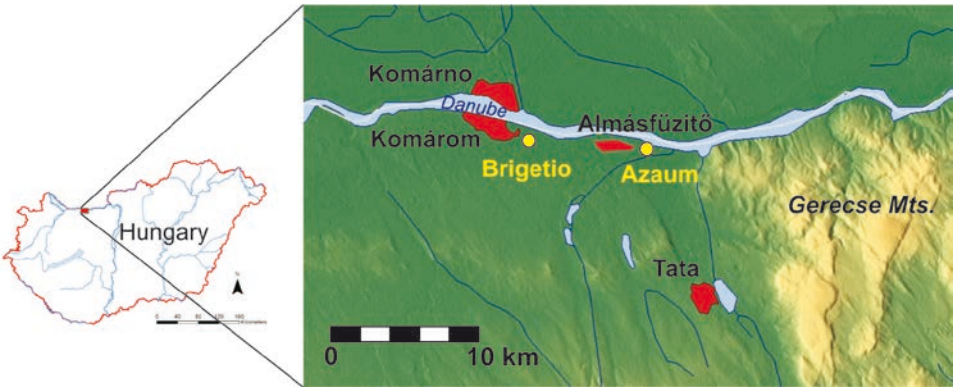

Fig. 1. Location map of the study area

Although the area is well researched by archaeologists since a long time, the reconstruction of the environment became a research topic only in the last decades (Deák 1995; Viczián, Horváth 2006; Deák et al. 2013). The research area lies on the Little Hungarian Plain on the floodplain terrace of the Danube. At the studied section of the Danube, south of the river, a filled-up paleo-subchannel can be identified running parallel to the present river for an approximately 15 km long section between Komárom and Almásfüzitő in which the Szőny-Füzitő-canal flows. Brigetio was bordered by the Danube River on the north and by an abandoned riverbed on the south. Azaum lied where the two channels met again. The Fényes stream also flew into the paleo-channel at this place, its north-south valley collected the streams of Gerecse Mountains and the waters of the abundant karst springs.

The previous geomorphological studies (Horvát, Viczián 2004; Viczián, Horvát 2006; Deák et al. 2013) concluded that an embankment was built in the common section of the Danube paleo-channel and the Fényes stream's valley in the Roman time. Two flood-gates were constructed in the embankment for getting the benefits of being able to control the water flow and to regulate the water level. The dammed water occupied the low-lying territories of the paleo-channel and of the Fényes stream's valley creating a lake or a marsh between the present Komárom, Tata and Dunaalmás settlements (Fig. 2).

The remnants of Roman construction are visible on L. F. Marsigli's map (1726) well known in the archaeological literature (Fig. 3). The Italian military engineer and traveller depicts a number of constructions from the Roman period

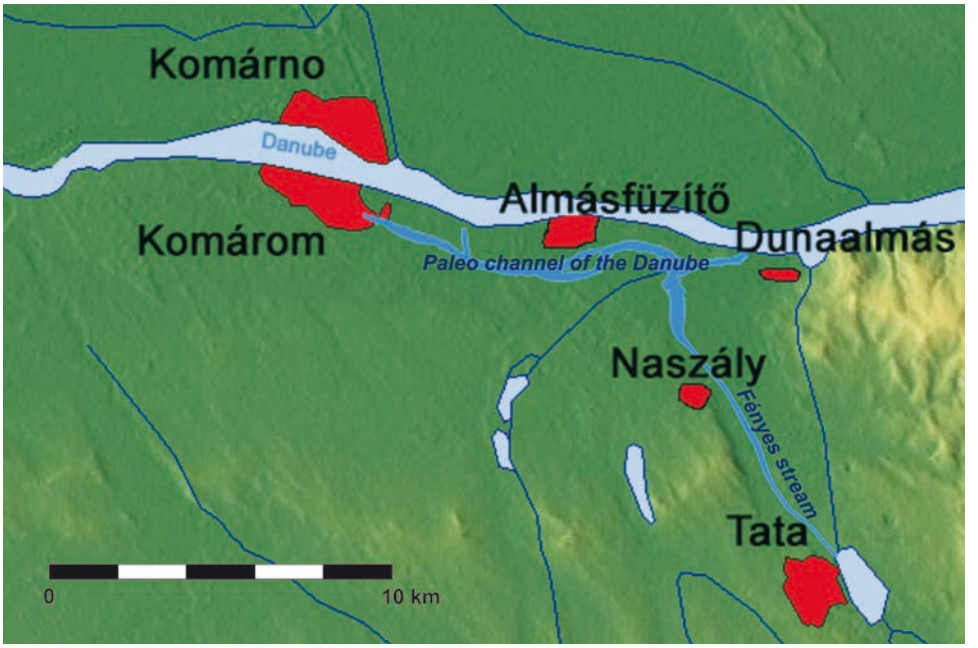

Fig. 2. Sitemap of the flooded area in the paleo channel of the Danube and the Fényes stream valley

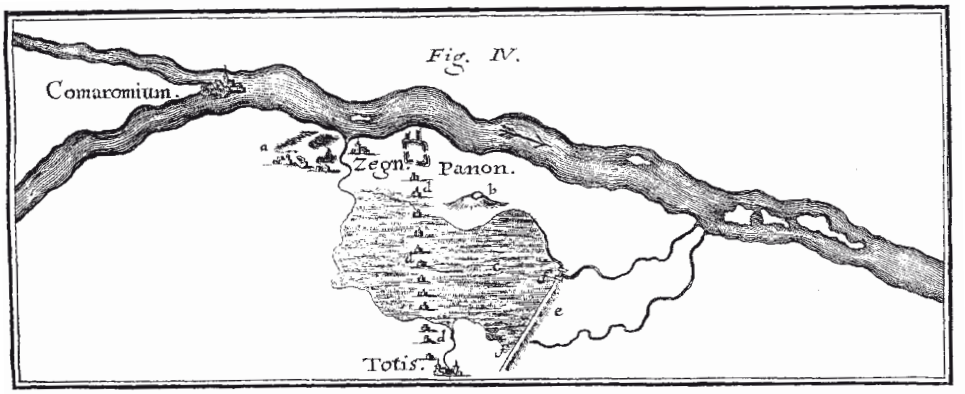

Fig. 3. L. F. Marsigli's map (1726) of the section of Danube between Komárom and Neszmély. Explanation: Comaromium — Komárom, Zegn — Szőny, Totis — Tata, a — Roman ruins at Szőny, b — artificial mound with a small fortress on top, c — marsh fed by a stream flowing from Tata, d — ruins of a water-conduit, e — dam, f — flood-gates

in the environs of Komárom. Several Roman ruins such as fortresses and a water conduit could be seen until the end of the 17th century. Even a marsh or lake fed by a stream and a dam with two flood-gates are depicted by L. F. Marsigli, which could be interesting from a geomorphologic point of view. The Roman buildings seen on the map were accurately identified by the archaeologist; nev-

ertheless they did not give a satisfying answer to the location and role of the marshes, the dam and the flood gates.

The purpose of our research was to study the marsh seen on the map and to reconstruct the Roman environment and understand the interaction between man and the environment since the Roman times.

MATERIAL AND METHODS

For reconstructing the Roman environment it was essential to get to know properly the geographical and geomorphological characteristics of the research area as well as the history of the area. Geographical research involved channel-crossing drillings in the southern side channel (south from the "Brigetio Island"), creating detailed cross-profile about the abandoned channel and its surroundings, geomorphological mapping (field survey based on topographical maps, air photos, satellite images and the profiles of open pits) and statistical-morphometric investigations: profiling the terrace-floodplain system taking profiles of shallow bore holes along N-S cross sections.

Digital elevation models were created based on topographical maps from the 20th century. We made a digital elevation model (DEM) of the surface showing the area before the large anthropogenic impact which characterizes the area today (red sludge reservoirs and oil refineries/reservoirs). We digitized elevation contours and used ArcGIS's "topo to raster" tool — which is an iterative, finite difference interpolation technique. However this DEM is only showing the surface which is present after the Roman surface alterations made before about 1700 years. We tried to reconstruct the geomorphology of the area by analyzing the abandoned channel-sediments through 28 shallow (max. depth: 4.2 m) drills in order to know the exact depth and sediments of the original Danube subchannel. Using that information we did an interpolation, creating several polygons with the relative depth values compared to the present surface as attributes. In the next step we converted the contours we used for DEM creation to points and subtracted the polygons' value from the elevation points — then we did the interpolation again. With this method we managed to get two more DEMs: one showing the surface at the time the Romans built the dam and the one that existed several hundred years later, when the active riverbed started to turn into a marsh. Our model was made using the different DEMs showing the surface from the Roman age we created different flooding maps for different water height scenarios — but also analyzed the relative height of the settlement. It's quite obvious, that it was built on the highest point — a relatively safe area in case of flooding.

Besides the classical geomorphological research methods and DEMs we attempt to get familiar with all the related historical, local historical and archaeological sources, as well as to get into contact with the researchers of these

fields. Special emphasis was laid on studying archive maps (from the 17th century) depicting the area.

RESULTS

There are not enough historical sources to prove the continuous existence of the marsh or lake since the Roman period; therefore we must confine ourselves to some indications. Several cartographic records representing the hydrographical conditions were found thanks to archival research (Viczián 2009). Hereby only the most essential and important sources are presented.

The map of G. G. Priorato (1672) is one of the first detailed sources providing an exact view of the marsh (Fig. 4). It was made at the time of the Turkish occupation of Hungary and it shows the siege of Komárom in 1661. With the help of this map we are brought to understand the importance of the wetlands in wartime and the defensive role of marshes, rivers, and streams. The embankment built by the Romans as well as the system of streams and marshes are excellently shown on this map.

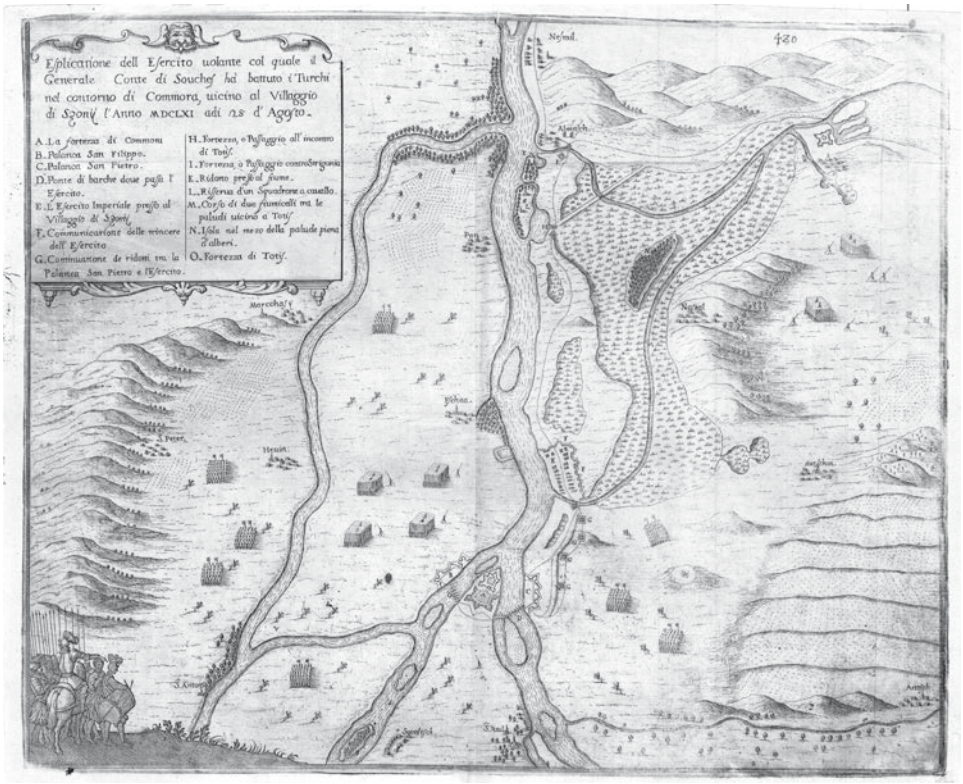

Fig. 4. Map of Komárom's siege (Priorato 1672) showing the study area south of the Danube (right on the map). Note: north is to the left, east is up

The description of the researched area by the great polyhistor and geographer M. Bél (1735, 1989) is in line with G. G. Priorato's map. M. Bél writes about the stream coming from Tata in this manner: *"it has the name Zugó, it goes rapidly towards the village Naszal (Naszály). But since even to these days the amazingly walled embankment, which once restrained the stream and was built on royal expense, holds it up again, it flows into a fishpond, which is a mile long and about half a mile wide. It spreads out till Szőny, and flows into the Danube through exactly three channels. One is at the very same Szőny village, the other at Almás and the third principal one, because of the square shaped stones used for its construction, at Füzitő"*.

The Roman flood-gate in the embankment at the channel of Füzitő (present Almásfüzitő) was the key object where the water level could be regulated. S. Mikoviny was entrusted with the work to drain the territory in 1746 (Deák 1995). He made a detailed map of the area with the plan of drainage works and gave a description about the territory (the map is in Magyar Országos Levéltár (MOL) — National Archives of Hungary, Kamarai S11 No. 290). The map shows the Roman embankment, the drawing of the flood-gates and the plan of the draining channels. The Roman flood-gates are shown on his map as a separate picture. S. Mikoviny describes the construction of the flood-gates by the Romans in his letter in Latin language to the Hungarian Chamber as follows: *"Two large flood-gates were erected by quadratic stones which emerge until now intact from the water"* (Baranyai 1928).

S. Mikoviny deconstructed the flood-gates in the dam, dug out two channels and drained the marshes. The artificial marsh or lake produced by the Romans' human impact existed until 1747. This fact is also confirmed by several additional sources, which are not mentioned in this paper. The Roman dam was the embankment of the Limes road and it is identical with the embankment of the current railway (Viczián 2009).

In order to reconstruct the Roman environmental conditions we have to know the extent of sediment accumulation in the marsh or lake area since the embankment's construction. S. Mikoviny describes in one of his letters that *"the plain covered by water has changed easily and inevitably into a marsh. Even its traces can be seen. When digging a channel in a fathoms depth under the soft mud another hard ground mass is found which is covered by gravel or turf in many places"* (Baranyai 1928). It is clear that S. Mikoviny described the accumulation of silt on the surface of the riverbed gravel. By subtracting the thickness of the sediments accumulated prior to the Roman times from the total thickness of the drillings, the level of the Roman surface was obtained. On higher elevations at higher flood plains, the thickness of the sediments covering the Roman ruins were considered. The resulting values were interpolated and assessed in GIS (Fig. 5). The Roman level of the water dammed behind the embankment was defined based on the explanation of S. Mikoviny, who gave a precise description about the height of the water level raised by the flood-

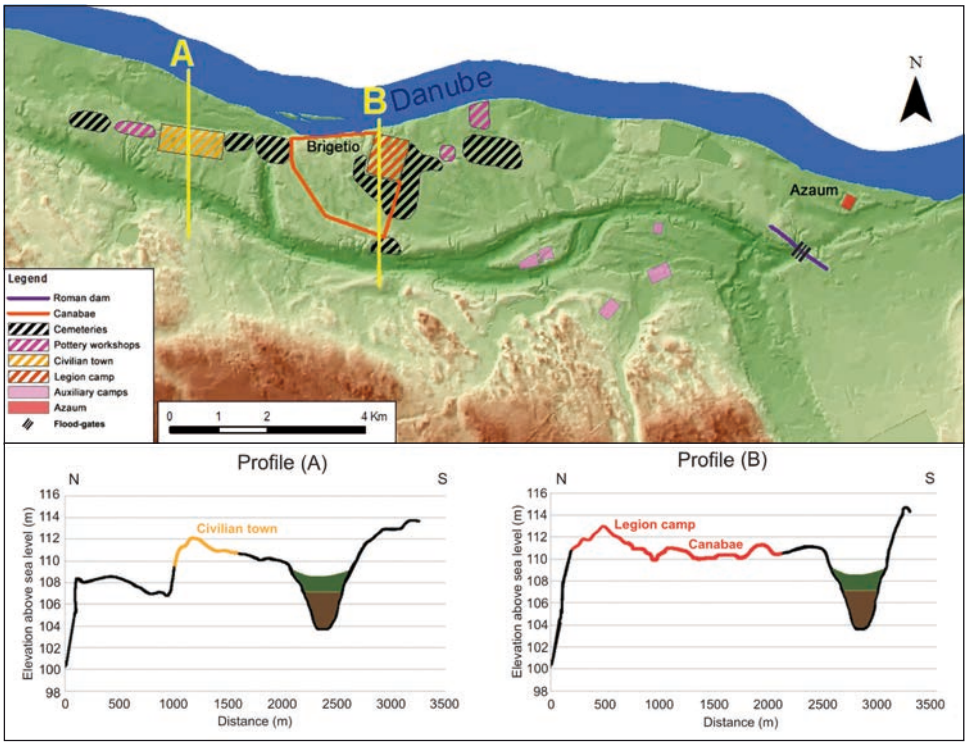

Fig. 5. Digital elevation model of the study area, and cross-profiles: A — of the „Brigetio Island", between the present Danube and the southern subchannel in the vicinity of the Roman municipium/civilian town; B — of canabae/military town. These inhabited objects were built on the highest terrains, on the levées of the higher level of the Danube floodplain. The cross profiles show the current channel surface (at about 109 m a.s.l.) and the uppermost layer of the Roman (now buried) channel-crossing road in the southern subchannel (at 107 m a.s.l.)

gates. The area's inundation model was prepared based on this information (Fig. 6) to study different water level scenarios. The archaeological findings and the dam reconstructed by S. Mikoviny both suggest this level as a maximum since the height of the settlement is at 110–111 m a.s.l. It is probable that the settlement was built somewhat higher to avoid floods in the city. The surface of the Roman road we found was at 107 m a.s.l.

The birth and thriving of Brigetio is directly connected to the geomorphological surface evolution of Danube's vicinity and the changes of floodplains. The Roman governed network of settlements were built on the Danube's right bank beginning from the 1st century AD. The area's most prosperous era had been the first decades of the 3rd century AD, which then declined gradually. Inhabitants fled or resettled in the direct neighbourhood, then inside of the legionary camp (Barkóczi 1944–51; Borhy 2006). Scattered Hun and Langobard objects from the 5–6th century AD were also found in the area. However,

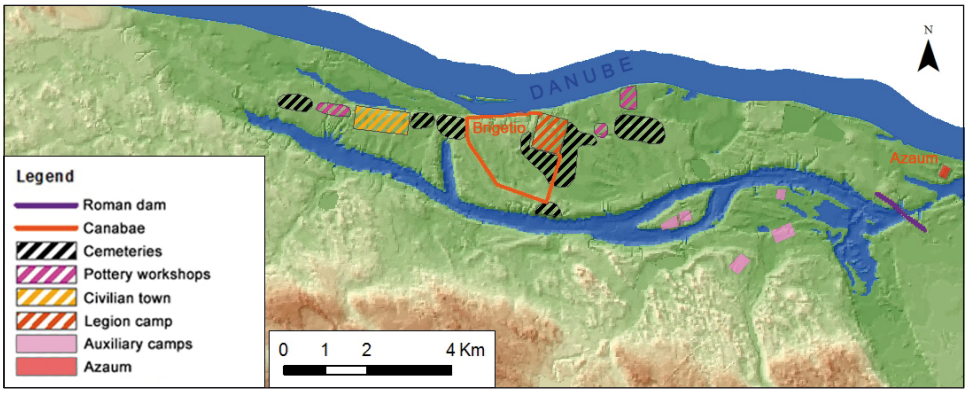

Fig. 6. Inundation model of the study area based on the DEM with the simulated water level at 106 m a.s.l.

the site's continuous colonization is not proved by archaeological data (Borhy 2011). What might be the reason for the area's relatively short inhabitability? What were the advantages that brought Romans here, what factors made their settling possible at that time, and why exactly at that time? Why has the area become uninhabited later?

Geomorphology and hydrography have the answers for these questions. After the formation of the higher floodplain (I. terrace – Pécsi 1959, early Atlantic – Gábris et al. 2012) it still took a long time for human colonization to begin. Accumulation of the higher floodplain sediments dates back to the end of the Atlantic and the first half of Subboreal phases. The formation of the higher floodplain took place during the last third of the Subboreal (Gábris 1995, 1997; Horváth 2000, 2002). The formation of the channel braid located south of the island that later gave the location of Brigetio dates to the end of the Late Bronze Age (3500–2800 BP). This means that a large island was formed surrounded by the main Danube channel and a smaller side channel in the south. This subchannel was 100–150 m wide with depth between 2 and 5 meters – with shallows in the channel bed.

Higher water levels, a flood phase due to climatic humidity at the end of the Subboreal phase forced earlier settlements to move to higher grounds: a new incision began to form (Horvát 2002). This resulted in the strong incision on the northern edge of "Brigetio Island" and the levee-development on the northern and central part (due to the frequent floods and high flood levels). Also the island's southern channel became inactive during this period. Its channel bed got higher than the Danube's channel bed's elevation. Thus its western inflow filled with sediments.

During the Early Subatlantic (Late Iron Age and the first two centuries of the Roman imperial period) levees in the direct vicinity of the Danube have been already inhabitable, as a result of dominantly lower and decreasing water

levels (due to drier climate). This water level change is reflected in the growing number of Danube bank settlements, too.

Therefore, the Brigetio settlements were not built on the island surrounded completely by water, but it was rather peninsula-like. The settlement itself was built on the top grounds of the island (Fig. 5), on the Danube's higher floodplain only on the wider levees and their remnants (110–113 m a.s.l.). The palaeo-Danube subchannel bordering the former island has already begun to filled up as a result of floodwaters overflow above the sediment plugs and between the leveés. Data from our drillings and sediment profiles prove that 2/3 of the channel depth has already been filled with fine (clay) sediments: from 103.8 m to 106 m a.s.l. The Roman road crossing the channel (road pavement at 107 m a.s.l.) was built on this basement.

Consequently, — after the Roman era — the Roman built Brigetio became inapt for human inhabitation because of the Danube's floods and the large marsh dammed by the Roman embankment (the southern channel crossing road to the former Brigetio now lying under 1 m fine sediment). Romans built their legionary fortress and settlements in good time, good place. But the thriving of the city brought such human environmental impact, which made the area less suitable for habitation again following the Roman era.

The Roman's embankment building activity across the southern paleo-Danube subchannel and the regulated floods by dammed waters meant the onset of anthropogenic floodplain evolution. The inactive Danube subchannel remained a marshy area until 1747 (Deák 1995; Viczián, Horvát 2006).

CONCLUSIONS

As a common result of the natural morphogenetic processes and human impact on the environment a cultural landscape has been formed that bears the traces of both factors. The history of the marsh occupying the area south of Komárom and its role in the life of settlements and inhabitants in various ages could be revealed by multilateral, interdisciplinary research.

The Roman settlement complex Brigetio was built on the Danube's higher floodplain at the wider levees and their remnants (110–113 m a.s.l.) surrounded by the present Danube in the north and a smaller subchannel in the south. The formation of the subchannel dates to the end of the Late Bronze Age (3500–2800 BP) and it became inactive during at the end of the Subboreal phase, in the Early Iron Age when its western inflow was filled with sediments.

Brigetio was built on a peninsula-like area partly surrounded by water. Data from our drillings and sediment profiles prove that 2/3 of the subchannel depth has already been filled with fine (clay) sediments by this time.

Our researches confirmed that an embankment was built by the Romans in the common section of the subchannel and the Fényes stream's valley. Two

flood-gates were built in the embankment controlling the water flow and regulating the water level. The dammed water occupied the low-lying territories of the subchannel and of the Fényes stream's valley creating a lake or a marsh between the present Komárom, Tata and Dunaalmás settlements.

Following the Roman age the dams were abandoned, the area became a marsh which gradually filled up. Archive maps and historical sources prove that the area remained a wetland until 1747 when S. Mikoviny drained the territory.

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REFERENCES

Baranyai J., 1928. *Régi utazások Komárom vármegyében: a legrégibb időktől a múlt század közepéig*. Offprint from Komáromi Lapok, Spitzer S. Ny., 33–95, (in Hungarian).

Barkóczi L., 1944–51. *Brigetio*., Dissertationes Pannonicae, Ser. 2, No. 22, Budapest.

Bél M., 1735 (1989). *Descriptio comitatus Comaromiensis*. Manuscript. [in:] Bél M., *Az újkori Magyarország földrajzi-történelmi ismertetése, Komárom vármegye*. József Attila Megyei Könyvtár, Tatabánya, 1–83. (Translated by L. Vilimszy, 1989), (in Hungarian).

Borhy L., 2006. *Brigetio/Komárom-Szőny, Komárno*. [in:] *Legionsadler und Druidenstab. Vom Legionslager zur Donaumetropole*. F. Humer (ed.), Textband, Carnuntum-Wien, 152–153.

Borhy L., 2011. *Das Legionslager Brigetio und sein ziviles und militärisches Umfeld in der Spätantike*. [in:] *Römische Legionslager in den Rhein — und Donauprovinzen — Nuclei spätantik-frühmittelalterlichen Lebens?* M. Konrad, Ch. Witschel, (ed.), München, 533–547.

Borhy L., Bartus D., Czajlik Z., Rupnik L., Számadó E., 2011. *Tábor-város a Duna mellett. Brigetio (Komárom/Szőny) — Fortress/City next to the Danube*. [in:] *Rómaiak a Dunánál. A Ripa Pannonica Magyarországon mint világörökségi helyszín (Romans on the Danube. The Ripa Pannonica in Hungary as a World Heritage Site*. Zs. Visy (ed.), Pécs, 42–51, (in Hungarian).

Deák A. A., 1995. *Mikoviny Sámuel és a Tata környéki "posványságok" lecsapolása*. Hidrológiai Közlöny 75, 5, 289–294, (in Hungarian).

Deák M., Nagy B., Viczián I., 2013. *Az elmélet és gyakorlat találkozása a térinformatikában*. IV. J. Lóki (ed.), Debreceni Egyetemi Kiadó, Debrecen, 181–188, (in Hungarian).

Gábris Gy., 1995. *A paleohidrológiai kutatások újabb eredményei*. Földrajzi Értesítő 44, 101–109, (in Hungarian).

Gábris Gy., 1997. *Gondolatok a folyóteraszokról*. Földrajzi Közlemények 45, 3–16, (in Hungarian).

Gábris Gy, Horváth E, Novothny Á, Ruszkiczay-Rüdiger Zs., 2012. *Fluvial and aeolian landscape evolution in Hungary — results of the last 20 years research*. Geologie en Mijnbouw — Netherlands Journal of Geosciences 91, 1–2, 111–128.

Horváth A., 2000. *Hazai újholocén klíma és környezetváltozások vizsgálata régészeti adatok segítségével*. Földrajzi Közlemények 48, 149–158, (in Hungarian).

Horváth A., 2002. *Újholocén klíma- és folyóvízi környezetváltozások vizsgálata hazai régészeti adatok segítségével*. http://geogr.elte.hu/PHD_konferencia_ELTE_2002/doktori_konferencia_anyagai_2002/horvathaniko.pdf (in Hungarian).

Horváth F., Viczián I., 2004. *Brigetio (Ószőny) — Azaum (Almásfüzitő) limesszakaszának római kori emlékei a terület geomorfológiai viszonyainak tükrében*. [in:] *A táj változásai a Kárpát-medencében, Víz a tájban*. Gy. Füleki (ed.), Környezetkímélő Agrokémiáért Alapítvány, Gödöllő, 223–227, (in Hungarian).

Marsigli L. F., 1726. *Danubius Pannonico-Mysicus observationibus Geographicis, Astronomicis, Hydrographicis, Historicis, Physicis perlustratus*. Amsterdam.

Pécsi M., 1959. *A magyarországi Duna-völgy kialakulása és felszínalaktana* Földrajzi Monográfiák 3. Akadémiai Kiadó, Budapest. 345 pp., (in Hungarian).

Priorato G. G., 1672. Map of Komárom's siege.

Szabó M., 2011. *Élet a hadsereg árnyékában* (Life in the shadow of the army). [in:] *Rómaiak a Dunánál. A Ripa Pannonica. Magyarországon mint világörökségi helyszín*. Zs. Visy (ed.), Pécs, 89–93, (in Hungarian).

Szabó M., Visy Zs., 2011. *Menettáborok Brigetio környékén* (Marching camps in the vicinity of Brigetio). [in:] *A Danube limes program régészeti kutatásai 2008–2011 között. Jelentés a Danube Limes Unesco World Heritage Site pályázat keretében a PTE BTK Régészet Tanszékének kutatócsoportja által végzett kutatásokról*. Zs. Visy, M. Szabó, A. Priskin, R. Lóki (ed.), Pécs, 107–112, (in Hungarian).

Viczián I., 2009. *Az ember környezetformáló tevékenységének történeti változásai a Komárom–Esztergomi-síkság és a Nyugati-Gerecse területén*. PhD Thesis, manuscript, PTE Earth Sciences Doctor's School, Pécs, 129 pp., (in Hungarian).

Viczián I., Horváth F., 2006. *A tatai mocsarak a római korban és Mikoviny Sámuel lecsapoló munkája*. Földrajzi Értesítő 55, 3–4, 257–272, (in Hungarian).

Visy Zs., 1989. *A római limes Magyarországon*. Akadémiai Kiadó, Budapest, 56–60, (in Hungarian).

Visy Zs., 2000. *A ripa Pannonica Magyarországon*. Corvina, Budapest, 34–40, (in Hungarian).