ZIRIDAVA

STUDIA ARCHAEOLOGICA

35

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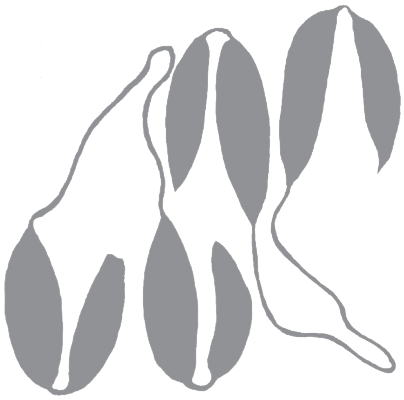

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Contents

REVIEWS

Using the water power in preindustrial Banat. A historical archaeology study on the Lower Timiș River*

Cristian Floca, Florin Gogâltan, Alexandru Hegyi, Patrick Chiroiu, Sorin Forțiu

Abstract: One of the most important uses of water throughout history is its use as energy source. According to documents, the low plain area of the Banat, crossed by many rivers and streams was a watermills' land for several centuries. The recent field research we have conducted confirms the high density of these structures in a segment of the lower Timiș, south of the Timișoara city, an almost unknown and endangered river heritage. A careful archaeological documenting of the situation on site contrasted with the analysis of dozens of historical maps and certain background data provided by history and dendrochronology, allowed us to outline a spatial and temporal picture of these hydraulic systems. We undertake this investigation as a small, first step of a resourceful research subdomain, necessary for the historical specificity of the Banat, namely *river archaeology* or *riverscape archaeology* as an integral part of historical archaeology.

Keywords: historical archaeology; river archaeology; watermills; Timiș River; dendrochronology.

Introduction

The high value that human societies granted to water – in everyday life, domestic use, economic production, and spirituality – has always urged all civilizations to manipulate watercourses[1].

In the Banat area, such concern for "domesticating" water may be widely documented starting with the 18th–19th century large-scale works, however smaller interferences on watercourses are attested before modernity[2].

The historical context in which the Banat area has evolved, followed its course in natural connection with the geographical realities of the region. In terms of society's relationship with the surface water network, two major historical stages may be distinguished, which depict two worlds almost foreign to each other: the old, traditional and the new, modern. From the first sedentary human communities settled in the area until the twilight of the Middle Ages, the *ancient world* portrays settlements and waters as unitary tissue, organically developed, in which human communities moved and lived in close connection with the hydrography of the area, in accordance with its dynamics. The communities owned a system of *traditional ecological knowledge* acquired empirically, adapted through different socio-cultural processes to the environment, with which they coexisted in dynamic balance and wise management of resources. Such balance was necessary in order to ensure subsistence of the community for long periods of time[3].

This long historical phase is, in the Banat area, conspicuously interrupted by the region's passing under the House of Habsburg's control, which would mark the beginning of a new era. The structures of the western society, far superior technologically, with an authoritarian political force, would be enforced through major changes of the entire local habitat, adapting the land and hydrography to the new views of the state force. Commenced in the 18th century, this extensive process of *metamorphosis* would become visible mainly by late the following century, when many of the imperial administration's major projects would be completed. Especially during the last two centuries, the historical relationship of human communities with the surrounding river ecosystems has been profoundly altered, while the peculiarities and resource variety of a water land such as the Banat have

* English translation: Gabriela Safta.

1 Tempelhoff *et al.* 2009, 2.

2 We refer here to the construction of dams on the Timiș, attested, as we will see, as early as the 15th century.

3 Ivașcu 2018, 8.

dissolved into a modern homogeneous and levelled habitat[4], with social and environmental losses difficult to estimate.

More historical and cultural information on how people capitalized on the surface water resource in the Timișoara plain can help us understand the current situation, when society's relation with surface waters falls short. This outlook may contribute to the development of better and more careful methods of harnessing and managing water.

Although more difficult to document, the interventions of ancient human communities on watercourses or in connection with stagnant surface water bodies prior to modernity, may sometimes be recovered or reconstructed. A special class of historical water management systems were the hydraulic installations used in milling activities[5]. The „Archeology of Mills and Milling"[6], „Mühlenarchäologie" or „Archäomolinologie"[7] has become in recent years a field of research that is gradually finding its methodology[8].

During a *riverscape archaeology* project, carried out on the Timiș river area between Albina and Giroc[9] from 2018 to 2020, a series of systematic surveys of the meadow and riverbed were performed, on which occasion a rich and unique river archaeological heritage was discovered, consisting mostly of wooden structures or ensembles. The finds consist mostly of fixed elements, composed of pillars or posts, to which add moving parts, displaced from their original position (wooden objects, bricks, stones etc.). This is a fragile heritage, exposed for several centuries to the conditions provided by the streambed (floods, frost, drought and exposure to air, alluvium), processes that have greatly damaged the goods and appearance of the original constructions. Nonetheless, the layout and appearance of the surviving elements, put together with the history and dendrological analyses, can recover only a small part of what was once a specificity of the water land, such as the historical plain of Banat.

Compared to the mountainous Banat, well documented in terms of watermills due to the preservation of these structures until late (some still operate today), the plain area, affected much earlier by modern interventions, lost the possibility of documenting standing structures. Nevertheless, certain aspects of what lay there in terms of heritage may be made much better known, especially through the tools of historical archaeology[10].

Aims

The constant decay to which this archaeological and historical river heritage is exposed to could lead to its extinction before history is able to acquire too much information about it. In this respect, we proposed to systematically document a stretch of the lower Timiș river, with the aim of finding answers to questions such as: how did the different civilizations inhabiting the low Banat plain harness and manage the water resource over time? What was the use of the post assemblies visible in the Timiș riverbed and when are they built? Were there any watermills on the Timiș? If so, when did they operate? What is the difference between the watermills in the mountainous Banat and those from the plain?

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4 Pinke 2014, 93.

5 Lucas 2006; Gräf 2006; Liebert 2008; Maříková, Zschieschang 2015; etc.

6 Watts 2002.

7 Berthold 2015, 235.

8 Liebert 2015; Véron 2017.

9 This research was conducted for the personal doctoral thesis of Cristian Floca, under the tutelage of the West University of Timișoara, titled: "*Viețuind printre ape. O istorie regresivă a habitatului uman din Câmpia joasă a Banatului, la confluența pârâului Pogăniș cu râul Timiș*" ("*Living among the waters. A regressive history of the human habitat from the Câmpia Joasă a Banatului, by the interflow of the Pogăniș stream with the Timiș river*"), under the supervision of PhD. habil. Florin Gogâltan. Significant segments of the text here have been extracted from the above.

10 See Hicks, Beaudry 2006. We thank here the editors of the *Ziridava. Studia Archaeologica* journal for supporting this field of archaeological research in Romania as well. This study thus adds to the results of the archaeological excavations conducted in the late and modern medieval city of Sibiu (Nițoi, Urduzia 2014), Timișoara (Micle et al. 2017) and the 18th – 19th century Quarantines of Gheorgheni-Pricske (Demjén, Gogâltan 2015) and Ciuc-Ghimeș (Demjén, Gogâltan 2017), or of certain archaeological find classes framed between late Middle Ages and the 20th century (Gruia 2012; Stoia 2012; Demjén 2018; Demjén 2019; Ghemiș, Zgardan 2020; Demjén 2020).

Natural context

The Great Hungarian Plain is one of the most complex river systems of Europe, developed by tectonic and climate factors, the latter causing major vegetation changes, which impacted hydrography[11]. The land of Banat, as it has been historically defined, occupies the SE corner of the Pannonian Basin, being characterized by some of the lowest relief units from the entire Basin. The historical region of the Banat is located between the Carpathian Mountains (Banat Mountains) to the east and the courses of the Danube, Mureș and Tisza rivers, on the other three sides. The region's plain area is framed by the Western Plain of Romania and is part of the vast Pannonian Basin (Fig. 1). The area is characterized by a flat, subsidence plain, strongly hydrated by numerous watercourses and stretches that, especially in historical times, were easily flooded.

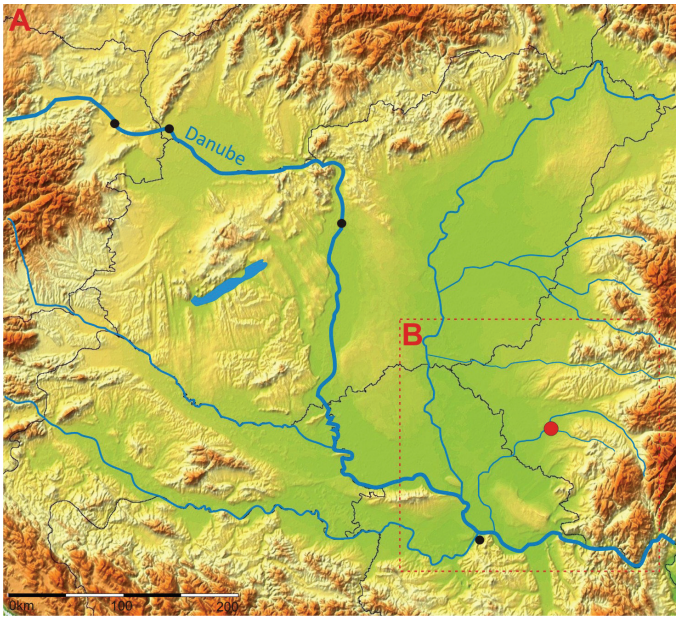

Fig. 1. The Pannonian Basin (A) and the historic Banat (B), with the marking of the study area (red dot).

Our study area is framed in *the low plain with alluvial-proluvial deposits of the lower Timiș river*, in the Ciacova Plain subunit, an area with a typical subsidence appearance which in historical times was subject to extensive water divergences and wandering, with marked meandering and often mooring (its western part)[12].

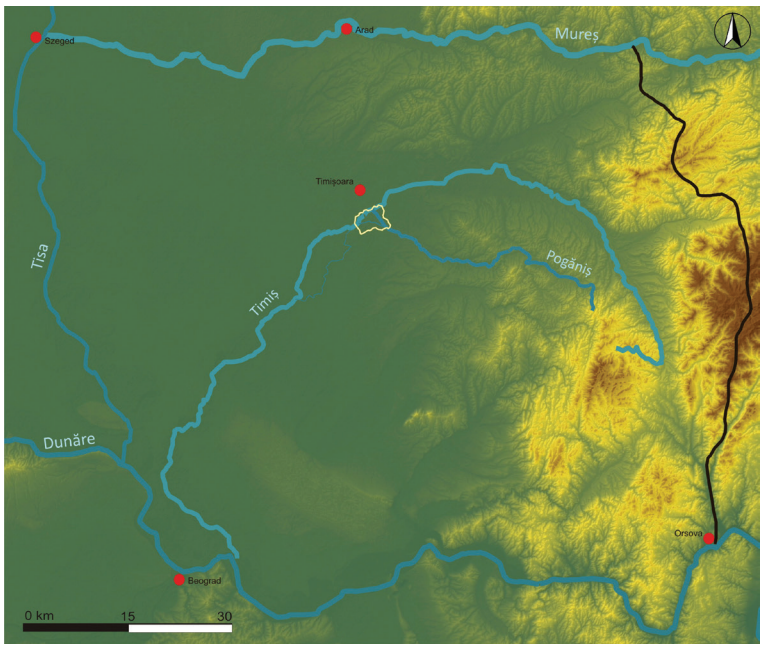

Fig. 2. The historical Banat with the marking of the hydrographic limits and researched area (white polygon).

Among the watercourses of the Banat, Timiș river is the largest inland river, crossing the region from the eastern mountain limit where it has its source (the Semenic Mountains) to the river limit in the southwest, where it flows into the Danube (Fig. 2). Stretching over 339 kilometres, the Timiș river drains the waters of the Banat Mountains (Țarcu, Godeanu and Poiana Ruscă) and the piedmont hills of Lugoj and Pogăniș[13]. Our study has been carried on the lower river sector, typical of an area with small gradient and widening valley (major riverbed), which is why it has been subject to regulating and damming[14].

From a historical point of view, in the studied river segment, significant portions of the current riverbed are common with the old riverbed, of the 18th century and the centuries prior to this century,

[11] Kiss *et al.* 2014, 1.
[12] Ianoș *et al.* 1997, 57–59.
[13] Munteanu 1998, 9.
[14] Munteanu 1998, 9.

which is why this area's potential in terms of wood heritage is high. Instead, where the river route is more recent and more damaged by the regulating project, the wooden structures present on the old riverbed disappearing with its drying because once removed from the flooded environment and subjected to silting, the old installations decay or are completely covered.

Used methodology

Systematic field surveys carried out in riverbed and flood plain

Checking and documenting the Timiș river meadow supposed a different approach compared to land areas. We refer primarily to its riverbed. There is a largely unknown heritage on the water's surface that comes to light especially when the water level drops. In order to check and document the river sector between the bridge of Albina and the Giroc Monastery, several field investigations were carried out in the optimal autumn period (November 2018, October 2019). The sector, which covers approximately 65 hectares (the water surface of the Timiș river), was surveyed from water, beaches or bank levels. The observed heritage, consisting largely of wooden ensembles (but also brick or even stone), present in the water surface or in its vicinity, was marked distinctively from the sites discovered on land. Thus, each ensemble believed unitary received the area code within whose range it lay, followed by the watercourse name where it is located and a number (for instance Uliuc-*Timiș 4*), the count starting from upstream to downstream.

Fig. 3. Uliuc-*Cotu Morii,* image taken during measurements (November 2019).

Differential GPS (DGPS) and Real-time kinematic positioning (RTK) aided reconstruction of the layout

From the first travels we noticed several complex ensembles with numerous pieces, some very small (tens of posts), unnatural for a bridge as often deemed, a priori. In order to identify the layout of these assemblages (especially for understanding their function) we resorted to accurate survey measurements of all the elements we could observe. Evidently, the plan of the discovered elements is distorted. Some elements are missing, others are covered by sand alluvium or vegetal and residual (anthropogenic) remains.

Not infrequently, measurements involved visual inspection and underwater recording of the elements, many parts being completely immersed even at low flow (Fig. 3). In this sense, minimum water levels and settling periods are ideal.

The large volume of points and variety of their appearance required the use of classifications and codes as early as the field registration, transferred on the overall plans drawn for each site. We termed *pylon 1* the largest posts, circular or square in section with section sizes between 20–25 cm / side or diameter.

Posts with *pylon 2* code resemble *pylon 1*, however they are smaller (15–20 cm / side) and are often circular in section, preserving the natural shape of the tree from which they were carved. Elements called *pole* generally represent un-worked circular posts, with a diameter of 6–12 cm; they are sharp at the end stuck in the ground; exceptions are the posts from the Giroc-*Timiș 1* site, with a different appearance and size or those from the Uliuc-*Timiș 6* ensemble, many of which are square in section.

Preliminary dating by the dendrochronology method

The specificity of the finds from the Timiș riverbed, composed of pylons and wooden poles,

together with the lack of dating possibilities of these structures based on artefacts, required a search for dating solutions. Being wooden structures, the chosen option was dendrochronology. We aimed to reconstruct the beginning period of these structures, as their end could be estimated cartographically. 12 samples were collected from eight assemblages (mills), in order to measure the annual tree growth rings used in the construction of the facilities.

Most thick elements were sought, of which complete sections were cut manually or by chainsaw (Fig. 4, 5), thus having a better picture over the samples compared to the drilling method. Visibly worked (shaped) parts were chosen to avoid erroneous sampling from a fossilized tree that has nothing to do with the site. Concurrently, the sampling also aimed at minimum losses of the elements' integrity, end parts already damaged by the passage of time and air exposure being cut. From the point of view of the used wood, it was found that all pylon samples were oak (*Quercus sp*.).

Fig. 4. Uliuc-*Timiș 4*, sampling the horizontal beam.

The sample is dated with annual precision if it contains the last annual growth ring, namely the ring which forms in the year when the tree is cut. In many cases, however, for various reasons (initial wood processing and timber decay over time), the samples do not contain all annual rings that the tree has formed. As a result, the dating is relative, based on an estimate of the number of missing rings.

An indication for these estimates is the presence of sapwood rings. In oak species, for example, the average number of sapwood rings differs from one region to another. In Maramureș area, sapwood averages a number of 10–16 annual rings[15]. A key condition for accurate dating is the number of rings which the analysed sample contains. Reliable results are obtained when the sample contains a minimum of 50 rings[16]. Between 30 and 50 rings, the dating may include errors, and less than 30 annual rings is not recommended[17]. In the present study, samples containing between 18 and 84 rings were analysed (see Table 2).

The analysis of the samples taken followed the standard dendrochronological procedures[18], consisting of samplespreparation with abrasive paper of three different granulations (150, 240 and 600), followed by counting, measuring and dating the annual rings. The LINTAB 5 measuring station[19] and the TSAPWin software interface[20] were used to

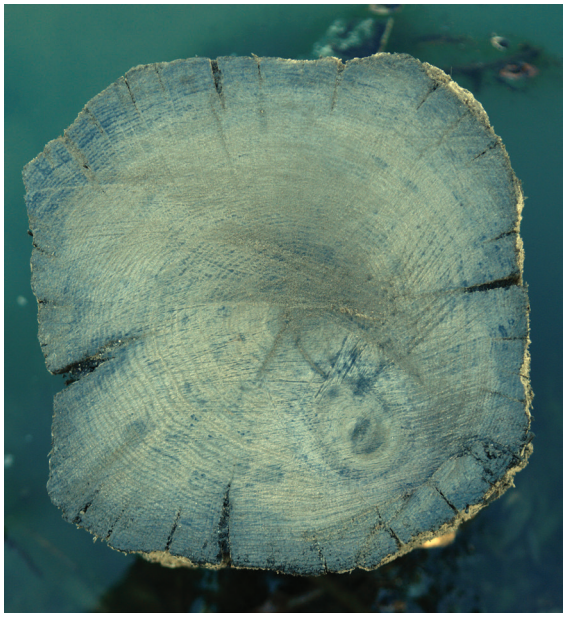

Fig. 5. Uliuc-*Timiș 2*, the pylon of which the sample was collected, counting 72 growth rings.

[15] Nechita *et al.* 2018.
[16] Speer 2010.
[17] Nechita 2014.
[18] Bräker 2002.
[19] http://www.rinntech.de/content/view/16/47/lang,english/index.html (29.09.2021).
[20] Rinn 2012.

measure the annual rings. A floating dendrochronological series results for each analysed sample after measuring ring widths. This floating chronology is crossdated with a reference chronology both statistically and visually. The statistical indicators used in this study are CDI (*Crossdate Index* – an index created especially for crossdating tests that combine GlK and T-values – Rinn, 2012), Glk (Gleichläufigkeit – general concordance coefficient between two time series[21]) and T-Value (correlation test sensitive to extreme values[22]). Minimum values for statistical dating CDI> 30, GlK> 60 and T-Value> 5 are generally recommended.

The reference chronology is a time series that spans several centuries and characterizes the multiannual growth of a certain tree species in a certain area[23]. Since currently there is no reference chronology for oak in the Banat plain area, we have attempted here to date the samples using reference chronologies currently available in our country (Maramureș, Povergina / Crivina, Odorhei, Valea Târnavelor, Brașov / Trei Scaune).

Dating using the Maramureș chronology[24]

The Maramureș chronology spans 781 years (1236–2016), the authors indicating its relevance for the Banat area as well[25], the chronology being successfully used for dating some wooden structures from the Theresia Bastion of Timișoara[26].

The crossdating results of the analysed samples are summarized in Table 1. For most samples, the values of the statistical indicators are below the recommended limits, while the obtained years fall into very different periods. With the exception of the Giroc-*Timiș 1_s.1* test, no sample has values above 30 of the CDI index, and the said sample contains only 22 rings, hence the result may contain significant errors. In the Uliuc-*Timiș 3* and Unip-*Timiș 1* tests, acceptable statistical scores were obtained (only CDI is slightly below the threshold of 30). Theoretically, the dating for these two samples could be considered statistically, but the data obtained raise important questions.

In dendrochronological practice, it is emphasized that statistical crossdating should be checked by visual crossdating, with the aim of validating the statistical results[27]. Subsequent to visual appreciation of crossdating, it is noted that in some cases, the visual match is better for periods when statistical values are smaller.

Table 1. The results of crossdating with the *Maramureș chronology*

Sample	**Rings**	**Most recent ring**	**Statistical indicators**		
			CDI	CDI	CDI
Uliuc-*Timiș 3*	72	1942	29	63	5.1
Unip-*Timiș 1*	45	1482	28	73	7.9
Giroc-*Timiș 1_s.1*	22	1637	35	79	5.6

The results of crossdating the analysed samples with the Maramureș chronology prove to be inconclusive, most likely owing to the rather different climate conditions between the Maramureș area and the Banat plain. Another reason for the unsuccessful dating is the fact that only three samples contain more than 40 rings. For samples with less than 50 rings, the dating may be erroneous even if better statistical values are obtained.

Dating using the Povergina / Crivina chronology[28]

The dendrochronological investigations performed in 2020 with the wooden churches of Crivina de Sus and Povergina (located in the Făget area, at the foot of the Poiana Ruscă Mountains) made possible the set up of a reference chronology on oak extending over a period of 222 years, between 1537

[21] Eckstein, Bauch 1969.
[22] Baillie, Pilcher 1973.
[23] Popa 2004.
[24] Novel information, from the research of Patrik Chiroiu, 2020.
[25] Nechita *et al.* 2018.
[26] Chiroiu *et al.* 2018.
[27] Rinn 2012.
[28] Novel information, from the analyses of Patrick Chiroiu, 2020.

and 1758. This chronology is not yet complete or published and has the disadvantage of the limited range it covers. The reason why it was used here is the proximity to the discussed area.

The results of crossdating the samples with the Povergina / Crivina chronology are presented in Table 2. Only six of the analysed samples had statistically acceptable scores, while the visual crossdating of these samples was also satisfactory. Firstly, it is noted that statistical scores are better than with the dating using the Maramureș chronology, while the time interval is more homogeneous. One must note that none of the samples contain sapwood rings, which results relative dating.

The very good scores obtained by the Giroc-*Timiș 1_s.1* and Uliuc-*Timiș 1_s.1* samples are interpretable, since they contain few annual rings (22 and 21 respectively). From the analysed samples, only Uliuc-*Timiș 3*, with 72 annual rings and good values of statistical indicators may be accepted as successful dating. Other noteworthy results are the Uliuc-*Timiș 4_s.1* test, with a particularly good visual crossdating, even though the CDI value is below the 30 unit threshold, and the Uliuc-*Timiș 7_s.3* test, which has a significant value of the Glk indicator, even if the CDI value remains well below the recommended threshold. However, since the dating of the samples are relatively close in time, this might suggest that the analysed wooden structures were built in the same period or at most within a few decades' time span, during the second half of the 17th century.

Table 2. The results of crossdating with the *Povergina / Crivina* chronology

Sample	**Rings**	**Most recent ring**	**Statistical indicators**		
			CDI	CDI	CDI
Uliuc-*Timiș 1_s.1*	21	1658	48	95	6.1
Uliuc-*Timiș 3*	72	1688	30	65	5.4
Uliuc-*Timiș4_s.1*	45	1691	23	68	3.5
Uliuc-*Timiș4_s.2*	84	1707	23	68	3.8
Giroc-*Timiș 1_s.1*	22	1666	44	86	6.1
Uliuc-*Timiș 6_s.2*	35	1733	27	72	3.6
Uliuc-*Timiș 7_s.3*	28	1694	18	81	2.3

Dating using Transylvanian chronologies (Târnave Valley, Odorhei, Braşov-Trei Scaune)[29]

Eight samples were sent to Miercurea Ciuc. Six had from 30 rings upwards, the minimum lab allowed for initiating the analyses. Out of the six, only two samples could be satisfactorily dated (Table 3), as shown by the issued report: *the 47-year series of **sample 1** (Unip-Timiș 1). It was dated by the Braşov-Trei Scaune area chronology between 1519–1565, hence in the absence of sapwood rings it comes from an oak cut around 1578 or later. However, given the rather small concordance values and the large distance between the sample place and that of the chronology, this dating must be regarded as uncertain. **Sample 2**. (Uliuc-Timiș 3) contained 70 rings and its series was dated with the aid of the Târnave Valley chronology and the Odorhei area chronology, between 1479–1548. Thus **sample 2**. – again calculating with the missing sapwood rings – comes from an oak cut around 1561 or later this year. Although some questions still remain with respect to the validity of chronologies within Transylvania for the Banat area, the relatively high comparison values still support the possibility of accurate dating*.

Table 3. The dating of the two Timiș samples performed at Miercurea Ciuc, according to Transylvanian chronologies

Sample	**Rings**	**Chronology**	**GIK**	**T-value**	**Synchronous position**	**Dating**
Unip-*Timiș 1*	47	*Braşov-Trei Scaune*	70.7/99.0%	3.58	1519–1565?	about/after 1578?
Uliuc-*Timiș 3*	70	*Valea Tîrnavelor-Odorhei*	74.6/99.9%	5.11	1479–1548	about/after 1561

As it may be easily observed, the chronological framings of the Miercurea Ciuc laboratory are entirely different from the results obtained on the Povergina chronology, which raises big questions regarding their validity.

[29] Novel information, from the analyses of Tóth Boglárka, 2019.

Looking at the results obtained as a whole, at this time, it is possible to argue that the use of the Maramureș chronology is not suitable for the studied area regarding the analysed pieces. By using Transylvanian chronologies for two of the eight samples, acceptable values of statistical indicators were reported. If one examines the three tables, comparable statistical values may be noted, however the dating results are very different. The most likely cause for these discordant results is the relatively large distance of the Maramureș and Transylvania regions and different climate conditions compared to the area studied here. The proximity of the Povergina / Crivina region and the grouping of the results in a relatively short period (less than half a century) suggest that the dating obtained using this chronology could be the closest to reality.

Lastly, the results of the dendrochronological analysis underline the need to achieve a robust chronology for the Banat area, to be used for datings in the west of the country. Currently, work on this chronology is carried out within the West University of Timișoara, and the first step was to establish the partial chronology from Povergina / Crivina. This partial chronology is already proving to be very useful in dendroarchaeological and dendrohistorical studies from the area, while the dates obtained in this study require the taking of more samples (preferably with more than 50 annual rings), which would validate and extend these results.

History of the field investigations

If we refer to checks from the water line, the contemporary research has not focus on the study of the wooden structures from the Timiș riverbed. Although occasionally noted by archaeologists or historians, they were quickly overlooked, being classified as remains of medieval or modern bridges. In the 80'ies of the last century, during an expedition on the Timiș river, Gh. Lazarovici also arrived in the Uliuc area, where he observes and photographs the pylons from *Cotu Morii* (Uliuc-*Timiș 7*), which he ascribes to a medieval bridge (Fig. 6-left, with the original denomination of the picture)[30].

In a more recent study in our area, L. Măruia, relying on the examination of the Josephinian map mentions the wooden pylons from Giroc-*Mescal*, which he ascribes to a late medieval bridge or water-mill[31]. A few pylons of the ensemble there are illustrated in a photo.

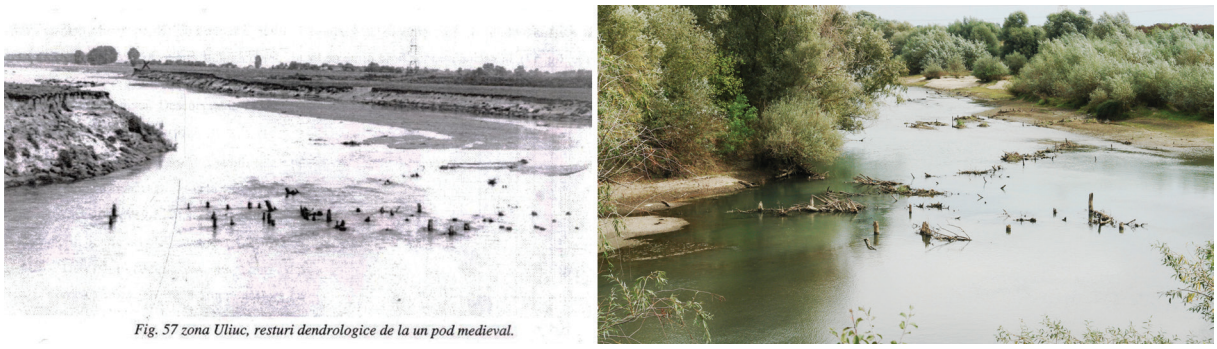

Fig. 6. The Uliuc-*Timiș 7* ensemble, photographed in the 80'ies by Gh. Lazarovici (left) and by us in 2019 (right).

Documentary records on the hydraulic installations from the Banat lowland area

Medieval sources

The Banat area has been conducive to water milling since an early age, given both the natural conditions so rich in aquatic resources and its historical context. We refer, for example, to the ancient period of the region, when the Roman empire, during which the vertical wheel watermill with horizontal axis appeared and developed[32], had a strong influence on the evolution of the Banat settlements.

We do not know at this stage of the research exactly when this activity began in the Timiș river area or for that matter, in the Banat in general; some historians deduce that once with the Roman

[30] Lazarovici *et al.* 2001, 83.

[31] Măruia *et al.* 2011, 174.

[32] From Vitruvius treatise on architecture, written in the last century before our era, it is known that at that time the Romans had switched to the hydraulic mill wheel with horizontal axis (Botzan 1984, 235).

conquest and the empire's influence in the area, their used technique must have been applied on the rivers of Dacia[33]. The hypothesis is not farfetched since the need for milling was high in a prosperous agricultural society. In fact, the distribution almost everywhere in the settlements of the first centuries after the conquest of grinder fragments speaks of the expansion of the milling occupation, even if this may be primarily an activity independent of the hydraulic energy. It is very possible that certain installations were developed in historical times previous to the Middle Ages on rivers from our area, however evidence is missing so far.

More information and first definite data about the area of concern can be found here dating back to the Middle Ages. For the Romanian space, the earliest written record of water-powered mills dates from the 11th century (with certain doubts), the documentary account coming precisely from the area of the Banat plain, namely Cenad[34]. Certain data related to the presence of watermills in Banat, and more precisely on the Timiș river, come from 1256 and refer to two mill wheels from the Ciavoș village (currently Grăniceri), the mills there being mentioned in several later documents[35]. From the second half of the 14th century onwards information multiplies, references to the existing mills on the Timiș (as well as on the other rivers) being sometimes punctual.

Relevant information on the technical aspects of a mill may be found in a 1424 document, which mentions the existence of a vertical wheel mill on the Timiș, located in Jebel[36]. The statement in the document "*unum molendium trium rotarum desubtus pellens super fluvio Themes sed aliquando per sicctitatem cessans*"[37], means "*a three-wheeled mill operated from below on the Timiș river, yet which stopped some time ago from drought*"[38]. Thus, there is more information of interest near our study area, as early as the 15th century: we are dealing with a lower intake mill, as mills in the area could have been provided with more than one wheel, while their operation occasionally, during dry seasons, could have been discontinued, which, however, does not seem to have taken place on a regular basis.

As graphic representations, the earliest illustration of a hydraulic mill in the Timișoara plain area that we identified is from the Bega river, near the Timișoara Fortress, drawn by F. Wathay in 1604-'06 (Fig. 7)[39]. A mill building is now rendered near the entrance gate into the fortress, a construction that may be a good parallel for the structures discovered in our area.

Here are shown two distinct watercourses, one that borders the fortress walls and another at a short distance from it, the mill lying on the right side of the latter. We know that it is a mill because of the big wheel adjacent to the building and placed in the riverbed. The structure's details are worth noting as analogy as we are dealing with a simple assembly. A small quadrilateral building, with a few small windows, covered with shingles, provided with a large wooden wheel. Barely are the several horizontal lines on the building's walls, which reference a beamed construction.

Fig.7. Watermill on the *Bega* River at the gate of the Timișoara Fortress, 1604-'06 (Feneșan 2016, 333, Fig. 11).

Written sources from the early modern era

By early 18th century, a document of the region's new administration decrees that: *where mills have once been in place, and now sawmills were built, the old right of private property no longer applies*[40], evidence that this installation type was inherited by the Habsburgs from the old Ottoman administration.

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33 Bucur 1979.
34 Răuț 1993, 26.
35 Răuț 1993, 26, 27.
36 Răuț 1993, 35; this is evidently, what we today call *Timișul Mort*.
37 Răuț 1993, 35.
38 The translation belongs to Dan Ungureanu, whom we would like to thank.
39 Feneșan 2016, 333, Fig. 11.
40 Hațegan, Kósa 2018, 47.

With the conquest of the Banat by the House of Habsburg, more valuable information about this type of waterpower harnessing date to the first half of the 18th century. Over 32 years (1719-'51) more than 20 mentions related to watermills can be found in the documents of the Banat Administration (Table 4). A lot of information may be extracted from there, from how facilities were managed, to their location or use. And from these accounts, it is noticeable that the force of water was not used only to engage wheels for grinding grain. From the beginning of the Habsburg administration come several mentions according to which on the Pogăniș brook, but also on other water courses, several sawmills would be built starting with 1719[41], while the existence of mill machine or whirlpools, although not recorded then, is mentioned by early 20th century by historian Nicolae Iorga[42] in his travel notes through Banat.

Table 4. Mention of watermills in the documents of the Banat Administration (1720–1751)

Year	**Day/ month**	**Passages regarding the watermills** (information synthesized by Baróti 1893–1907, adapted-translated by Hațegan, Kósa 2018)
1719	1.09	The administration says that where the mills once stood, and sawmills were then built, the previous private property law no longer applies.
1720	No date	Within a tax conscription of this month in Banat there are [...] 689 mills, of which 74 belonged to the tax authorities, 69 were spoonmills (water), 174 large private mills and 362 private watermills.
1721	12.01	A request from Lipova [on the Mureș] to the Administration shows that watermills make traffic difficult, while in the future their location should be regulated.
1721	14.01	And Schindler, the administrator of the Timișoara district, announces that he has collected the milling tax of 18 and 19 florins per mill, because only the best mills can barely pay that of 20 florins.
1722	2.03	The Aulic Council in Vienna demands that the floating mills on the Mureș, which obstruct the circulation of ships carrying salt from Transylvania, be demolished.
1723	No date	In 1723, the bridge over the Timiș was repaired, the Spanish and imperial mills were built, these in Lugoj, and the Fădimac sawmill was built.
1726	2.10	The administration notifies the Pancevo district that residents are milling their products at floating mills held by imperial officials, and not elsewhere.
1728	5.06	The administration orders that the German mayor of Timișoara, Jakob Cnadit, who wants to build 4 or 5 mills in Parța, not be prejudiced by the local inhabitants.
1728	21.06	The administration orders the inhabitants of Parța to help build Jakob Candid's mill, as they will be its beneficiaries.
1728	22.09	The administration orders the districts of Timișoara and Ciacova, that on the Bega sector, between Topolovăț and Recaș, mills can be built, however bridges should be high, to allow the circulation of ships.
1728	6.12	Wassy resumes the request of the Folia villagers not to be forced to go to the mill in Valeapai, which lies too far, and that they can manage on their own. Wassy notifies the Administration about the quarrel between the Peciu Nou and Cebza villagers, over the mill water.
1729	28.05	The administration shows that Jovan Bibic does not harm in any way the interests of the inhabitants of Giroc, if he builds a mill there.
1732	2.02	The Ciacova District informs the Administration that the Wassy administrator has built a mill in Ciacova, then ruined due to floods.
1735	24.01	The Ciacova district reports to the administration that the mills in the district, both the Romanian and the German, mill 12 *mierța** of grains day and night, and the millers' toll is of three flour *ocale*** or 3 pennies for each *mierța*.
1736	2.03	The Ciacova District asks the Administration to allow the construction of a mill at Șemlacu Mare.
1747	29.07	The Hungarian Aulic Chamber wishes the cleaning works of the Mureș, on the Banat side, had more workers, to remove the mills and floodgates which prevent the transport of salt.
1748	29.06	Contract between the Administration and the tobacco master Dominic Sakavin for the lease of the old tobacco mill, between the old and the new arm of the Bega and the construction of a new tobacco mill there.

41 Hațegan, Kósa 2018, 44, 47.

42 Botzan 1984, 244.

Year	**Day/ month**	**Passages regarding the watermills** (information synthesized by Baróti 1893–1907, adapted-translated by Hațegan, Kósa 2018)
1749	12.07	The administration wishes that when upon the release the Mureș from mills, the circulation of the salt ships would ease.
1749	26.08	The Aulic Council informs the governor on the disappearance of the mills on the Banat bank of the Mureș, but also on the mills maintained on the Transylvanian bank.
1750	30.04	Imperial order regarding the mills on the Bega.
1750	16.07	The administration writes to miller Jakob Helbmann, from Caransebeș, that instead of building another mill, he would rather take care either of the existing one or the imperial mill from Lugoj.
1751	19.05	The Ciacova district shows the request of the Opatița, Birda and Valeapai residents to use and repair the mill on the Pogăniș river.

* *(an ancient grain measurement unit, varying between 8 to 200 kg upon regions and periods)*

** *(an ancient weight measurement unit, equal with 1.271 or 1.291 kg or for volume measurement equal with 1.288 or 1.520 l) depending on the regions from Romania)*

Modern cartographic sources

After the Habsburg conquest and the draft of the first mapping supports, mills began to be spatially located on the banks of the Banat rivers. Cartographically, for the 18th–19th century only part of the Timiș river was used for milling, namely the river's middle sector, located on today's Romanian territory (Lugoj – downstream of Rudna)[43]. It is not excluded that the imperial administration banned such installations within the border district of Pancevo, however until recorded documentarily, this remains a conjecture.

Fig. 8. Map of the Timișoara district, 1720, Șag area with the three mills marked with a red dot.

District maps are the first to represent these structures (Fig. 8). More precisely, the Map of Timișoara District[44], of 1720, marks several such constructions on the Bega River (18 mills on the Izvin – Cena segment) and only three on the Timiș river, in the Șag-Parța area, not far from discussed area here[45].

On the Mureș River no structure is illustrated for this time, which leads us to believe that the map does not faithfully represent the facts on site regarding the mills[46].

The local maps drawn up after 1750 would shed more light on many more structures along the Timiș River. First illustrations of a mill may be found in the Coștei-Hitiaș area, once with the great hydrological development works there. Several mills are drawn and named; each being ascribed to the village it belonged to[47]. Most structures have a narrow strip that crosses the river to the mill represented next to the riverbed (Fig. 9).

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43 The analysis of the Josephine map (carried out for the border districts between 1780-'84.) and of the 1822 river and mills plan, showed that downstream Modoș (today by the Romanian-Serbian border) up to the flow of the Timiș river into the Danube, no mill is represented. Not too many local maps of the Serbian area are available *online*, except for the Pancevo area, where no installation has also been observed in the many local 18th century plans.

44 *Mappa von dem Temesvaer District*, 1720 (https://maps.hungaricana.hu/en/HTITerkeptar/561/).

45 We know that red dots represent mills from the legend of the Pancevo district map: *Mappa von dem Panczowaer District* (https://maps.hungaricana.hu/en/HTITerkeptar/551/).

46 Another questionable aspect regarding the mills' representation on these maps arises from the comparison of the maps of the two neighboring districts, Ciacova and Timișoara. If in Ciacova (1723) the mills from the Șag-Parța area are unmarked, on the map of the Timișoara district (1720) they are present.

47 The ilustrated one is called *Zweitte mühl von Schabar* [*the second mill from Jabăr*].

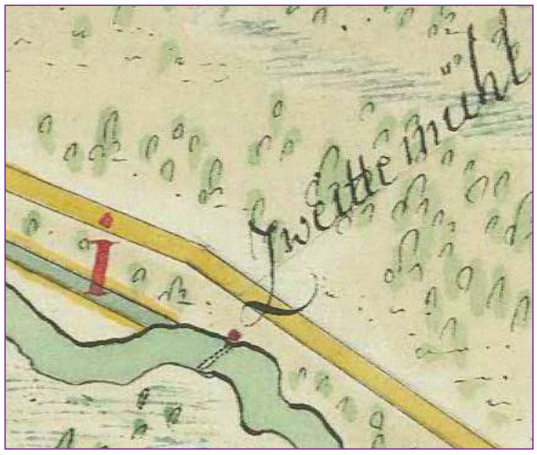

Fig. 9. Jabăr Mill in 1759[48].

Focusing on our area of study, earliest representations of water structures come from the Josephine survey (1769-'72). Three points are rendered on the Timiș riverbanks and one on diversion branch, but also near the main course. All 4 marks most definitely represented hydraulic mills, as confirmed by subsequent mapping. The four mills are set as follows: the one upstream is near Uliuc (*Cotu Morii*), on the village wise side; then follows one in the Ostrov area, located on a diversion arm of the river, close to their interflow, beyond the main arm of that time (thus on the bank with Medveș, now Urseni village); regulating the river and removal of the loop that formed the *Ostrov* would also lead to the disappearance of this mill, including in the field. The last two installations are located downstream and upstream of Cotu Mare, on the right bank, serving the Giroc (Iurok) settlement. The mills are rendered graphically with two different symbols. One is the classic mill, with a small rectangular polygon on the bank (mill building) and a rayed circle towards / in water (mill wheel) (Fig. 10). The second represents, in addition to the mill building, a line that crosses the river along the entire width of its riverbed. The line has several points below (Fig. 10, second from left). This type of representation is also found downstream, in three other cases, but simple representation, without this line, dominates. The vast majority of structures are connected to settlements and the remaining the territory by roads, specially built for these and often illustrated. Rarely, the road leading to a structure also runs to the other side of the river, which indicates the possibility of crossing the river with the aid of the hydraulic complex.

Fig. 10. Graphic representations of the mills on the Timiș (study area) on different 18th century maps.

A local map of Uliuc drawn up relatively in the same period (1774)[49], illustrates a different situation from that on the Josephine survey. On the Timiș river stretch between *Pusta Brodului* (the future "Albina" bridge) up to the interflow with Pogăniș, 4 mills are illustrated, within an area where the previous map shows only one. We believe this map, of much better accuracy, represents the true frequency of these structures at that time. Three of the points are located on the left bank of the Timiș, two belonging to Uliuc, which is why the mill area, marked with a green border and called *mühl grund* (*mill land* -Fig. 10, centre) is also shown. The other two are named after the locality to which they belong, Moșnița (*Moschnitza* -Fig. 10), respectively Sacoș (*Szacosch*). All four mills are classically

[48] *Project über hydraulische Wasser Arbeithen in dem Temesvarer...* (https://maps.hungaricana.hu/en/MOLTerkeptar/38761/).
[49] *Uiluk 1774,* physical map, examined at the National Archives of Hungary, Budapest.

illustrated. A local map of Uliuc, drawn up almost 20 years later, in 1793[50], keeps the same situation of the mills, with small graphic rendering differences (Fig. 10, right)[51].

Of the eight finds made in the field, only two were not identified on any of the available mapping supports (Uliuc-*Timiș 3* and Uliuc-*Timiș 6*). It is not excluded that these ensembles had already disused at the time of the Josephine survey (1769-'72).

Illustration of the mill with dam on the cartography of the time

Still from that period, a 1790 map regarding the hydrographic situation between the *two Timiș rivers*, depicts a lot of mills present on both river arms[52]. Many have that line that crosses the watercourse from the mill represented again. The map legend explains that the symbol represents "mills together with dam"[53], a detail of great significance. Proper mills are drawn more carefully or more rudimentarily. One can be noticed, from the Cebza area, very realistically rendered in plan (Fig. 11). From the quadrilateral building exits the axis leading to a large vertical wheel, which lies in water, just like in the case of the mill on the Bega, drawn by Ferenc Wathay in 1604-'06.

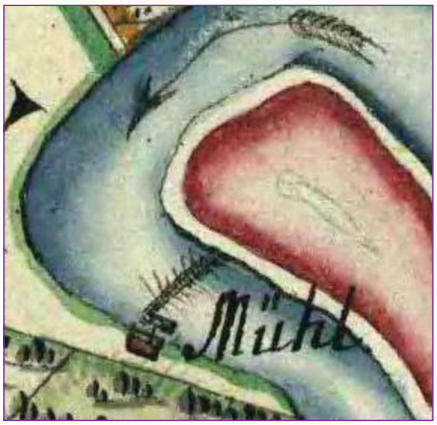

Fig. 11. Mill on Timiș, in the Cebza area, 1790.

The dam does not close the two banks, but stops at the wheel. Evidently, this dam[54] was aimed to block a large part of the riverbed, except for the mill wheel area; the model would be confirmed by subsequent detailed mapping, but especially by the field finds. In order to engage a wheel in the case of the slow flow of a plain river, a solution had to be sought to the speed it up. The ingenious solution consisted in the reduction of the riverbed's width. Draining the same flow of water through a much smaller opening gives the water a much higher speed, able to propel the large wheels of hydraulic installations; also, during dry seasons, when water levels decreased, the dam allowed water to increase its level right upstream.

On the Timiș the only parallels for the dam were found upstream, in Lugoj[55]; instead, the closest analogies come from the Pogănișstream close to its discharge into the Timiș. The 1895 cadastral map of Icloda shows several small dikes, crossing the streambed towards the wheel / wheels of a mill (Fig. 12); it is very interesting that the dam is connected to the mill and, in fact, to the opposite bank by a suspended bridge, which involves the discussion of the occasional water crossing bridge or even bridge function of the dam-mill ensemble (in one case the mill bridge is crossed even by a significant road, Fig. 12-down). Even though examples come from a much smaller watercourse, the technical principles illustrated here are also transferable in the case of the mills on Timiș.

Although somewhat later and on a smaller riverbed, parallels may be found in the Hungarian plain, where the mill project on the Rába river (Sopron), drawn in 1823, shows a simple dam type. There, the river course is artificially narrowed by a system of poles put into the ground on the banks (Fig. 13-bottom, with green), and near the mill another row of posts is set across the riverbed to the wheel, leaving a waterway only as wide as its width. Downstream the mill, the riverbed returns to its natural path, widening considerably.

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50 *Ujluk 1793,* physical map, examined at the National Archives of Hungary, Budapest.

51 The mill is rendered as a pink circle with rotating arms, and in the water, at each point, over the riverbed is also drawn a kind of line that flows downstream.

52 *Situations Plan der sechs Ortschaften Liget, Schaag, Paraz, Petroman, Csebsa, Macedonien, und des Temes Flusses von seiner Theilung bis zu der wiederumigen Vereinigung desselben samt allen aus dem Fluss entspringen/!/ und rükfallenden Ausrisse, Ergüssunge*, 1790 (https://maps.hungaricana.hu/en/MOLTerkeptar/1975/).

53 Original (in German): *Mühlen samt Wehr*.

54 Current definition of the weir: 1. A dam-like construction that allows water levels to rise upstream (DLRLC); 2. Construction of wood, concrete or iron raised across a flowing water, which serves to regulate upstream water levels with the aid of dams (dexonline.ro, 3.02.2021).

55 On the Franciscan map, a series of weirs appear from upstream to the downstream set across the Timiș riverbed.

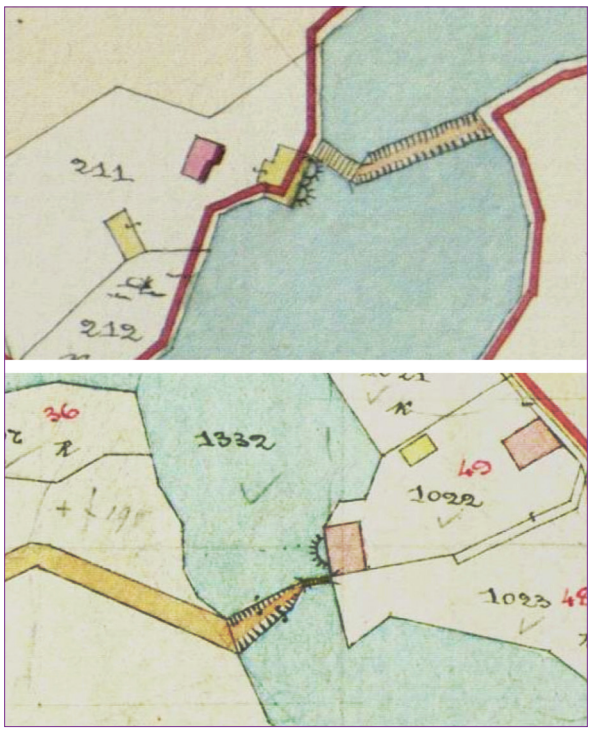

Fig. 12.Types of dams on Pogăniș, Icloda 1895[56].

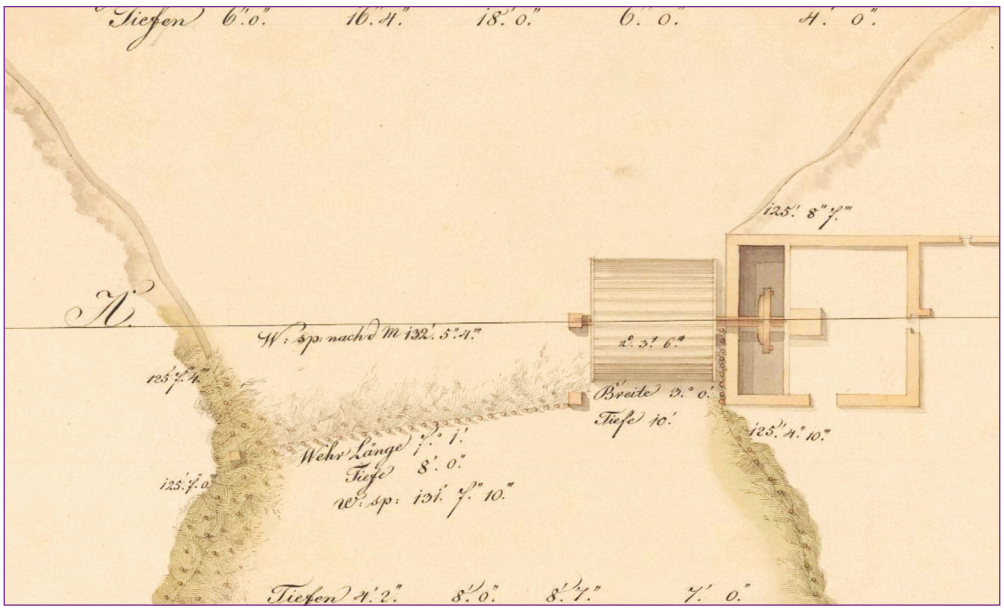

Fig. 13. Plan of a mill with dam from western Hungary, 1823[57].

It is impossible to say how many mills represented on the 18th–19th century maps of the Timiș were provided with a weir. Often, surveyors and cartographers paid little attention to this detail and marked only the mill's location. It is noted that sometimes, same mills are shown with weir, and a few years later without, while on site the weir's presence is confirmed. Occasionally, these never appear as having a weir, although it existed, further confirmed by riverbed checks. In other words, it is impossible to have a realistic overall view of this aspect based on cartography only. At most, we may consider that those mills, depicted as having a weir, had one indeed. It is certain that many more mills used such system.

Further analyzing the cartography of the time, to the same end period of the 18th century, from

[56] *Ikloda 1895*, physical map, examined at the National Archives of Hungary, Budapest.
[57] *Mola Moritzhiadaiensis sine Capite Molari sub 1823* (https://maps.hungaricana.hu/hu/MOLTerkeptar/29352/).

1788, dates the situation on Timiș recorded by a local map of the Giroc. The map is valuable as it marks the location of the mills, but also for documenting their name. We shall also reference here a few cases downstream our area. Between *Cotu Mare* and upstream of Șag, on the right riverbank, there are 5 plots of land which belong to certain mills, but only two installations on the riverbed. The first, at *Cotu Mare*, appearing also on previous maps (Josephine), is called *Ordia*, a toponym that the mill obviously derives from the important bridge there in existence until 1740, when it was destroyed by floods[58]. The mill is not represented, and there is a small distance between its land and the riverbank (Fig. 14, above). It is difficult to say whether or not the mill was still active at that time, but if the representation is accurate, it rather suggests we are dealing with a disused installation.

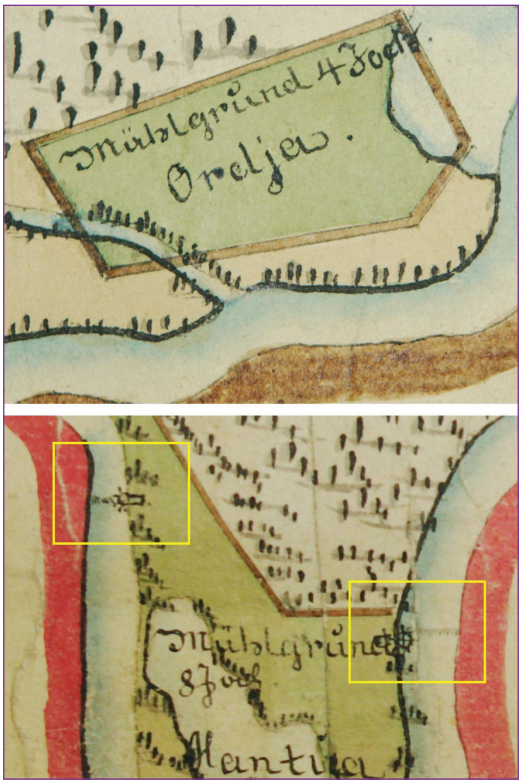

Fig. 14. Mills represented on the Timiș, in the Giroc area, 1788[59].

Another seemingly undeveloped mill, termed *Darabanz*, is on a bend downstream[60], while in the bend known by the locals as *Montova* are drawn two mills, on either side of the loop, with a joint land, called *Mantua*[61] (Fig. 14, below). In both cases, near the mills, crossing the Timiș riverbed, the accompanying weirs are sketched. The fourth position, from Șag, similar in representation[62] with the *Ordia* mill, is termed *Lom/Luom*.

Although all 4 mills lay within the Giroc boundary, the road network marked on the Josephine maps, when all mills appear active, suggests that they also served other settlements, Șag being one of them. Unfortunately, for the area of the southern bank of the Timiș, which belonged to Unip (*Ostrov-Cotu lui Toader*), no 18th century map is available, so the overall mills' map is blank for the 18th century there. Instead, an early 19th-century plan comes to aid. For our study area, later than the 1788 (Giroc) and 1793 (Uliuc) maps, the only representation that still renders watermills on the Timiș river is a 1822 general plan of the river (Fig. 15).

The Unip *Ostrov* area is also present, where the position of a mill on the left bank of the then river course is marked (Fig. 15, no. 20). Village territories are also marked, from which we may see that

58 Baróti 1896, 471.

59 Iurok 1788, Archive of the National Museum of Banat, Timișoara. *Mola Moritzhiadaiensis sine Capite Molari sub 1823* (https://maps.hungaricana.hu/hu/MOLTerkeptar/29352/).

60 Curve later disused and currently a fossil, where the Greek Catholic monastery of Giroc is located.

61 Since these are two mills, the land is double in size, being *8 Joch* [= jugers].

62 Without a mill and at a distance from the bank.

respective mill belonged to Unip. It is the only representation of a mill on the Timiș, which belonged with certainty to the Unip.

Fig. 15. "Map of the mills", 1822[63], segment with the studied area.

The riverbed rendering is more schematic, the authorities being mainly interested in estimating the number and distribution of mills by places. For this reason we can locate the position of the mill in the field upon zones. Oral history helps us in this regard. The Unip natives still call today an bend of Timiș in this area *Cotu Morii*[64]. Additional information emerges in the Medveș (Urseni) area as well, with three mills (Fig. 15, no. 21 and the two upstream). The numbered mill lies upstream *Cotu Mare*, also marked on Josephine maps, instead they identify two of the structures, located on the secondary arm of the river (which later became the main), which are unnumbered. Possibly, these were recently set up mills or only in a design stage, but it is also possible that the missing numbering is due to the fact they are not located on the main river course. It is certain though that one of these mills, that downstream, would survive until later, being the last represented cartographically for the whole river.

The 1822 plan, meant to map the topography of the Timiș river and its mills, also illustrates and numbers all these structures downstream of the Coștei hydrotechnical system. Up to the fork of the two Timiș rivers downstream of *Cotu lui Toader* there are 23 mills, and from there, on the arm from Parța there are 14 mills, and on the arm from Ciacova, 17 mills. The latter are drawn right in the area of the current border, in Modoș, where the final count reached number 60. Included in the count are a few mills on tributary streams, near the mouth of their outflow into the Timiș. One may argue that in 1822 the administration counted around 55 mills on the main course of the Timiș downstream of Lugoj. It is very likely that the fate of the mills was already sealed. The plan cartridge describes that it was drafted for *regulating the Timiș river and the mills that still serve it*[65]. Several local cartographic evidence up to mid-century record the mass disappearance of the mills. At least in our study area, the phenomenon seems to occur prior 1845 or even earlier, before 1838[66]. The generalization and speed of the process suggest a decision at the level of the region's administration, which ended this activity on the river. The time when the hydraulic installations disappear from the Timiș river therefore precedes the time when its regulating works began.

Examining the Franciscan map (dated no later than 1869[67]) throughout the river downstream of Lugoj we find only two watermills still preserving, but even those with a context that separates them from the main river course. One is right in our study area, at Medveș (Urseni) and the other near

[63] *Topographische Fluss-Carte. Der Temes von ihren Ursprung bis zum Einflusz in die Donau unterhalb Pancsova*, 1822 (https://maps.hungaricana.hu/en/MOLTerkeptar/4884/).

[64] Personal information from Vasile Mocanu, Unip, whom we thank here as well.

[65] *Hinsichtlicht der Temesfluss-regulirung und dessen Mühlen dienen möge.*

[66] A local map from Șag, of 1845 (Șag ... 1845), no longer shows any mill on the Timiș, in the area where two existed in 1822, a similar situation being found at Petroman, where on a 1838 detailed plan (*Petromány helysége határának térképe és újj szabályozásának*, https://maps.hungaricana.hu/en/MOLTerkeptar/4275) there is no mill of the Timiș (the current *Timișul Mort*), while in 1822 there were 4 such structures.

[67] *Franziscanische Landaufnahme*, 1860-'69 (https://mapire.eu/en/map/europe–19century-secondsurvey/).

Hitiaș, however it seems to have been already decommissioned[68]. The zone version of the map, drawn in 1866, also presents the mill, so that we may more precisely date the life extension of this structure.

The Urseni installation, previously mentioned, lay on the right side of by-pass of the Timiș, transformed when the weirs were built into a main course by disusing the old river route, which closed an island-like area (Slavic *ostrov*). We believe this is also the reason why the mill survived until so late. The *Ostrov* area belonged to Urseni until the 20th century, so the mill most likely served the community there as well (Fig. 16).

Fig. 16. Mill from Urseni, 1860-'69.

The installation appears as having two buildings, one with a wheel, representing the mill building itself and a second next to it, most likely the miller's home. Notation M: M: comes from the German *Mahl Mühle* = Table mill[69]. The mill was last represented in 1870[70], after which it is also decommissioned, probably once with the construction of weirs (whose building may be dated to 1876).

On site finds

Along the Timiș riverbed, on the river stretch systematically checked between the Albina bridge (*Podu Brodului*) and the eastern end of the Giroc woodland (*Cotu lui Toader*), our study has identified in the field and on maps 15 archaeological-historical sites, of which 12 may be interpreted to function as hydraulic installation (Fig. 17). Three points, marked cartographically as watermills, could no longer

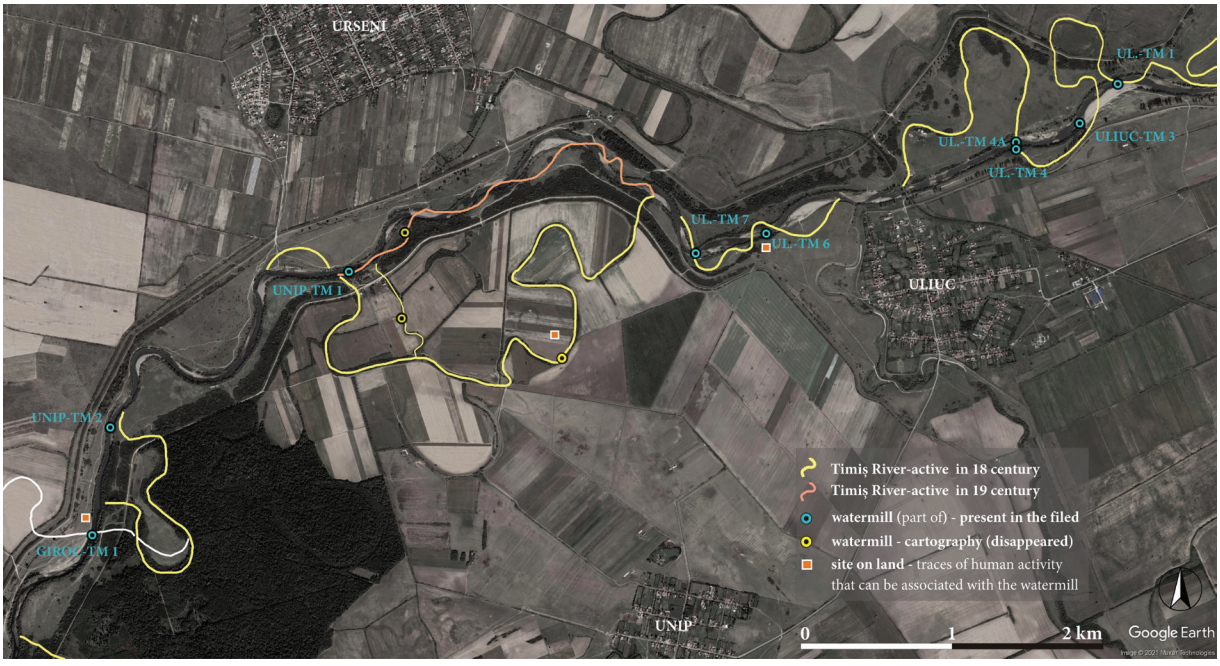

Fig. 17. Map of the wooden ensembles (part of the watermills) on the Timiș River, surveyed segment. Satellite image *G. Earth*™.

[68] The mill appears with the wheel represented at a distance from the river; it may have been supplied by a watercourse deactivated by the hydrotechnical works performed in the area.

[69] *Franzisco-Josephinische Landesaufnahme*, 1869-'87 (https://mapire.eu/en/map/thirdsurvey25000/).

[70] Variant of the Franciscan map.

be identified in the field, likely destroyed, or completely covered by alluvium. In total, 12 sites were discovered in the field, representing, with one exception, wooden ensembles, which received a special indication compared to the classical archaeological site (on land), given their special nature. According to the cartography and their appearance, eight of the points may be ascribed as hydraulic mills (to which add the three disparate – Table 6), three as bridges, Uliuc-*Timiș 2 (?)*, Uliuc-*Timiș 5* (modern bridge, previous the current railway bridge) and Giroc-*Timiș 2* (stone bridge), while the function of one find cannot be specified (Urseni-*Timiș 1*).

Of the mills discovered on site, five are in the Uliuc area: Uliuc-*Timiș 1*, *3*, *4*, *6* and *7*, two near Unip: Unip-*Timiș 1* and *2* and one in Giroc (~ *Timiș 1*). These eight distinct sites, called *objectives*, shall be described and illustrated individually in Appendix 1.

It may be argued that the presence of this structure types must be directly related to the history of the riverbed. In the discussed sector, a large part of the current riverbed intersects the river course prior the regulating works (19th century), which allowed conservation (by water) of a fairly dense wooden heritage for such a small stretch of the entire river.

Dam mills

The dam mills were not documented in the academic literature for this area until now due to a lack of field research of hydraulic installations in the Banat lowland area. Our field inspections were completely novel in this regard. The topography of the elements found in the field and then clarified by the blueprints, illustrated from the beginning the constant presence of pole and occasionally pylon assemblies, which often cross the current riverbed and which together with pylon alignments formed a unitary system. Map examinations and certain available parallels quickly confirmed that watermills in this area of the Timiș had a more complex installation, being provided with a dam designed to block water, generally perpendicular or slightly slating on the riverbed, starting from one end (closed) and stopping near the opposite bank, where a small gap left room for water to pass.

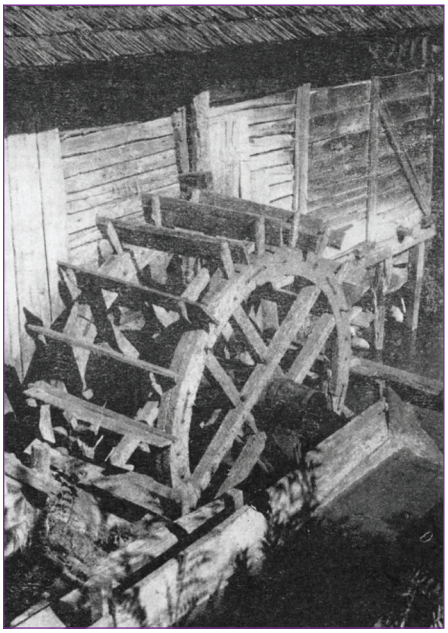

Fig. 18. Wing wheel of the mill from Albești, Argeș (Irimie 1968, 425).

These weirs were designed to increase water levels upstream and obtain increased flow at higher speeds in the desired stretch, where the installations meant to harness the water force lay.

The vertical mill wheel was placed in this point (Fig. 18), while the mill building was related to the land on the riverbank, as unanimously illustrated on all cartographic supports. It is impossible to say to what extent the mill building was suspended above the riverbed, but the dense pylon alignments by the end weirs suggest that at least part of the construction lay on pillars and not on the ground. A series of analogies confirm the type of mill partially or completely suspended on pylons[71] (Fig. 18). It is very possible that, in the remaining opening for the wheel, water was controlled by wooden gutters for improved control, maintenance of water flow and of the way it propelled the wheel, provided with wings (Fig. 18), palettes or cups.

Analyzing the layout of the documented ensembles, we notice that their construction technique differs. The various communities that built them produced heterogeneous ensembles in terms of the system typology used, under varying conditions and time spans. If we strictly refer to the evidence surviving in the field that we have documented in the discussed sector, there are five definite mills with weirs in the study area. Three of them lie upstream and downstream of Uliuc and the other two upstream and downstream of *Cotu Mare*.

The specialists who focused on the study of Banat watermills suggested for the case of vertical

[71] This is the case of watermills with the ASTRA Museum of Traditional Folk Civilisation (eg: Mill from Rogojelu, Cluj County, no. 57).

wheel mills, including from the plain area, the use of a channel excavated to carry water to the mill wheel[72], similar to the parallels especially identified in areas with higher relief. As cartography illustrates[73], but especially the layout of the finds in the field, it may be noted this system was not used for the mills we documented and likely was not used in general for the lower Timiș area.

The dam generally consisted of a series of long poles implanted into the riverbed near each other, in a linear assembly as a whole. Their density was very high, the alignment being up to 3–4 m wide and 30–35 m long. The poles were generally circular in section, being young strong hardwood straight growing trees (for instance ash or cornelian cherry[74]). In some cases, beside circular poles there are worked posts, square in section. Their ends were sharpened to penetrate the ground into which they were implanted. Several pieces removed from water or the ground, are indicative of this fact (Fig. 38).

A solution was required to block the water flow. Most likely in-between the poles, there was a wattle of branches for reinforcement, at least on the front side (upstream). Parallels with other areas, but also certain local evidence[75], support this hypothesis. In fact, the dam could consist, as one can imagine, either of a filling (earth, gravel, etc.) bordered by a fencing against erosion or only such fencing. For the first case, more complex, pleads the ensemble of *Cotu Morii* (Uliuc), which, as shown by the Josephine map, was intended to support a bridge[76]; at the same time, the topography and appearance of the pylons and poles are not indicative of the support of a superstructure (plank bridge), thus the hypothesis of a "filled" dam that could be crossed may be considered. Of course, this hypothesis must be further verified by find parallels with similar cases (dam set up on calm waters, with wide riverbed).

Works related to a mill's assemblage, of changing the river course, damming, and balancing the mills, were of hydrotechnical nature requiring not only labor, but also know-how. Dam maintenance was certainly an operation that the community using the facility had to deal with. This must have occurred during dry seasons when water levels were low. In 1424, on a mill on the Bârzava, the result of a trial is that the two parties in question had to maintain the weir, each with a half[77], which shows the importance given to this task.

In two of the documented situations, the dam seems to also fulfil the function of a bridge. At the *Ordia* mill, the dam was built of square section pylons, arranged on two collinear rows, which allowed the existence of a superstructure with a narrower bridge / bridge role (approx. 2 m). At Uliuc, in *Cotu Morii*, the dam contains an irregular alignment of very robust pylons, circular in section, elements that speak of a much sturdier dam than in the other cases (built of poles); the reason why such an effort would have been worthwhile is the intent to have a riverbed crossing. There, the Josephine map (1769-'72) renders a road reaching the mill from both banks, proof that there must have been a small footbridge next to the wheel gap. It is handy for us to imagine a technical solution of this kind, as we found on the Pogăniș brook, near the studied area, where all three mills have a bridge between the dam and the mill bank, and in one case an important local road crosses the brook on this bridge (Fig. 12, below).

If one incorporates the documented layout, insofar as surviving, together with the information provided by the cartography of the time, we can ideally sketch the picture of a dam watermill like that of *Cotu Morii* (Fig. 19), whose major operating principle seems generally valid for the case studies in this part of the Timiș, except for the dam execution technique. As the detailed map from *Timișul Mort* (1790) suggests, most weirs did not fulfil the role of a bridge between the two banks; the few cases likely also intended for such purpose, was only partially fulfilled, during seasons with average and low water flows, when it did not spill over the weir.

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72 Răuț 1993, 37; Țeicu 2012, 52.

73 From Lugoj to Cebza, but also in the case of the *Ordia* mill (Giroc-*Timiș 1*), a simple dam is rendered cartographically, without a water supply channel.

74 Acacia, a species extensively used for making poles, is cultivated in Romania only since mid-19th century, being native to North America.

75 During the 90'ies, it seems that within the Uliuc-*Timiș 1* objective branch reinforcements could were still visible in-between dam poles, as Mr. Daniel Pandelovitch of Uliuc, claims, whom we thank for the information.

76 The map renders a road that runs towards the mill, on the opposite bank.

77 Răuț 1993, 36.

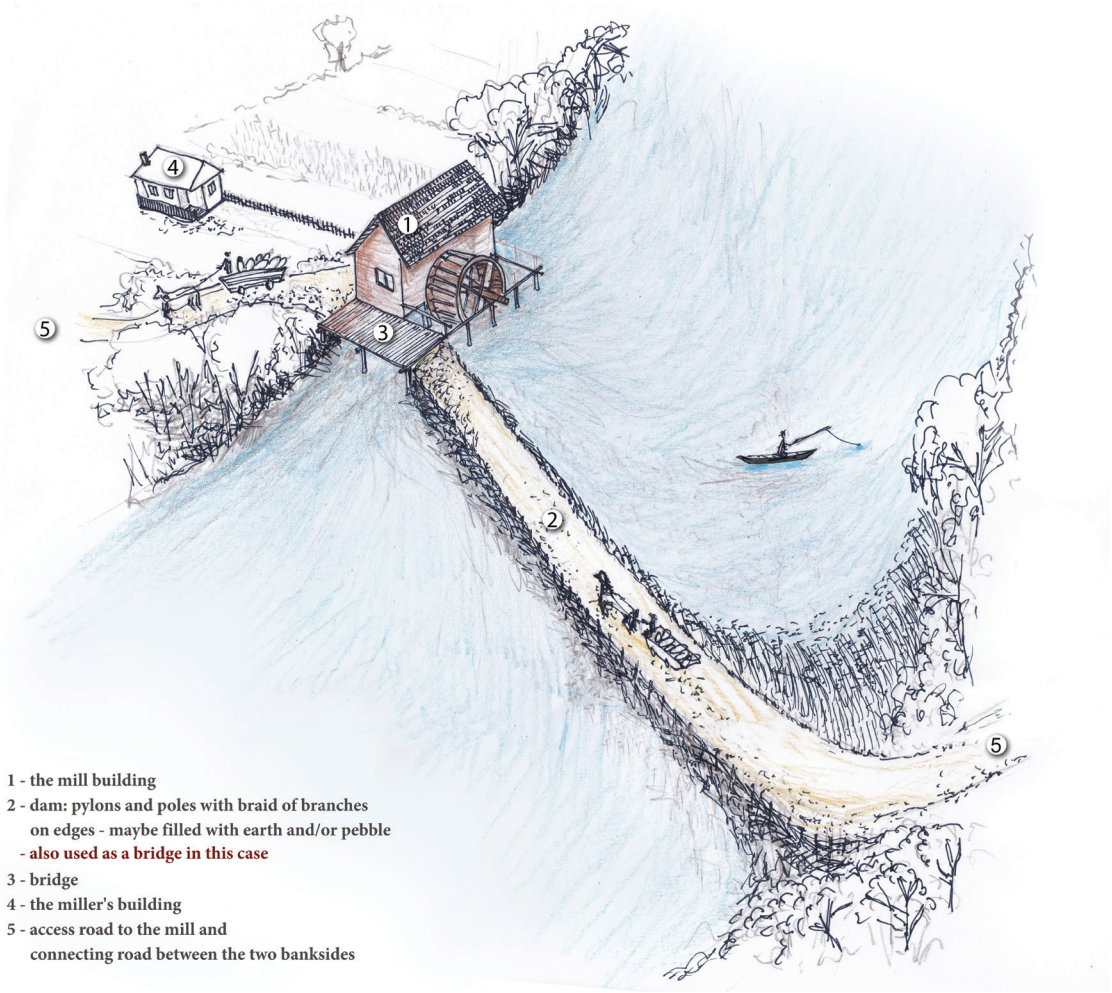

Fig. 19. Watermill with dam (which also fulfils the function of a bridge there). Ideal reconstruction (drawing Alina Floca).

Preliminary dating of the mills on the Timiș by the dendrochronology method

Of the 12 dendrological samples taken from the watermills discovered on the Timiș river, only half (six) provided results that may be taken into consideration scientifically, while out of these only two or three data provide somewhat dating certainty (Table 2). The lack of a chronology established for the Banat lowland area is the main cause for the inability to achieve more accurate dates by the dendrochronology method, at this time. Nevertheless, the fact that the obtained data are homogeneous and chronologically close (Table 5), corroborated with the acquired historical data suggest that the wooden structures discussed here were built relatively in the same period, in the last decades of the 17th and early 18th century; this hypothesis must be confirmed by the analysis of more consistent evidence in the future.

Table 5. Results of preliminary dendrological dating by the *Povergina / Crivina* chronology.

Sample ID	**Site**	**Most recent ring**	**Estimated date (minimum Age)**
Giroc-*Timiș 1_s.1*	Giroc-*Timiș 1*	1666 (?)	≈ **1680** (?)
Uliuc-*Timiș 1_s.1*	Uliuc-*Timiș 1*	1658 (?)	≈ **1675** (?)
Uliuc-*Timiș 3*	Uliuc-*Timiș 3*	1688	≈ **1700**
Uliuc- *Timiș 4_s.1*	Uliuc-*Timiș 4*	1691	≈ **1700–1720** (?)
Uliuc- *Timiș 4_s.2*		1707	
Uliuc- *Timiș 7_s.3*	Uliuc-*Timiș 7*	1694	≈ **1710** (?)

Disappearance of hydraulic mills on the Timiș

The extinction of watermills on the Timiș river is related to the river regulating project, one of the main objectives of the Habsburg House after the conquest of the Banat. This phase began in the area of study by mid 19th century, more precisely after 1853 and before 1865, if we rely on cartographic supports. Later, between 1865 and 1876, the dams were built[78]. It is impossible to say precisely why prior these hydro-developments, the mills were decommissioned, but they generally disappear between 1822[79] and 1835–1845, i.e. between the last map on which mills are rendered on the main river course, drawn up especially for their inventory, and the subsequent local maps, available to us. It seems that the disuse of the facilities occurred following a political decision, the same that no longer allowed the development of farming works between the two dams, as illustrated by the cartographic supports.

If on the lower Timiș harnessing water energy ceases in the 19th century, in the Timiș area upstream of Lugoj the river would still be used on this economic segment for at least a century, which is confirmed by the 1957 statistics, when 138 mills documents are documented there, of which 90 with buckets, 41 with vertical wheels and 7 with turbines[80]. In the discussed area, the Pogăniș river is in the same situation, several mills being used until after the Second World War[81].

Eventually, likely after the expansion of the electricity network in rural areas alongside the access to electrically driven engines result in the abandonment of the hydraulically operated installations use, technically outdated in terms of productivity and efficiency.

Conclusions

Taking into account the chronology obtained based on dendrological analyses corroborated with historical and cartographic information, it is possible to argue that many of the discussed watermills were built in the area of study as early as the Ottoman occupation, operating for more than a century after the conquest of the Banat by the House of Habsburg, during which, under the new administration, new mills were built while those existing were still in use. It is not excluded that some of the objectives present in the field are even earlier than the 17th century, since such installations are recorded nearby, also on the Timiș, as early as the Kingdom of Hungary (1427). It is impossible to hypothesize on the origin of the hydraulic installations operating along the Timiș river for the lack of documentary information, however it is certain these must be sought earlier than the 15th century. In this respect, archaeology supported by different dating methods may play a decisive role in the future.

One may contend that, at least in the case of the mentioned river stretch, most of the objectives of the surviving wooden heritage were watermills. It is not excluded that within mills, cartographically attested under this generic name, other installation types occasionally operated such as textile processing installations such as the *mill machine* or *whirlpool*[82], of which the first, depending on their type, could be used for processing textiles or oilseeds[83]. As early as the 14th century there is a mention of a mill with wheel moving a mill machine at Saldobady[84], while at Gladna (Timiș), in the 20th century, a mill machine operated by a bucket wheel was still in function[85].

A category of field finds difficult to reconstruct in appearance is represented by smaller ensembles, integrated or adjacent to the mills (sometimes isolate), generally made up of smaller pieces (poles), which could fulfil different roles: wool or hemp washers (recorded by local oral history in the Uliuc area[86]), fishing facilities etc.

Occasionally, mill assemblages were also used as communication hubs between the two banks of

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78 Floca 2021, 82–85.

79 *Topographische Fluss-Carte. Der Temes von ihren Ursprung bis zum Einflusz in die Donau unterhalb Pancsova*, 1822 (https://maps.hungaricana.hu/en/MOLTerkeptar/4884/).

80 Irimie 1968, 446.

81 From the oral history we find that in Berini and Otvești, on the Pogăniș, watermills still existed until the fifth and sixth decades of the 20th century; personal information Daniel Popovici, Berini and Toth Lajos, originally from Otvești, whom we thank here too.

82 Irimie 1968, 439.

83 Streza 2014

84 Răuț 1993, 37.

85 Irimie 1968, 433.

86 Personal information Florin Micșa from Uliuc, whom we would like to thank.

the Timiș river, which was not exactly easy to solve considering the width of its riverbed. In three of the studied cases (Table 6), the topography and morphometrics of the finds together with the cartographic evidence suggest the use of dams and bridges, having a dual role. Several parallels regarding this hypothesis must be sought.

The preliminary results obtained by our documentation so far outline the image of mill assemblies rather different from the installations studied for the mountainous Banat, parallels with them being suitable only in certain respects. The scale that the lower Timiș had, compared to mountain waters, required the development of different installations, of more significant size and with a greater impact at ecological or social level. Therefore, we believe that the right parallels must be sought in the Great Hungarian Plain, which in many respects has, at historical level, conditions similar to the Banat lowlands.

Table 6. List of finds and associated relevant data.

No.	**ID**	**Toponym**	**Function**	**Type**	**Lifetime of installation (century/year AD)**		**Dendrology Dating**
					Begin	End	
1	Giroc-*Timiș 1*	*Ordia / Mescal*	mill and bridge (?)	dam	end of 17th century (?)	1822-'53	uncertain
2	Uliuc-*Timiș 1*	*Pusta Brodului*	mill	dam	end of 17th century (?)	1822-'53	uncertain
3	**Uliuc-*Timiș 3***	*În Baltă N*	mill?	?	≈ 1700	< 1769	certain
4	Uliuc-*Timiș 4*	*Podu CFR E*	mill	dam?	Early 18th c. (?)	1822-'53	certain?
5	Uliuc-*Timiș 6*	Șântărie	mill and well	dam	< 1769	< 1769	not relevant
6	Uliuc-*Timiș 7*	*Cotu Morii*	mill, bridge, installation	dam	early 18th c. (?)	1822-'53	uncertain
7	Unip-*Timiș 1*	Ostrov V		?	1772–1822	1869-'87	not relevant
8	Unip-*Timiș 2*	*Cotu Mare*	mill and bridge (?)	dam	< 1769	1822-'53	not sampled
9	a mill of Urseni 1	*Ostrov NV*	mill	?	1772–1822	1822-'53	lost mill
10	a mill of Urseni 2	*Ostrov*	mill	?	< 1769	1772–1853	lost mill
11	a mill of Unip	*Cotu lu Mărcuț*	mill	?	< 1769	1822-'53	lost mill

The two new administration centuries (18th and 19th century) of the Banat represent a phase of great changes in terms of how settlements used water. There is a large difference between the 18th century facts, when surface water resources are used with priority, and the 19th century, when a series of processes and activities developed throughout history nearby rivers disappear or are deeply altered, while focus shifts increasingly to groundwater resources. The first century of imperial administration marks, for the Banat area, an extensive activity of harnessing the energy generated by water flows via a large number of hydraulic installations, generally aimed for milling. This type of water recovery is a continuation of the previous century legacy, a utility which settlements in river vicinity would enjoy until the first decades of the 19th century, when such activity would cease on the largest inland river of the Banat.

Outlook

The disappearance of watermills from the landscape of the Banat lowlands marks a loss of a defining segment of the technical and cultural heritage of the area[87]. Field research or the study of history may recover, albeit to a small extent, part of the memory of a prosperous water land, such as the historic Banat, where the way of life of the human communities gave rise to particular habitats and landscapes, varied and prosperous.

[87] Țeicu 2012, 53.

The accelerated degradation to which this river heritage is exposed, and its threat of extinction makes a systematic documentation of the Timiș riverbed, and not only, necessary, timely and for team effort (archaeologist, historian, ethnographer, geographer). Knowing how ancient human communities created connection bridges (through bridges) or harnessed the power of water (through mills) can inspire current sustainable developments for the local communities, which live along rivers and beyond.

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Appendix I. Analytical sheets of the objectives discovered in the field

GIROC – TIMIȘ 1 Location (STEREO 70): 469270.936; 210750.538

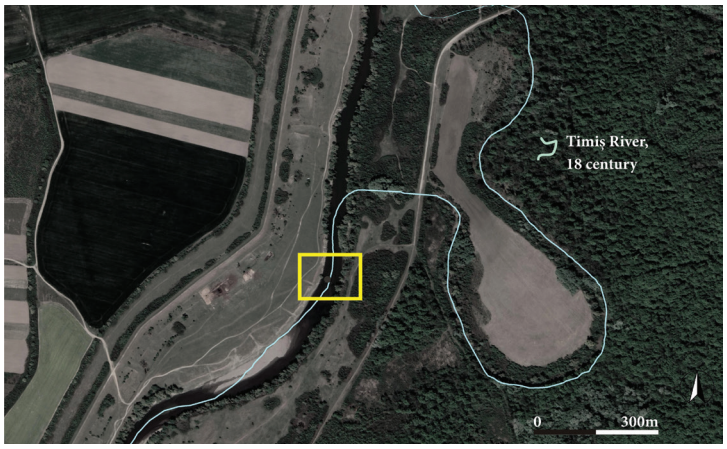
Ordia / Mescal Mill

a. site: hydraulic mill (lower part) and bridge (?).

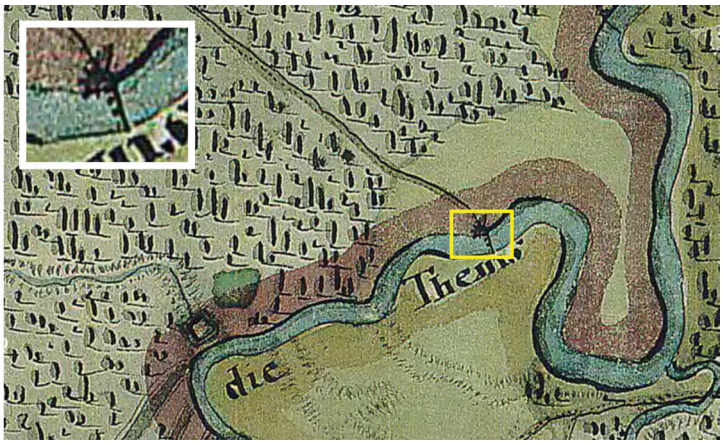
b. type: with dam (possibly also used as deck).

c. location and hydrographic context: the area of the Unip woodlands, downstream of *Cotu Mare*; crosses the nowadays Timiș riverbed. Compared to the 18th century, it seems that the riverbed migrated approx. 10–20 m towards the north but kept the same direction.

d. documented materials: the objective is composed of an assemblage of poles, pylons, and planks, all set in the Timiș riverbed. The planks and most pylons and poles exhibit traces of sides' working, being square or rectangular in their section, while some remained circular, maintaining the tree shape. The large pylons *(pylon 1)* are numerous and represent the core of the ensemble and they most probably supported several closed constructions. Their sections are circular or square, with section sizes between 20–25 cm / side or in diameter.



Satellite image *G. E.*™, 2020-upper part; map, 1769–72- lower part.



The elements termed *planks* are canted beams, with rectangular section and approx. 15–20 cm width and a thickness of 10 cm. They are arranged exclusively in the central area of the ensemble. The smaller pylons *(pylon 2)* are slightly smaller (15–20 cm / side). They are a few only. The elements called *poles* are many. These are smaller trunks, worked on 4 sides, with a square section of 10–15 cm. The two samples harvested from the pylons are part of the oak species (*Quercus sp.*), a hardwood of which, most likely, were built the large elements currently visible in the field.

e. layout: compared to the current riverbed, is it oriented obliquely (NW-SE). The Josephine map shows the dam crossing the riverbed perpendicularly; there the mill wheel lies at its end, near the right slope, while the mill is rendered somewhere by the edge of the bank. The elements are so organized that in some places they are aligned (pole and pylons), frames (pylon) or polygons (planks)

The large pylons group largely westwards, where they draw several alignments, enclosing a compact area. Another group of pylons (Fig. 22-A), also aligned in-between, is found isolate upstream (north), raising the question of whether it is connected to the coherent assembly below or it is rather a distinct structure (possible bridge). The smaller pylons (pylon 3) are set collinearly, in two long parallel alignments in the southern part, where they played the role of a dam. Another cluster forms a dense alignment in the northern area (Fig. 22).

The planks outline a small, relatively circular structure, with a diameter of approx. 1.5 m (Fig. 22-central square frame), but some of these elements continue in the extension of this seemingly closed polygon. Several moving pieces were discovered on the river bottom, lightly stuck in the sand,

so that water could not dislodge them. These are scantlings or small sized beams, processed and joined (shaping, drilling, joining using wooden nails), which reference certain armlets integrated into more complex gear sets (Fig. 21-frame, Fig. 23).

f. dating of the site:

f.a. beginning of the structure: late 17th century (?); according to the dendrochronological measurements, the Giroc-*Timiș 1_s.1* sample has the most recent ring dated, questionably, to 1666, however for the absence of sapwood, the dating is placed after 1680.

f.b. decommissioning of the structure: the Josephine survey records the presence of an active mill there in 1769–1772, while the local map dated to 1788 no longer represents the installation from the riverbed, but only the mill plot from the bank, which may signify its decommissioning at that time. Nevethless, the 1822 "map of the mills" illustrates again an installation along the riverbed; taking into account this representation, it may be argued that the most probable decommissioning of the *Ordia* mill occurred between 1822–1853, like the vast majority of these installations on the Timiș; it is not excluded that at the turn of the 18th–19th century the mill was decommissioned (if the 1788 illustration is accurate), being later reinstated.

g. cartographic representation: on the Josephine map (1769-'72) a mill is rendered, to which is attached a linear structure with "pins", which crosses the Timiș riverbed. A 1788 local map of Giroc, relatively in the same area, marks the plot of a mill place, called *Ordia (Ordja)*. Still cartographically, from the Timișoara district map (1720), we know that *Ordia* was the name of a bridge located in this area (still unclear whether in *Cotu Mare* or *Cotu lui Toader*!), known since the 17th century as *Pons Ordia*.

h. research history: Gogâltan *et al.* 2007, 163 (finds possibly associated with the site); Măruia *et al.* 2011, 174; in 2006 the excavations on the multi-layered site of *Mescal* are resumed by the Museum of Banat and the West University of Timișoara, results being compiled in an excavation report published the following year. Three squares located on the eroded shore of the Timiș are excavated. In addition to prehistoric finds, artefacts attesting "temporary inhabitancy" dating to the late Middle Ages are revealed, as well as three burials (of which, two are for children) with coffin traces and several bronze coins (issued in 1781 and 1782, 1802), indicative of a modern cemetery there (around 1800). In 2007, during the documenting of the archaeological site of Giroc-*Mescal*, the *ArcheoGis* team of Western University of Timișoara (supervised by L. Măruia and D. Micle) observes the assemblage of pylons there, which they intuitively interpret as "bridge or late medieval watermill"; a series of pottery artefacts that may be associated to the mill and framing between late 17th century and the 18th century are then collected.

i. preservation state: medium; the pylons are in full process of degradation; several elements are covered by sand alluvium or plant and residual (anthropogenic) remains present in the central area (of maximum density).

j. notes / interpretation: we associate the ensemble of *Ordia* mill with the late medieval and early modern artefacts discovered at *Mescal* during the 2006 excavations on the right river side (100 m from the wooden pylons), represented by a habitation level (?) documented by artefacts and a late 18th century cemetery (three tombs). Field finds may be directly correlated with cartographic representations. It is certain that the mill took its name from *Podul Ordiei* (*Pons Ordia*), which functioned at least during the 17th century until 1740, when it was destroyed by water. It is highly likely that the mill operated, at least for a while, in parallel with the bridge, as suggested by the dendrological dating and the late 17th century – early 18th century artefacts from the mill area; after the bridge was destroyed, the mill still operates for about a century, mentioned in 1822 on the "mils map". Possibly related to the mill's operation is the small cemetery of Mescal, dated around 1800. As illustrated by the Josephine map (1769-'72), at least during that time, the *Ordia* mill was used by the Giroc community and possibly by other communities in that area (possibly even from the Timisoara Fortress).

k. plates:

Fig. 20. Giroc-*Timiș 1*, assembly plan. Drone photography (October 2019)

Fig. 21. Giroc-*Timiș 1*. Close-up: pole alignments forming the dam of the *Ordia* mill; distant plan: the high bank where the multilayered site of Mescal is located; frame: wood piece recovered from between the pylons. Photo from riverbed level (October 2019).

Fig. 22. Giroc-*Timiș 1*. General plan, drawing.

Artefacts

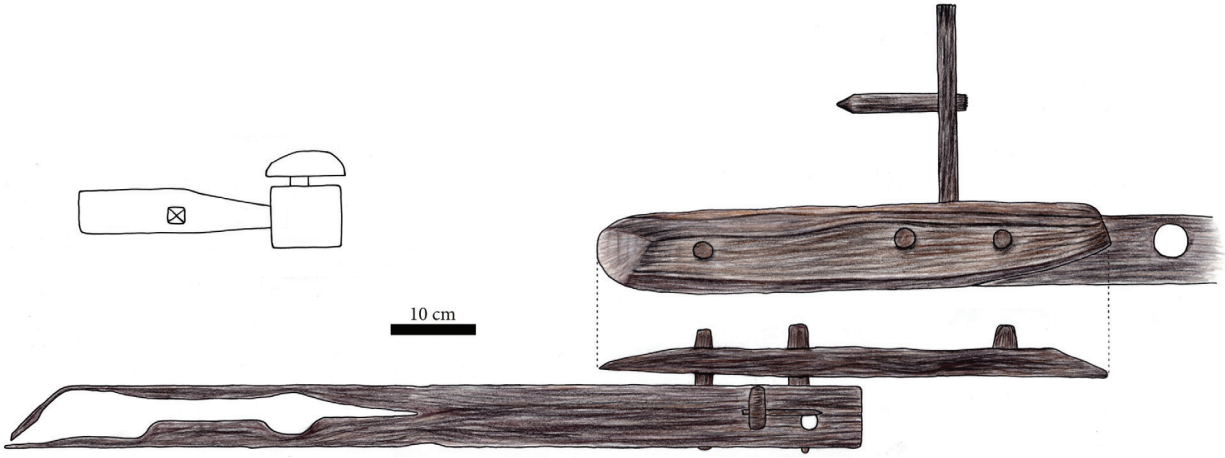


Fig. 23. Giroc-*Timiș 1*. Wooden device discovered between the pylons of the ensemble, drawn by Alina Gheorghe.

Fig. 24. Pottery fragments collected by fieldwalks from the Giroc-*Mescal* site (*Objective 2*), selection after Măruia *et al.* 2011, 180, 181, 186.

ULIUC – TIMIȘ 1 Location (STEREO 70): 471985.177; 217808.893

Pusta Brodului

a. site: hydraulic mill (lower part).

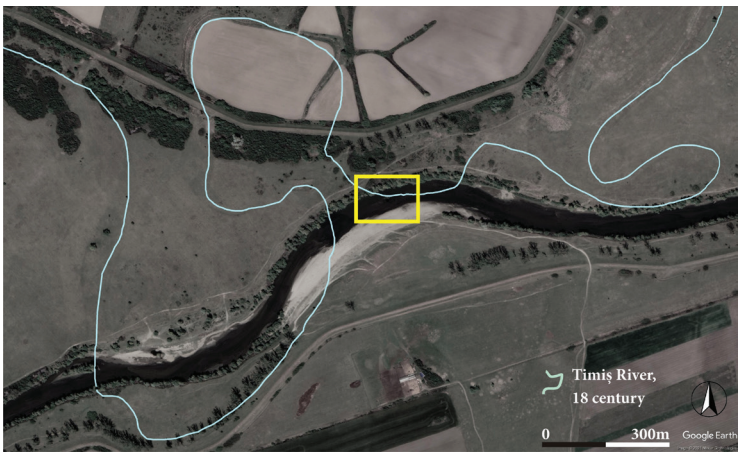
b. type: with dam.

c. location and hydrographic context: between the bridge of Albina and the place at Uliuc; crosses the current Timiș riverbed. It seems that historically the riverbed orientation was similar in this sector, the river flowing from east to west.

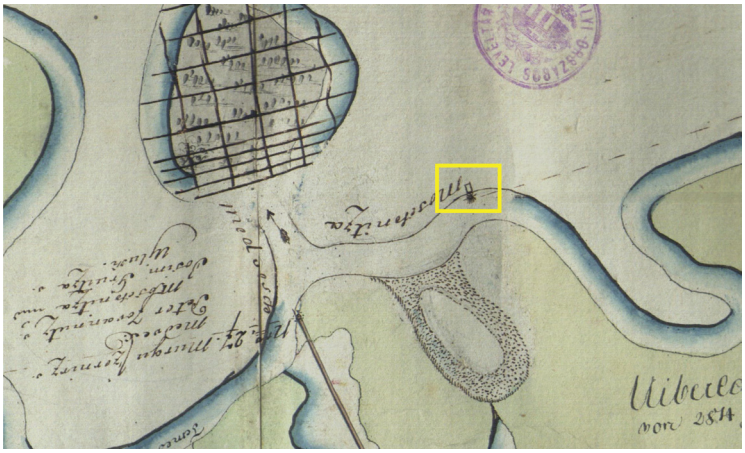
d. documented materials: the objective is composed of an assemblage of pylons and poles, all set up in the Timiș riverbed. Larger pylons *(pylon 1)* have a square section and a 15–20 cm side, while those smaller *(pylon 2)* have a circular section and a ca. 15 cm diameter. All poles are circular in section

(4–6 cm), with a surviving length from soil level of 1.5–2 m (Fig. 26). Their tip is worked, having a square section. The sample harvested from a pylon belongs to the oak species (*Quercus sp.*), of which, most likely, the other pylons were also made.

e. layout: the large pylons group almost exclusively towards the right slope (lying almost entirely underwater), with smaller circular intertwined pylons. They seem to form certain alignments, but it is difficult to specify their original position, as many pieces are slightly turned or tilted by water over time. As the local cartography illustrates, the mill building lay on the right river bank, while the dam extended from there to the other bank. The poles cluster densely from the limit of the pylons group towards the left slope, forming an alignment ca. 20 m long and ca. 5 m wide (Fig. 27). An isolate group of such poles lies to the west of the ensemble.



Satellite image *Google E.*™, 2020-upper side; map, 1774- lower side.



f. dating of the site:

f.a. beginning of the structure: the second half of the 17th century or the second half of the 18th, the sample was dendrologically dated to the last decades of the 17th century, however the dating is far from satisfactory, leaving room for lots of questions. In 1774, the mill is cartographically shown as in operation; the fact that the mill is not recorded by the Josephine survey would imply that it was built between 1769-'72 and 1774, but it is not excluded that the Josephine map had omitted to render the mill, even though existing. **f.b. decommissioning of the structure:** in 1793 the mill is documented and in 1822, on the "mills map", a mill is depicted upstream by over 0.5 km, which we believe can be attributed to the poor accuracy of respective map. On the basis of the 1822 representation, the decommissioning of the mill of Moşniţa from *Pusta Brodului* may be placed between this date (1822) and mid century (ca. 1845-'53), given that no local cartographic support from this interval available to us no longer illustrates any mill in this sector of the Timiș river. Most likely, the mill was disused before the performance of the regulating works of the Timiș, initiated after 1853.

g. cartographic representation: the mill was identified on two local maps, of 1774, where it appears as a simple mill, written *moschniza* (to which it belonged) next to it, and that of 1793, with the same rendering, yet with mention *Mühle nach Moschniza gehöring (mill belonging to Moşniţa).*

h. research history: novel.

i. preservation state: poor; in the process of degradation and burial of the pylons, caused by the frequent decrease of water levels and wood exposure to air, but also to alluvium.

j. notes / interpretation: as illustrated by the second half of the 18th century local cartography, the mill was used by the Moşniţa community.

k. plates:

Fig. 25. Uliuc-*Timiș 1*, assembly plan. Drone photo O. Micșa (October 2019).

Fig. 26. Uliuc-*Timiș 1*, pole alignment forming the dam and the pole sharpening type (frame). Riverbed side photo (October 2019).

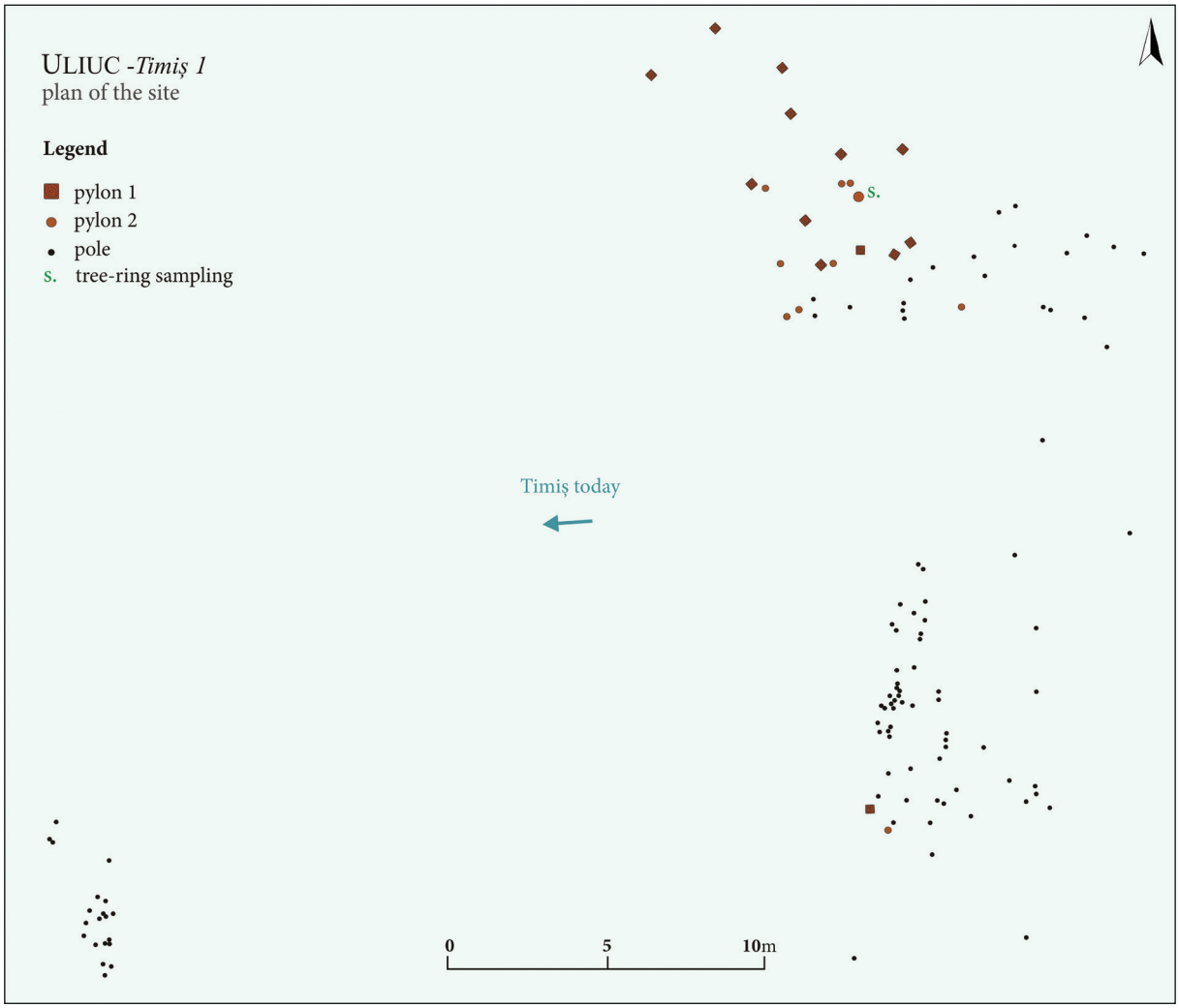


Fig. 27. Uliuc-*Timiș 1*, general plan, drawing.

ULIUC – TIMIȘ 3 Location (STEREO 70): 471732.495; 217539.584

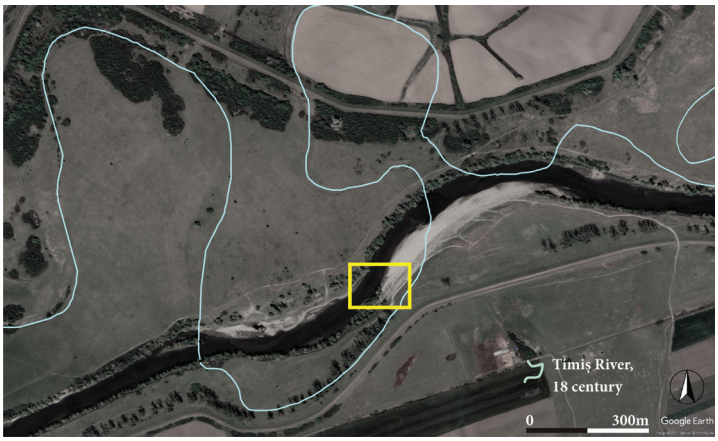
În Baltă N

a. site: hydraulic mill (lower part).

b: type:?

c. location and hydrographic context: between the bridge of Albina and the place at Uliuc; borders the left current Timiș bank. In the 18th century, the riverbed is rendered relatively on the same route, slightly southwards than the current.

d. documented materials: the objective is composed of an assemblage of pylons, bricks and poles, set up in the Timiș riverbed and partially on its banks. The large pylons *(pylon 1)* are square in section and have ca. 15–20 cm sides, while the smaller pylons *(pylon 2)* are circular in section, with a diameter of approx. 15 cm. The bricks are generally fragmentary. The sample harvested from a pylon belongs to the oak species (*Quercus sp.*), of which, most likely, the other pylons were also made.



Satellite image Google E.™, 2020

e. layout: the core of the ensemble lies near and on the left riverbank and is composed of pylon alignments, bordered southwards by a clustering of fragmentary bricks**.** Several disparate pylons and poles are found upstream in this area. By the northern end of the ensemble, on land, next to a less dense alignment of pylons there is an apparent bed composed of poles, the end of which partially protrudes from the eroded bank (Fig. 29-C). Their flat and orderly appearance, along with a few elements for processing the parts suggest a development most likely associated with the downstream structure of pylons and bricks.

f. dating of the site:

f.a. beginning of the structure: around 1700; based on dendrochronology, a pylon within the structure was satisfactorily dated.

f.b. decommissioning of the structure: the structure likely ended its activity before the Josephine survey (1769-'72) since no cartographic support from these maps until nowadays illustrate anything in this location.

g. cartographic representation: cartographically unidentified.

h. research history: novel.

i. preservation stare: bad; in the process of degradation and burial of the pylons, caused by the frequent decrease of water levels and wood exposure to air, but also to alluvium.

j. notes / interpretation: although the structure's conservation state (truncated layout) does not allow a clear specification of its functionality, the Uliuc-*Timiș 3* ensemble seems to be part of the series of hydraulic installations on the Timiș, being a pre-modern structure, as shown by the dendrological datings, reinforced by modern cartographic evidence (on which the structure is missing). Ideally, in the future this dating hypothesis would be confirmed by a second sample taken from there.

k. plates:

Fig. 28. Uliuc-*Timiș 3*, assembly plan. Drone photo O. Micșa (October 2019).

Fig. 29. Uliuc-*Timiș 3*, the assemblage of wooden pylons and brick clustering, westwards (A), detail of the brick clustering (B) and the poles and branches set up (C), November 2018.

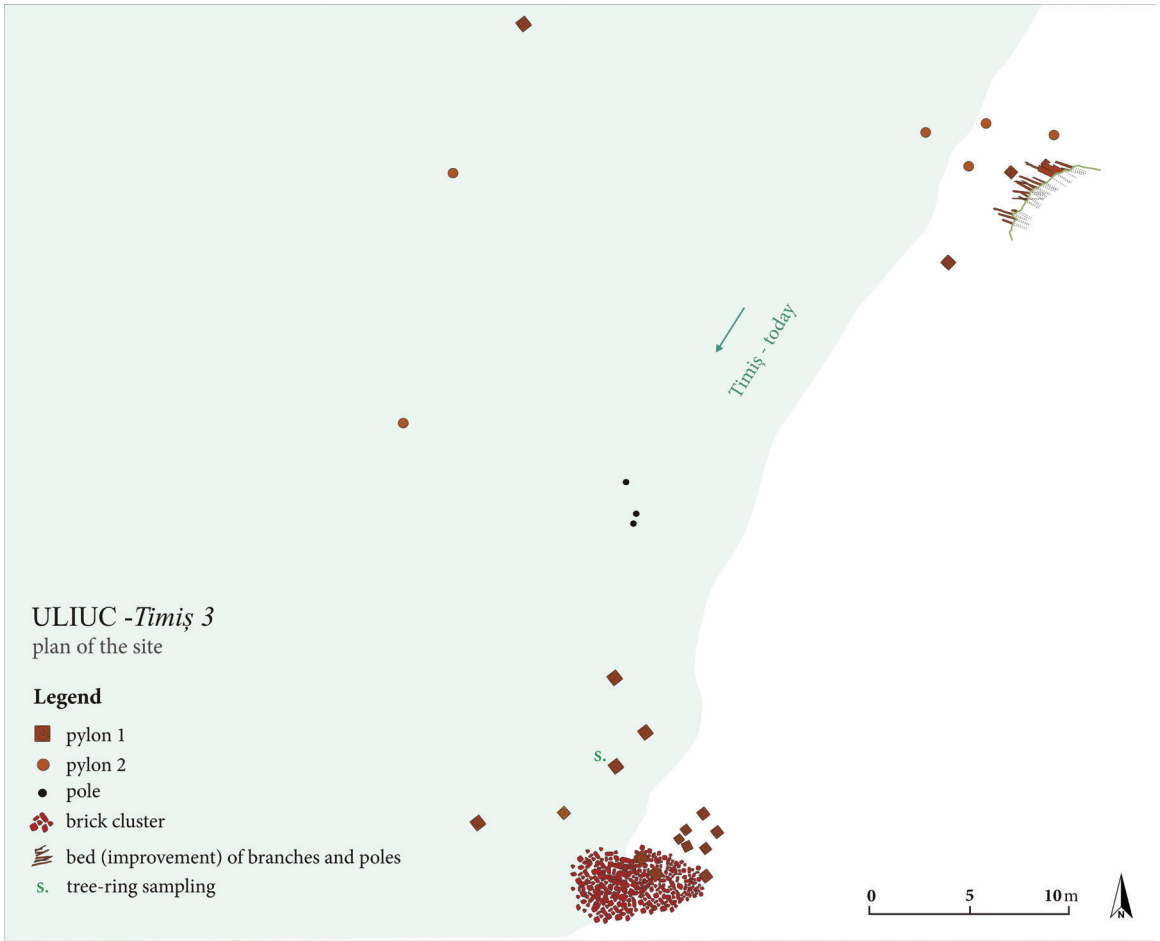


Fig. 30. Uliuc-*Timiș 3*, general plan, drawing.

ULIUC – TIMIȘ 4 Location (STEREO 70): 471577.42; 217102.444

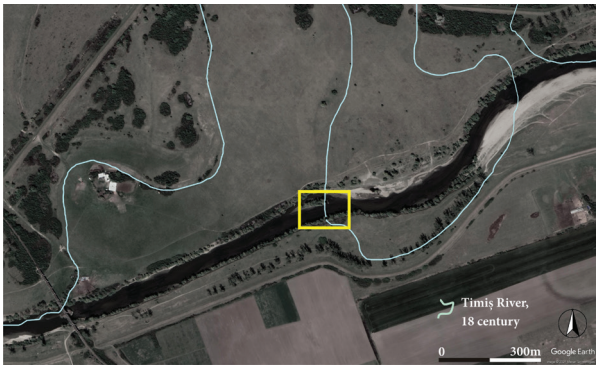
Podu CFR Est

a. site: hydraulic mill (lower part).

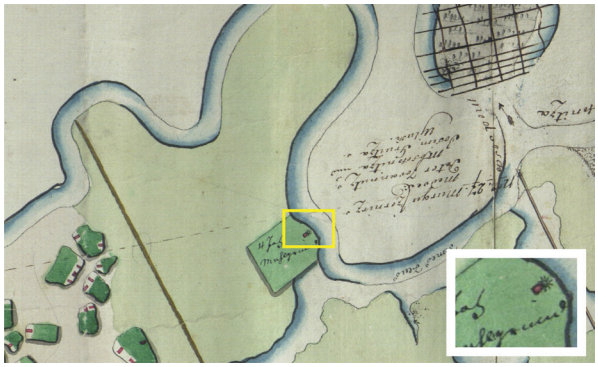
b. type: with dam (?).

c. location and hydrographic context: upstream the railway bridge at Uliuc.

d. documented materials: the objective is composed of an agglomeration of pylons, planks, a massive beam, and poles, arranged in the Timiș riverbed and partially on its banks. The large pylons *(pylon 1)* are square in section and have 15–20 cm sides, while the smaller pylons *(pylon 2)* are circular in section, with a ca. 15 cm diameter. The planks represent boards about 4 cm thick and 20 cm wide, while their supporting beam is square in section and has a side of about 40 cm. The samples harvested from this beam and from a pylon belong to oak species (*Quercus sp.*), of which, most likely, the other elements were also made.



Satellite image *Google E.™*, 2020-upper part; map, 1774- lower part.



e. layout: The ensemble contains two spatially distinct assemblages, one in the riverbed, in the area of an island (generated by the presence of pylons itself), marked with letter A and the other on the left river side, marked with B. The latter is a special find among all installations known to date. In-between several large pylons (up to 1.5 m tall), shaped in a square form in section, there is a bed of thick boards (planks) placed on a massive beam, also worked. The boards set on the extremities are carved in an L shape, with a vertical side over 20 cm high. The beam is frontally supported by two of the large pylons, two other smaller pylons (also square) being stuck midway the beam into the ground, still for fixing the piece. The joining of the elements forms a 2.5 m wide groove, which most likely was used to direct the river flow through there, at a time when the riverbed flowed perpendicularly (SN) to the current route (EW see the two figures above). At a 50 m distance towards the other bank, on the SN alignment, assemblage A consists of a group of pylons square in section, which form a polygon, but also the assembly of smaller pylons, circular in section, adjacent to several poles, part of an apparent alignment (between zones A and B).

f. dating of the site:

f.a. beginning of the structure: early 18th century (?); two samples could be dated dendrochronologically, with some questions.

f.b. decommissioning of the structure: 1822-'53: the mill's decommissioning may be placed between 1822 (its last cartographic representation) and mid-century (ca. 1845-'53), since no local cartographic support from this interval available to us no longer illustrates any mill in this sector of the Timiș river. Most likely, the mill was disused before the implementation of the regulating works of the Timiș, started after 1853.

g. cartographic representation: although not represented on the Josephine map, the mill is recorded a few years later on a 1774 local map, then on the one from 1793 and, finally, on the "mills map" of 1822 (where it is numbered 17). On all supports it is rendered as a classic mill, lying on the left river side.

h. research history: novel.

i. preservation stare: average; the boards, but also by the pylons, are in state of degradation, caused mainly by the frequent decrease of water levels and wood exposure to air, but also by alluvium.

j. notes / interpretation: the only find that may be interpreted as a gutter from all installations in the studied stretch. Once the Timiș river is regulated, the sector downstream the mill undergoes major changes, the large bend there being removed to the detriment of a straight segment, which would be traced and excavated from the mill up to the current railway bridge (Fig. 31). As cartography illustrates, the mill served the Uliuc community, at least during the 18th century – early 19th century.

k. plates:

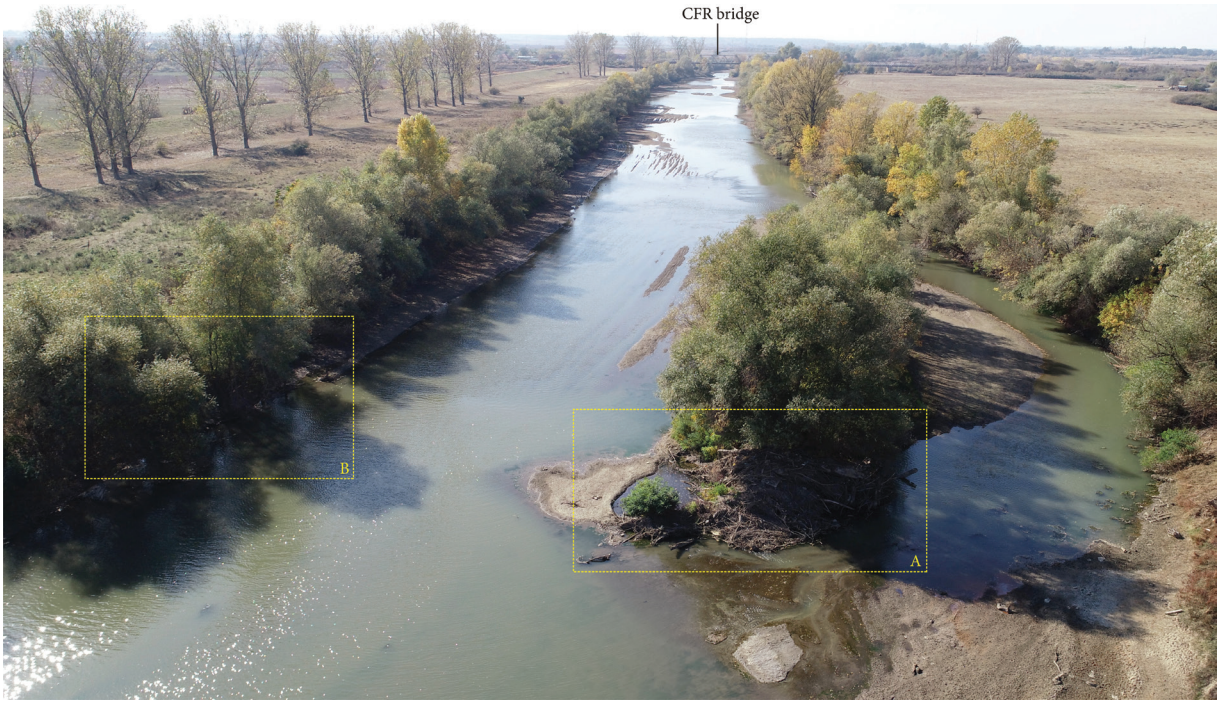


Fig. 31. Uliuc-*Timiș 4, groups A (right) and B (left), eastern view.* Drone photo O. Micșa (October 2019).

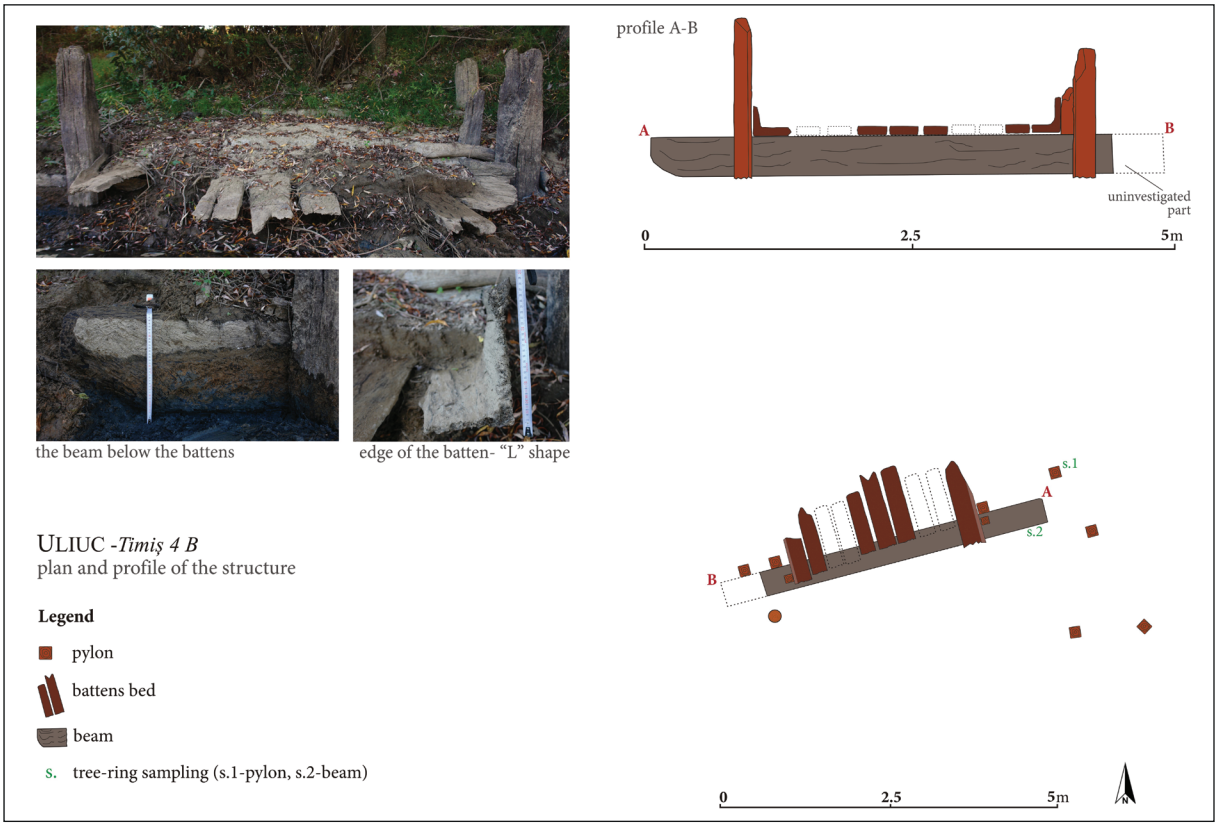


Fig. 33. Uliuc-*Timiș 4B*, field images and drawing of the plan and profile of the gutter.

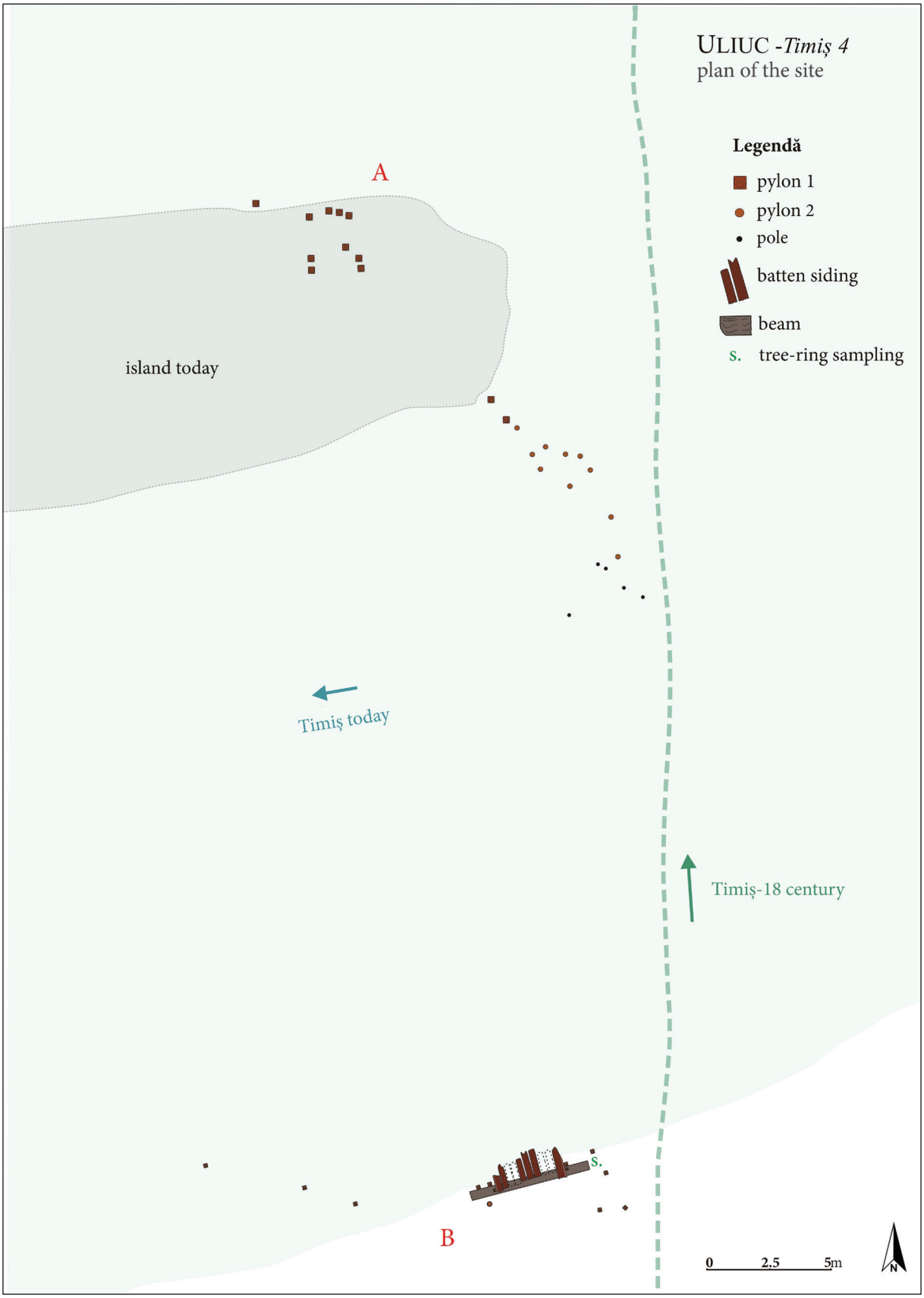


Fig. 32. Uliuc-*Timiș 4*, general plan, drawing.

Fig. 34. Uliuc-*Timiș 4B*, riverbed view, eastwards (October 2019).

ULIUC – TIMIȘ 6 Location (STEREO 70): 471088.67; 215390.434

Șântărie

a. site: hydraulic mill (lower part) and well.

b. type: with dam.

c. location and hydrographic context: located downstream of Uliuc and the discharge of Pogăniș into the Timiș, the objective crosses the Timiș riverbed, currently diagonally (NE-SW). In the 18th century, the riverbed had a slightly different direction in this point.

Satellite image Google E.™, 2020

d. documented materials: the objective is composed of an agglomeration of pylons and poles, all arranged in the Timiș riverbed. An alignment of fragmentary bricks spreads along the dam, pieces being likely associated with the hydrological installation. A few wide, thin boards are associated with the pylons on the right bank. The large pylons *(pylon 1)* have a square section and a side of 15–20 cm, while the smaller pylons *(pylon 2)* have a circular section and a diameter of approx. 15 cm. The poles are both square (shaped) and circular in section (4–8 cm), being the most significant assemblage of such elements among all installations (over 130 pieces) and by far the one with the most worked poles also in the upper part; the pieces have a surviving length of up to 0.5 m from the ground (Fig. 38). Their tip is sharpened, being square in section. The three samples harvested from the pylons as well as the sample from the well walls discovered there belong to the oak species (*Quercus sp.*), of which, most likely, all elements were made.

The well with wooden casing

Once with the find of the assembly of pylons and poles, midway the riverbed, partially flooded, was identified a wooden fountain. The casing, square in section, with a side of 1 m and composed of four planks joined by splices (Fig. 35) is visible on the surface by a row of such planks, but their row continues in depth, as we confirmed when attempting to see whether it was not a moving part lying in the secondary position. Unfortunately, we cannot provide more information about this structure at this time.

Fig. 35. Well with wooden casing. Shot when found (November, 2018).

Its spatial association with the ensemble of the mill there (Uliuc-*Timiș 6*), also not dated, provides no support for the attempt to chronologically frame the well. A glimpse to the detailed layout of the finds (based on survey measurements) in association with the hydrographic circumstances of the 18th century, suggest that the well would lie in an unnatural location, precisely midway the riverbed. It is not excluded that the well was prior to the ensemble, while their association is accidental.

e. layout: the large pylons are grouped, first, in the middle of the riverbed, in an orderly ensemble that forms several alignments. On the front side of the pylons (the first to meet the water flow) there is a small "dam" consisting of a weave of square poles in section, set up between two pylons (Fig. 36). The well lies at approx. 5 m from this group. A smaller assemblage of pylons, associated with a few boards, is located 30 m N-E of the large group of pylons.

The poles, still found in a very significant amount, form a long alignment of approx. 40 m and 3.5–4 m wide.

f. dating of the site:

f.a. beginning of the structure: most probably before the 18th century; the three samples taken for dendrochronological analyses did not prove relevant for dating, hence the hypothesis on the dating relies on the lack of cartographic representation of the structure, which might place it prior the emergence of the maps.

f.b. decommissioning of the structure: the structure likely ends its activity before the Josephine survey (1769-'72) since no cartographic support from these maps onwards record this structure.

Fig. 36. The small "dam" formed by poles framed between pylons, seen from the east.

g. cartographic representation: unidentified cartographically.

h. research history: novel.

i. preservation stare: average; pylons are in a state of degradation caused mainly by the frequent decrease of water levels and wood exposure to air.

j. notes / interpretation: It is perhaps worth mentioning that in the vicinity of the ensemble, on the left side, several archaeological finds have been made, of which the traces of a rich medieval inhabitancy, would be of interest (the 14th – 15th century, objective *Uliuc 1*). It is not excluded that the mill or well may be associated with the settlement there, which may only be proven by further research. A brick cluster (secondary position of the pieces) willing along the dam, may be associated with the ensemble, but in this research stage we can't be sure of this.

k. plates:

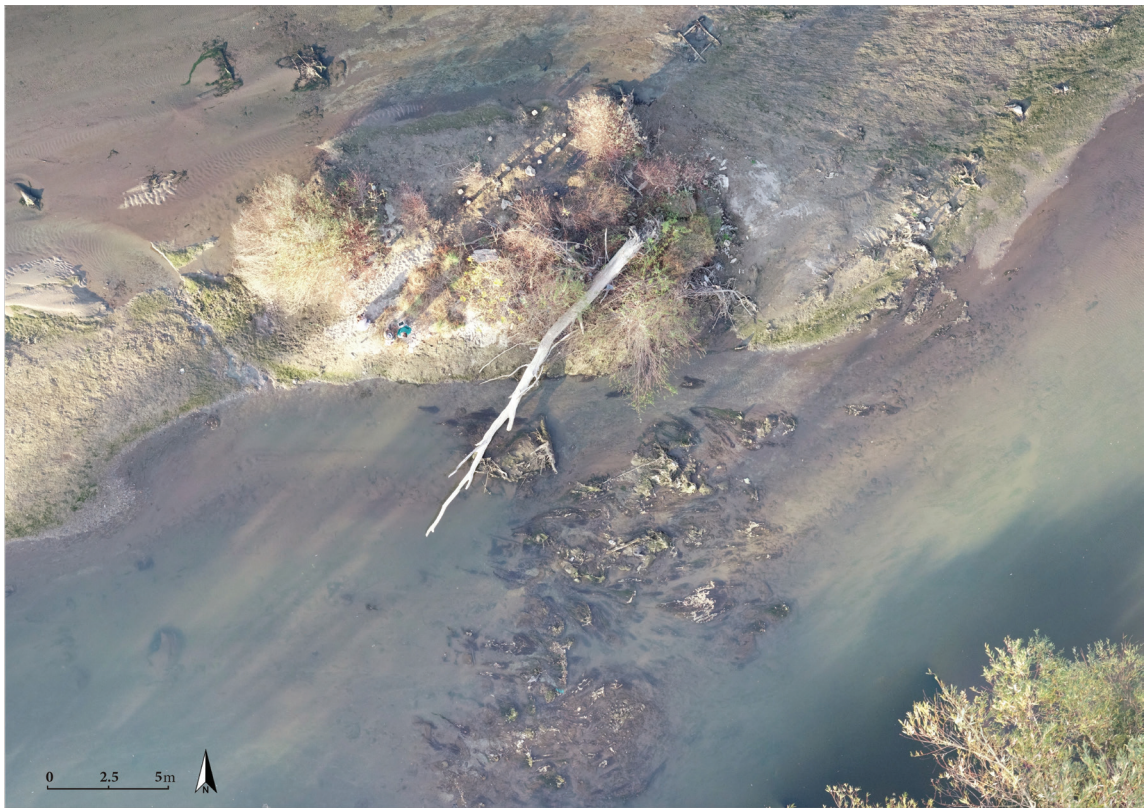


Fig. 37. Uliuc-*Timiș 6*, assembly plan. Orthophotoplan (November 2018).

Fig. 38. Uliuc-*Timiș 6*. The alignment of poles forming the dam, view from the south (October 2019) and detail with the working of poles at the top (frame).

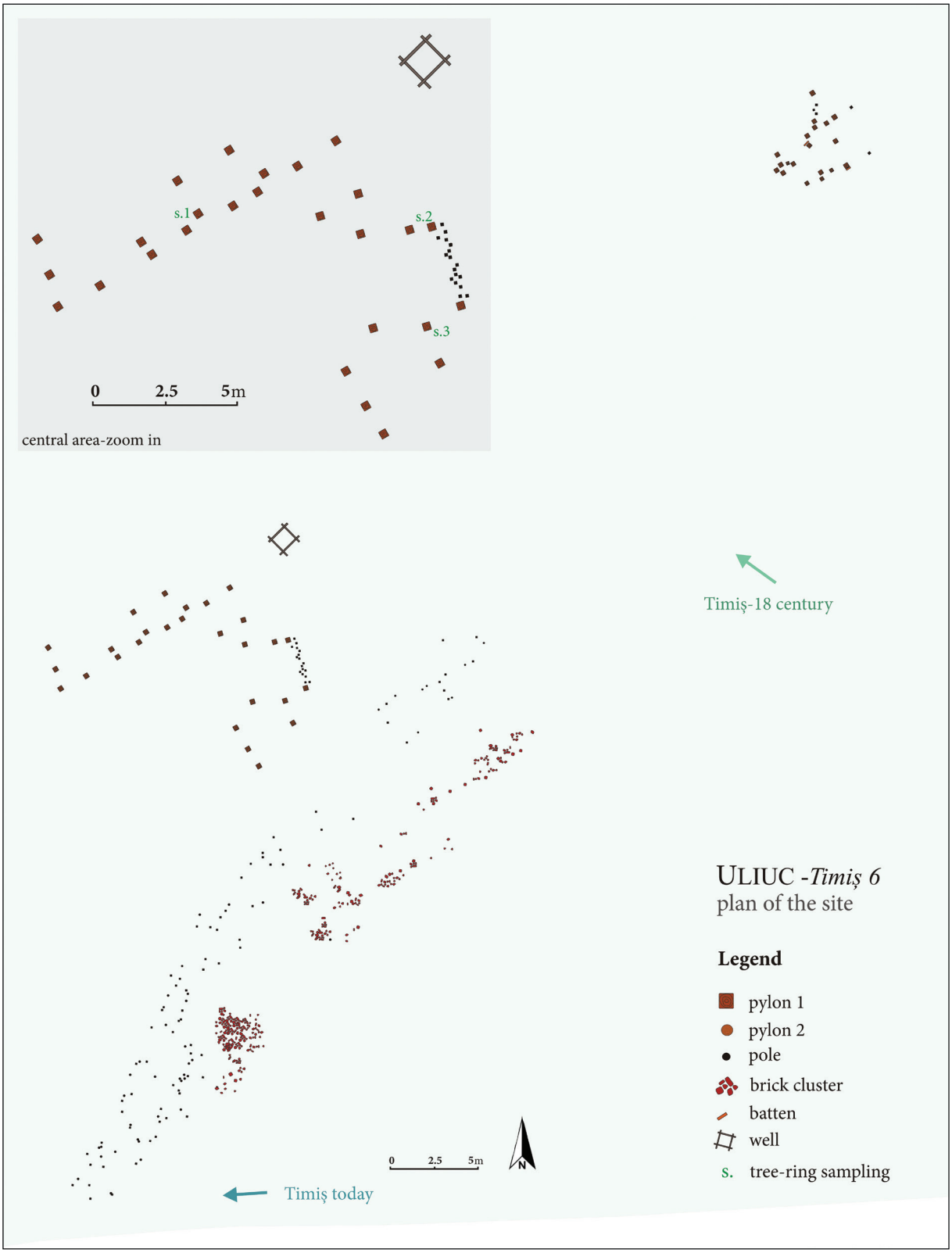


Fig. 39. Uliuc-*Timiș 6*, general plan, drawing.

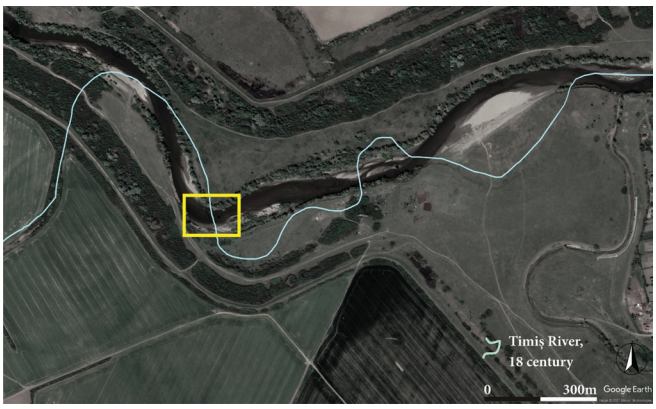
ULIUC – TIMIȘ 7 Location (STEREO 70): 470977.833; 214908.621

Cotu Morii

a. site: hydraulic mill (lower part), bridge and installation of uncertain function.

b. type: with dam.

c. location and hydrographic context: located downstream of Uliuc and the discharge of Pogăniș into the Timiș, the objective crosses the Timiș riverbed, currently diagonally (SE-SW). In the 18th century, the riverbed had a different direction at this point, which placed the structure much more naturally and logically in relation to the water flow, considering its function. As rendered, the mill lay on the left river side.



Satellite image *Google E.™*, 2020-upper part; map, 1774- lower part.

d. documented materials: the objective is composed of an agglomeration of pylons and poles, all arranged in the Timiș riverbed. The large pylons *(pylon 1)* have a square section and a side of 15–20 cm and a height above ground of up to 1.8 m, while the smaller pylons *(pylon 2)* have a circular section, with a diameter of approx. 15 cm.

There is also a third category of pylons (pylon 3), square in section, yet with a 10–15 cm side. All poles are circular in section (4–6 cm), with a surviving length above the ground of 1.5 m (Fig. 42, left). Their tip is shaped, being square in section. A few elements protruding from the ground have a preserved length of approx. 3 m (Fig. 42, right). The three samples harvested from the pylons belong to the oak species (*Quercus sp.*), of which, most likely, all elements were made, except for the poles.

e. layout: the large pillars are grouped and aligned downstream of the structure, on the S-N direction; their layout pleads for the existence there of a closed construction (s) (mill building). The smaller, circular pylons, associated with a series of poles, extend on a long alignment of approx. 40 m wide and 3.5–4 m wide set slightly obliquely along the current riverbed. As shown by their arrangement, they formed a very durable dam (weir), the used elements being more robust than with the remaining studied facilities. To the east, 20 m upstream of this alignment there is a relatively semicircular set of poles (Fig. 43-marked with A), which starts from the current bank of the river and encloses an area 20 long m and 12 m base width (internal surface of over 100 m2).

f. dating of the site:

f.a. beginning of the structure: early 18th century (?); based on dendrochronology, one of the three samples taken from the field could be dated rather questionably. Cartographically, the mill there is first recorded in 1769-'72.

f.b. decommissioning of the structure: 1822-'53: the mill's decommissioning may be placed between 1822 (its last cartographic representation) and mid-century (ca. 1845-'53), given that no local cartographic support of the interval available to us further records any mill in this sector of the Timiș river. Most likely, the mill was disused prior the implementation of the regulating works of the Timiș, commenced after 1853.

g. cartographic representation: it is the most present mill within the analyzed maps, being recorded starting with the Josephine map (1769-'72), three local maps (1774, 1793 and 1812) and ending with the 1822 "mills map".

h. research history: Lazarovici, Drașovean, Maxim, 2001, 83; during a larger fieldwalk along the Timiș river, G. Lazarovici photographs the ensemble from *Cotu Morii*, which he ascribes to a medieval bridge.

i. preservation state: poor; the pylons are in process of degradation; several pylons exhibit traces of chainsaw cutting, evidence of their truncation in the contemporary era, as these pylons were a firewood source for the communities inhabiting the river vicinity.

j. notes / interpretation: as illustrated by the Josephine map (1769-'72) and according to the dam's appearance, made of robust pylons, it seems that it also functioned as a bridge; in addition to the road linking Uliuc village with the discussed facility, another road comes to the mill on the other bank, directly from Urseni (Medveș at the time), which involves access to the mill that must have been provided with a bridge in front of the wheel.

k. plates:

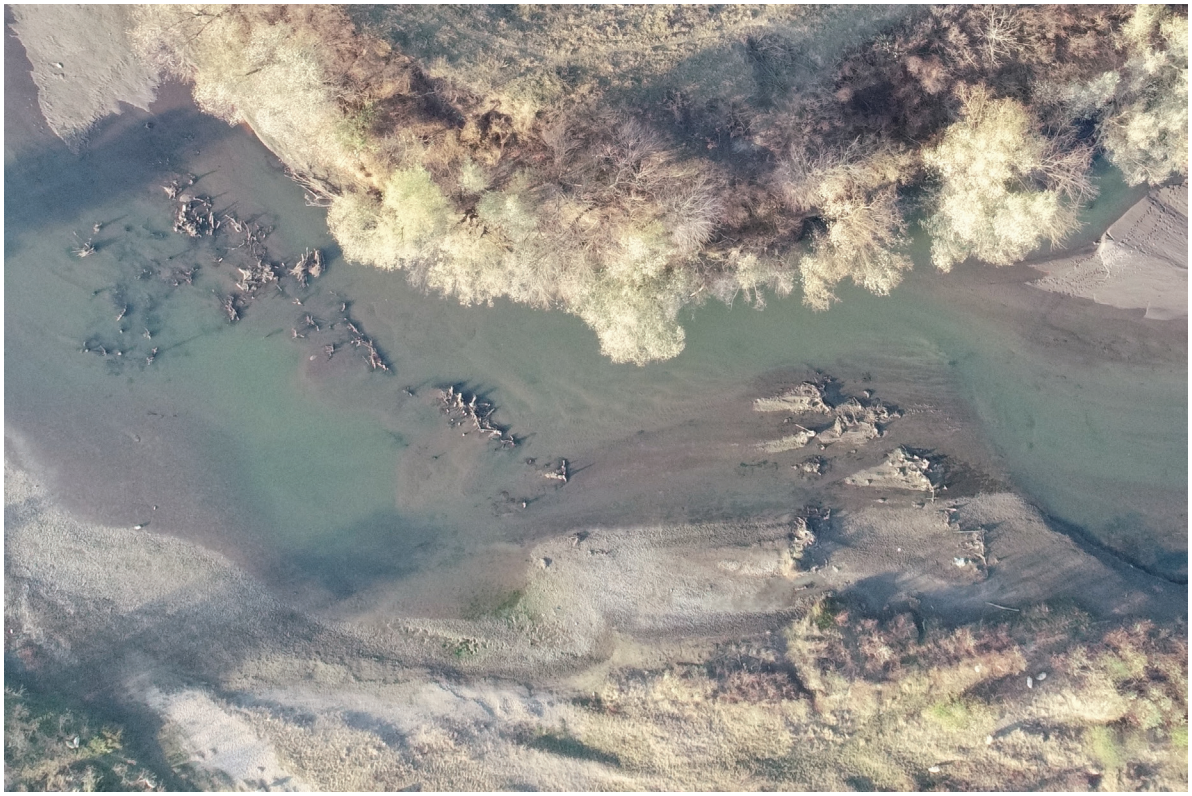


Fig. 40. Uliuc-*Timiș* 7, assembly plan. Drone photography (November 2018).

Fig. 41. Uliuc-*Timiș* 7, alignment of the large pylons. View towards East (November 2019).

Fig. 42. Uliuc-*Timiș* 7, details: the assemblage of poles and pylons with traces of contemporary interventions (left) and the length of a pole with sharpened tip, displaced, in relation to an individual (right).

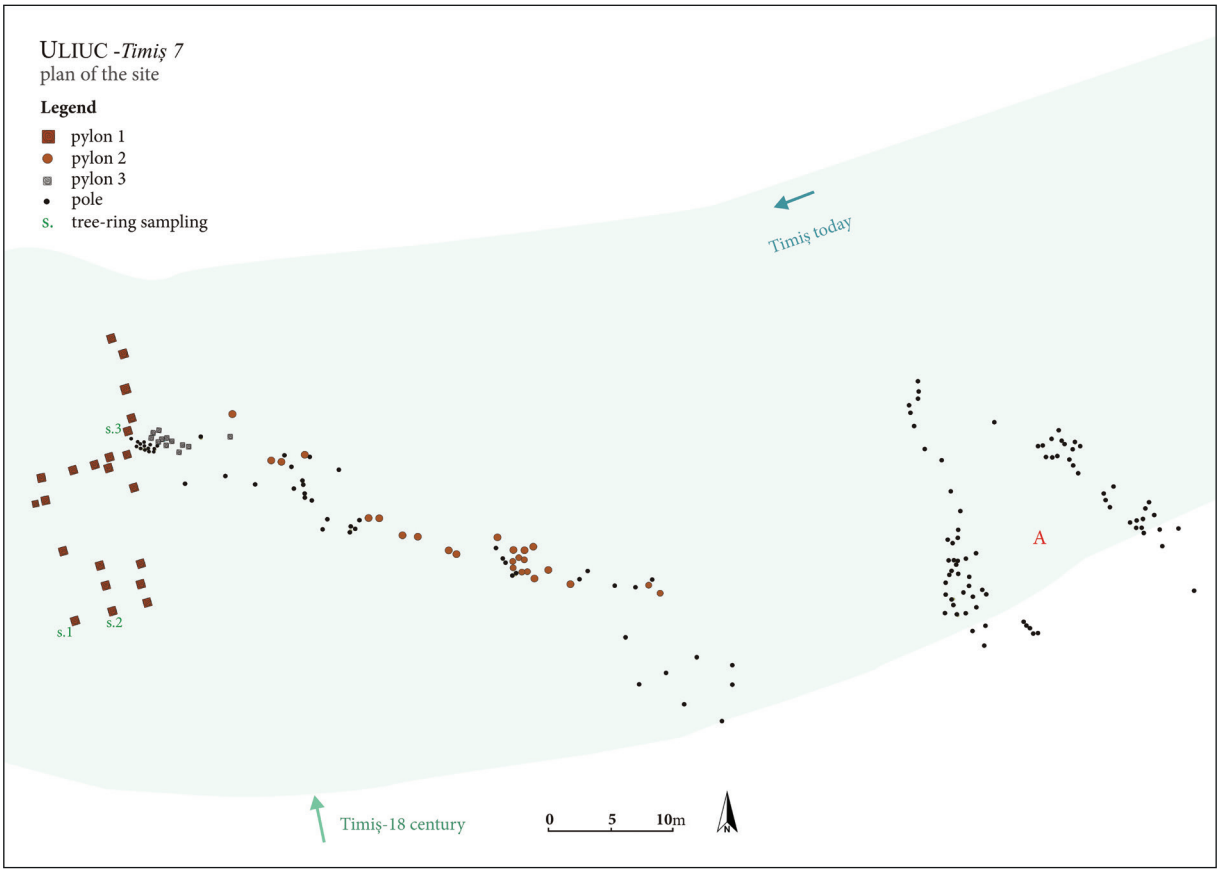


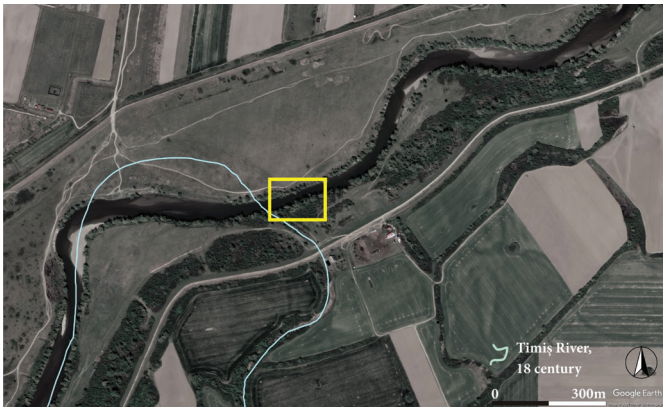
Fig. 43. Uliuc-*Timiș* 7, general plan, drawing.

UNIP – TIMIȘ 1 Location (STEREO 70): 470961.616; 212563.572

Ostrov V

a. site: hydraulic mill (lower part).

b. type:?



Satellite image *Google E.*™, 2020-upper part; map, 1822- lower part.

c. location and hydrographic context: near Urseni, close to the Unip pumping station, in the vicinity of the left bank of the Timiș river. In the 19th century, the mill there is shown on the other bank side (right); migration of the mill to the left bank may be related to the migration of the riverbed by a few tens of meters.

d. documented materials: four circular pylons in section, with a diameter of approx. 20 cm and surviving height out of the ground up to 2 m.

e. layout: collinear, the pylons most likely supported the mill building; the migration of the Timiș riverbed made that the area in front of the mill to be underground today, reason for which the establishment of other details related to the layout of the ensemble (possible dam) is impossible.

f. dating of the site:

f.a. beginning of the structure: 1772–1822; the first record of the mill is in 1822, but the lack of a post-Josephine map for the area in question (1769-'72, when the mill is not attested), hinders any accurate dating.

f.b. decommissioning of the structure: ca. 1869-'87; the third Habsburg survey (1869-'87 edition) consecrates the mill's disappearance from the Timiș river through its lack of representation. Most likely, the structure was disused once the Timiș river damming works were initiated in the period.

g. cartographic representation: the structure appears only on the 19th century cartography, more precisely on the "mills map" of 1822 and the Franciscan map with its different variants (≈ 1865-'70). It is the latest illustration of a mill on the Timiș river in the stretch discussed here, but also on a wider river segment.

h. research history: novel.

i. preservation stare: poor; pylons in process of degradation.

j. notes / interpretation: the Timiș riverbed segment there is a secondary course in the 18th century, a situation that changes during the 19th century, when it becomes the main course. Most likely, the fact that the riverbed was originally secondary allowed the mill to be preserved at least for 20 years later than all the other installations on the Timiș; as rendered, the mill was used by the Urseni (Medveș) community. Since the pylons are inaccessible from the steep bank, their surviving length is better preserved.

k. plates:

Fig. 44. Unip-*Timiș 1*, general view from the riverbed, westwards (2019).

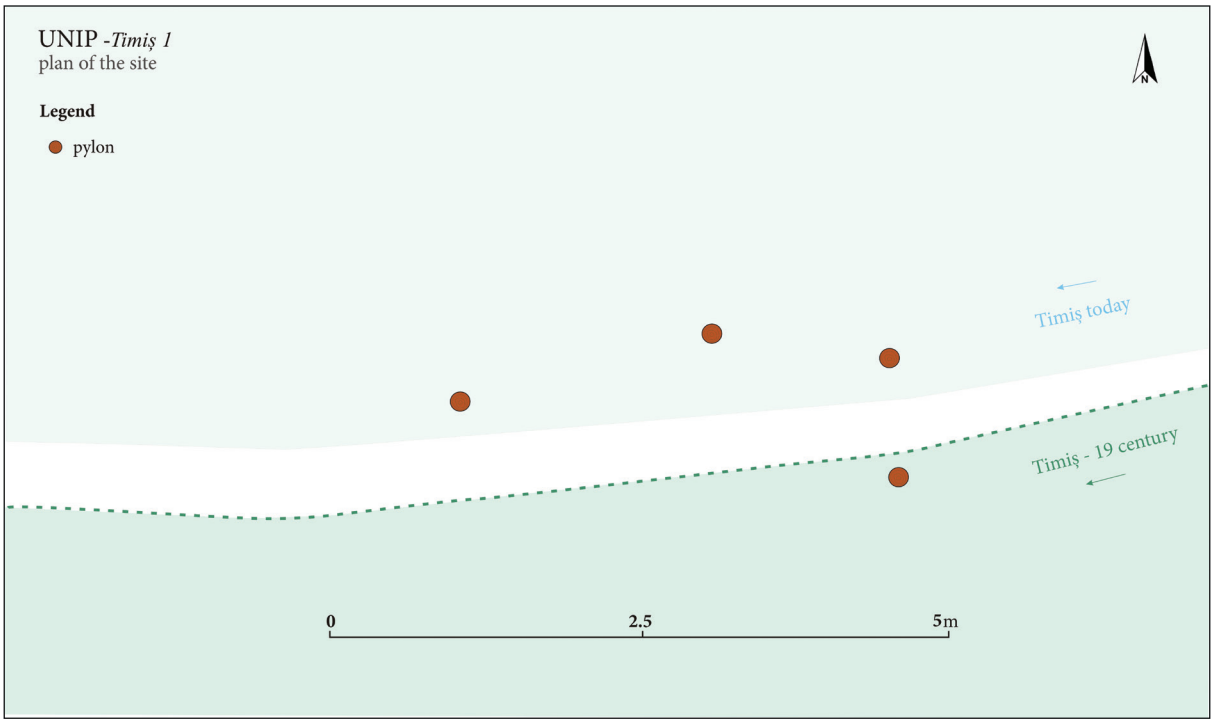


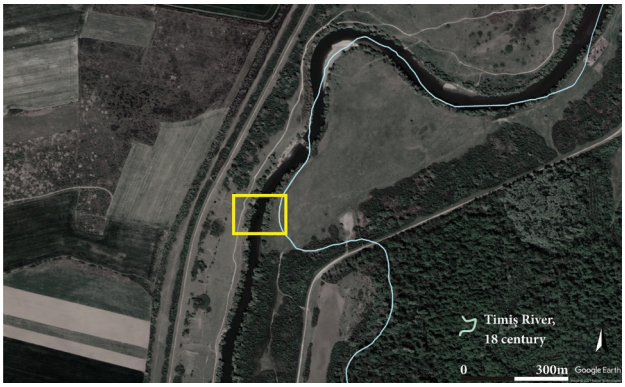
Fig. 45. Unip-*Timiș 1*, general plan, drawing depicting the migration of the Timiș.

UNIP – TIMIȘ 2 Location (STEREO 70): 469988.699; 210905.106

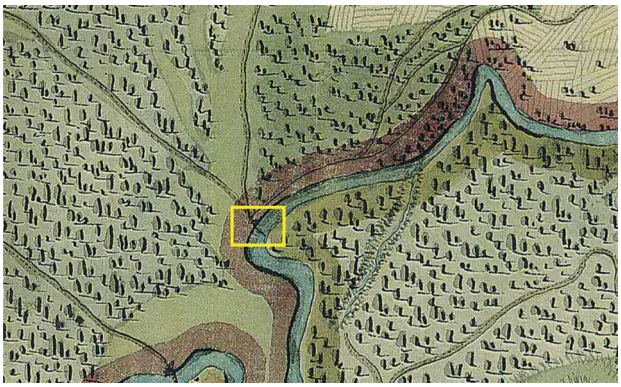
Cotu Mare

a. site: hydraulic mill (lower part) and bridge (?).

b. type: with dam.



Satellite image *G. E.*™, 2020-upper side; map, 1769-' 72- lower side.



c. location and hydrographic context: downstream of *Cotu Mare* (Unip Forest); the pylon lies at a point in the Timiș riverbed, but in the 18th century, this was an ensemble that crossed the entire riverbed.

d. documented materials: a circular pylon in section and 20 cm in diameter.

e. layout: isolate element, located midway the Timiș riverbed. Cartographically, the site is rendered similarly to Giroc-*Timiş 1*, namely a mill with dam that crosses the riverbed.

f. dating of the site:

f.a. beginning of the structure: 18th century or earlier; cartographically, the mill there is first attested in 1769-'72.

f.b. decommissioning of the structure: 1822-'53: the mill's decommissioning may be placed between 1822 (its last cartographic representation) and mid-century (ca. 1845-'53), given that no local cartographic support from this interval available to us further illustrates any mill in this sector of the Timiș river. Most likely, the mill was disused before the execution of the regulating works of Timiș, started after 1853.

Fig. 46. Unip-*Timiș 2*, general view from the riverbed, from the east (October 2019).

g. cartographic representation: the Josephine map (1769-'72) and the "mills map" (1822); like the mill downstream of *Cotu Mare* (Giroc-*Timiș 1*), the mill is rendered with a line that crosses the Timiș riverbed which suggests the presence of a dam, possibly used as a bridge, since a number of roads on the right shore converge at this point and a road is rendered in the area on the other bank.

h. research history: novel.

i. preservation state: almost disappeared.

j. notes / interpretation: it is the most damaged structure among those documented, a fact that we attribute to the regulating works of the river by mid 19th century; these works moved the riverbed course by excavating a straight channel which most likely dislodged the old ensemble attested in the 18th century.

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Abbreaviations

AEM	Archäologisch-epigraphische Mitteilungen aus Österreich-Ungarn, Vienna.
AM	Arheologia Moldovei, Iași.
AMN	Acta Musei Napocensis, Cluj-Napoca.
AMP	Acta Musei Porolissensis, Zalău.
AMV	Acta Musei Varnaensis, Varna.
Angustia	Angustia. Revista Muzeului Național al Carpaților Răsăriteni, Sf. Gheorghe.
Anuarul MJIAP (S.N.)	Anuarul Muzeului de Istorie și Arheologie Prahova, Serie Nouă, Ploiești.
Antiquity	Antiquity. A review of world archaeology, Durham.
Archaeological Journal	Archaeological Journal. New Series. Chișinău.
ArchÉrt	Archaeologiai Értesitő, Budapest.
ArchPol	Archaeologia Polona, Warsaw.
ArchRozhledy	Archeologické Rozhledy, Praha.
ASM	Archaeologica Slovaca Monographiae, Bratislava.
BAR (Int. S.)	British Archaeological Reports (International Series), Oxford.
Biharea	Biharea. Culegere de studii și materiale de etnografie și artă, Oradea.
BMG	Bibliotheca Musei Giurgiuvensis, Giurgiu.
BMJT	Buletinul Muzeului Județean Teleorman. Seria Arheologie, Alexandria.
BMM	Bibliotheca Musei Marisiensis, Târgu Mureș.
Budapest Régiségei	Budapest Régiségei Régészeti és Történeti Évkönyv. Budapest.
CA București	Cercetări arheologice în București, București.
CCA	Cronica Cercetărilor Arheologice, București.
CIL	Corpus Inscriptionum Latinarum, Berlin.
CsSzMÉ	A Csíki Székely Múzeum Évkönyve. Csíkszereda.
Dacia (N.S.)	Dacia. Revue d'archéologie et d'histoire ancienne. Nouvelle serie. Bucureşti.
Dolgozatok	Dolgozatok a Magyar Királyi Ferencz József Tudományegyetem Archaeológiai Intézetéből. Szeged.
EphNap	Ephemeris Napocensis, Cluj-Napoca.
Erdély	Erdély. Turistai, fürdőügyi és néprajzi folyóirat, Cluj-Napoca.
FontArchPrag	Fontes Archaeologici Pragenses, Prague.
Földtközl.	Földtani közlöny, Budapest.
HOMÉ	A Herman Ottó Muzeum Évkönyve, Miskolc.
ILD	C. C. Petolescu, *Inscripții latine din Dacia*, Bucharest 2005.
JAHA	Journal of Ancient History and Archaeology, Cluj-Napoca.
Jahrb. RGZM	Jahrbuch des Römisch Germanischen Zentralmuseums zu Mainz, Mainz.
JAMÉ	Jósa András Múzeum Évkönyve, Nyiregyháza.
Karpatika	Karpatika, Uzhorod.
LMI	List of Historic Monuments, updated 2015.
Marisia	Marisia. Studies and Materials. Archeology. Târgu-Mureș.
MCA (S.N.)	Materiale și Cercetări Arheologice Serie Nouă. București
MemAntiq	Memoria Antiquitatis, Piatra Neamț.
NNA	Nordisk Numismatisk Årsskrift, Stockholm.
PAS	Prähistorische Archäologie in Südosteuropa, Rahden/Westf.
PAT	Patrimonium Archaeologicum Transylvanicum, Cluj-Napoca.
Paléo	PALEO – Revue d'archéologie préhistorique, Les Eyzies-de-Tayac-Sireuil.
Pallas	Pallas. Revue d'études antiques, Toulouse.

PNAS	Proceedings of the National Academy of Sciences of the United States of America, Washington.
PZ	Prähistorische Zeitschrift. Berlin.
RAN	National Archaeological Repertory.
RM	Revista Muzeelor, București.
Sargetia	Sargetia. Acta Musei Devensis, Deva.
SatuMareSC	Satu Mare Studii și Comunicări, Satu Mare.
SCIV(A)	Studii și Cercetări de Istorie Veche și Arheologie, București.
SCȘMI	Studii și Comunicări Științifice ale Muzeelor de Istorie, București.
SIB	Studii de Istorie a Banatului, Timișoara.
SlovArch	Slovenská archeológia, Nitra.
SP	Studii de Preiostorie, București.
St.Cerc.Antropol.	Studii și Cercetări de Antropologie, București.
StudUBB-G	Studia Universitatis Babeș-Bolyai. Seria Geologia, Cluj-Napoca.
ZborníkSlovNMA	Zborník Slovenského Národného Múzea. Archeológia, Bratislava.
ZSA	Ziridava. Studia Archaeologica, Arad.
ИАИ	Известия на Археолигическия Институт при БАН, София.