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OVER THE RAMPARTS AND THROUGH THE DITCH.
The Newest Possibilities for Topographical Research on the Csörsz Ditch

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In January of 2017 the Archaeolingua Foundation and the Cultural Heritage Studies program of Central European University organized a workshop discussion[3] to debate the archaeological, heritage preservation and nature conservation issues of the Csörsz Ditch. The participants agreed that as a result of powerful erosion and constant agricultural cultivation we are now at the 11th hour for the identification of certain sections of the Csörsz Ditch in the field, but that the use of the most modern remote-sensing equipment and methods could help to move research in this area forward from its current situation. In our essay we would like to demonstrate the possibilities intrinsic in the new methods through an evaluation of our ALS survey of the Csörsz Ditch section between Hajdúböszörmény and Hajdúhadház.

Ramparts, forts, fortifications and mounds constructed from earth make up a special group of archaeological sites in the Carpathian Basin. Perhaps the most spectacular and most interesting archaeological sites belong to this group, but these types of sites only represent a tiny fraction of archaeological sites.

The Csörsz Ditch (or Devil's Ditch), the result of earthworks at an enormous scale, is one of the most problematic archaeological features of the Carpathian Basin. This linear system of fortifications starts from the Danube Bend and runs in an easterly direction in the foreground of the North Hungarian Mountains. It reaches the Tisza River and crosses it continuing in an easterly direction, and then upon arriving at Újfehértó it changes direction sharply and turns to the south. Its further sections run in a north-south direction, arriving again at the Danube River.[4] The full length of this system of earthen fortifications, which in some places is made up of multiple parallel lines of earthworks, is about 1,260 km.[5]

The Hungarian research into the Csörsz Ditch began in the middle of the 19th century.[6] The construction period and function, as well as the purpose for the building of this structure, which according to estimations involved the movement of about 10-15 million m^3 of earth, is still to the present day an unsolved problem for archaeology.[7] Although due to the large construction projects that have become more common since the 1990s, cuts have been made through the Csörsz Ditch on several occasions and the cemeteries and settlements in its surroundings have been excavated,[8] the recent excavations have not provided more precise data on the structure of the fortifications or their chronological classification.

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[3] https://medievalstudies.ceu.edu/events/2017-01-27/torteneti-tajak-vizes-elohelyek-regeszet-kornyezettortenet-tajvedelem
[4] Garam, Éva – Patay, Pál – Soproni, Sándor: Sarmatisches Wallsystem im Karpatenbecken. *Régészeti Füzetek (Archaeological Brochures)* Ser II., No. 23. (Magyar Nemzeti Múzeum 1983), 112.
[5] Ibid., 46.
[6] Romer, Floris: Les fosses du diable en Hongrie. In: *Compte Rendu* (Budapest: Musée National Hongrois, 1878), 39–77.; Pulszky, Ferenc: Régészeti emlékek az Alföldön (Archaeological Remains on the Great Hungarian Plain). In: *Osztrák-Magyar Monarchia* írásban és *képben (The Austro-Hungarian Monarchy in Writing and in Illustrations)*, vol. VII, Hungary volume II (Budapest, 1891). Arcanum DVD.
[7] For one of the most complete summaries related to research on the Csörsz Ditch, see: Istvánovits, Eszter – Kulcsár, Valéria: Gondolatok az alföldi sáncok kutatásának jelenlegi helyzetéről (Thoughts on the Present Status of Research on the Earthworks on the Great Hungarian Plain). In: *Avarok pusztái (Plains of the Avars)*, eds. Anders, Alexandra – Balogh, Csilla – Türk, Attila (Budapest: Martin Opitz – MTA BTK MŐT, 2014), 73–83.
[8] Fischl, Klára: Előzetes jelentés a Csörsz-árok kutatásáról Csincsén (Preliminary Report on Research into the Csörsz Ditch at Csincse). *Somogy Megyei Múzeumok Közleményei (Reports from the Somogy County Museums)* 11(1995) 33–46.; Vaday, Andrea – Domboróczki, László: Mezőszemere, Kismari-fenék. Spätkaiser-frühvölkerwanderungszeitliches Gräberfeldsdetail. *Agria* XXXVII (2001), 5–206.

It is not the goal of our present paper to answer this question. However, an ever more precise knowledge of the structure and topographical condition of these earthworks can bring us closer to a determination of the construction and purpose of this linear system of fortifications.

The research conditions vary for the different sections of this system of fortifications. There are sections where they can be easily followed on the surface with the naked eye, but there are also places where no trace of the former structure has remained on the surface. The field identification of the Hungarian sections of the system of fortifications took place in the 1960s-1970s,[9] but despite this, their re-identification using remote-sensing equipment and methods is still in its beginning stages, and the opportunity for documentation is in the 11th hour due to erosion and agricultural cultivation.

THE RESEARCH AREA (Fig. 1.)

Fig. 1. Map showing the section of the Csörsz Ditch (1), running between Hajdúböszörmény and Hajdúhadház and the examined site (2). (Credits: Máté Szabó; source: Google Earth, DigitalGlobe 22 May 2011.)

The research area we selected is on the outskirts of Hajdúhadház, in its western border area, where the section of the Csörsz Ditch registered under identification number 50011 runs.[10] The area borders directly upon Hajdúböszörmény, and the highway connecting the two towns cuts through the archaeological site. In this section, the Csörsz Ditch has probably formed the administrative border for many centuries,[11] which is not

[9] Garam, Éva – Patay, Pál – Soproni, Sándor: Sarmatisches Wallsystem im Karpatenbecken. *Régészeti Füzetek (Archaeological Brochures)* Ser II., No. 23. (Magyar Nemzeti Múzeum, 1983).

[10] Lelőhelybejelentő adatlapok, Csörsz-/Ördög-árok késő római sáncrendszer, Hajdú-Bihar megye, 2010 (Archaeological Site Data Sheets. Csörsz/Devil's Ditch Late Roman System of Fortifications, Hajdú-Bihar County, 2010). [KÖH 600/3353/2010]

[11] One of the earliest depictions of the borderline can be seen in: Beck, Pál: *Tabula exhibens terram oppidi Hajdonicalis Böszörmény delineata anno MCCCLXXXIII*. Map Hvt-2 of the Hungarian National Archives' Hajdú-Bihar County Archives' Hajdúböszörmény Branch Archives.

a unique occurrence. Before large-scale agricultural cultivation became common, the earthworks and the ditch could be easily observed on the ground, and so as easily identified landmarks they were often used as border markers. It already appears in medieval deeds for the inspection of landmarks as "*fossatum magnum*" ("large ditch"), and on the border of Szihalom it was successfully identified as the Csörsz Ditch.[12] In the case of Hajdúhadház as well, the Csörsz Ditch is a remnant of historic landscape use and archaic settlement structure as a border landmark.

The remains of the system of fortifications and ditches in this section are found in a forest, and their survival is certainly thanks to this, or more precisely due to the sandy soil of the area,[13] which does not really allow for other types of cultivation besides silviculture. This water-poor area divided by a sandy ridge running north-by-northeast to south-by-southwest earlier may have been plains oak savannah, interdunal wetlands and sandy grasslands, which today has been replaced for the most part by plantations of primarily locust trees.[14] The Southern Nyírség region marks off a different type of natural environment to the north and west, and the soil also changes on the borders of the forest, which can be clearly identified by the current methods of cultivation. To the north of the examined area, or towards Hajdúböszörmény, we find extensive agricultural cultivation. The Csörsz Ditch running in the direction of Debrecen has fallen victim for the most part to the erosive effect of agricultural machinery in these areas, but in the forest significant

Fig. 2. The ditch and earthwork from the North (Credits: Tamás Horváth, 2 August 2016.)

[12] Foltin, János: *A Zázty-i apátság XI. századi alapító oklevelének taglalata* és *ismeretlen helyének meghatározása (The Analysis and Determination of Unknown Locations from the 11th Century Deed of Foundation of the Zázty Monastery)* (Eger, 1883); Balás, Vilmos: Az alföldi hosszanti földsáncok (Linear Earthen Fortifications on the Great Hungarian Plain). *Régészeti Füzetek (Archaeological Brochures)* Ser. II., No. 9.(Magyar Nemzeti Múzeum, 1961), 104–105.

[13] Dövényi, Z. (ed.): *Magyarország kistájainak katasztere (Survey of Hungarian Micro-Regions)* (Budapest: MTA Földrajztudományi Kutatóintézet 2010), 236–237.

[14] Ibid., 236.

remains can be observed even today. Unfortunately the vegetation of the period has been replaced with locust trees, but even so the system of earthworks can be traced in the canopied forest through the remains of its significant terrain features.

This section of the linear system of fortifications does not belong amongst the sections that are well researched from an archaeological standpoint, which can be explained due to the area's forest cover. The surveying of the site was first performed between 1962 and 1968 under the direction of Pál Patay. During the field work coordinated by the Hungarian National Museum it was possible to plot out about a 3 km long section of the fortification running through the Hajdúhadház Kutasi Forest, which continues on in a southerly direction in the Nagyerdő section of Debrecen. On the basis of field observations this section was classified in the category of *easily discernible*.[15]

Following this, no archaeological research was performed in practice on this section of the site. The next on-site examination was performed by colleagues from the Office of Cultural Heritage for the purpose of official public registration of this section of the site. After the clearly visible section with the identification number 50011, the sections with identification numbers 75509 and 75511 running to the north of it that cannot be as clearly observed on the ground were also registered.[16]

Fig. 3. The damaged earthwork and ditch from the South (Credits: Marianna Bálint, 11 February 2017.)

[15] Garam, Éva – Patay, Pál – Soproni, Sándor: Sarmatisches Wallsystem im Karpatenbecken. *Régészeti Füzetek (Archaeological Brochures)* Ser II., No. 23 (Magyar Nemzeti Múzeum, 1983), 34, 129.

[16] Lelőhelybejelentő adatlapok, Csörsz-/Ördög-árok késő római sáncrendszer, Hajdú-Bihar megye, 2010 (Archaeological Site Data Sheets. Csörsz/Devil's Ditch Late Roman System of Fortifications, Hajdú-Bihar County, 2010). [KÖH 600/3353/2010]

The next on-site examination was performed by colleagues from the Hajdúsági Museum in the summer of 2016.[17] During the field walk on the site, the ditch running along the eastern side of the fortification was successfully identified as well as the rampart on the western side. The rampart seems to have been disturbed, its top may have been smoothed down during work related to forest cultivation, so now it looks as if there were a shallower and a deeper ditch running parallel to one another. However, this condition is probably the result of modern disturbances (*Fig. 2.*).

The field walk on this section of the site was repeated in winter, when there was insignificant vegetation cover, but new and more precise structural observations could not be made despite the more favorable conditions for observation (*Fig. 3.*).

Leaving the Kutasi Forest, the ditch and the rampart disappear from the surface and their paths cannot be traced on the surface with the naked eye.

EVALUATION OF THE REMOTE-SENSING DATA

Active and passive remote-sensing technology is being used more and more commonly in the surveying of archaeological sites that have topological traces. Minimal or even micro-relief differences can be detected with the aid of aerial LiDAR (Light Detecting and Ranging) or ALS (Airborne Laser Scanning) laser-based remote sensing[18] or photograph-based 3D modeling.[19] The deviation tendencies can be enhanced in these

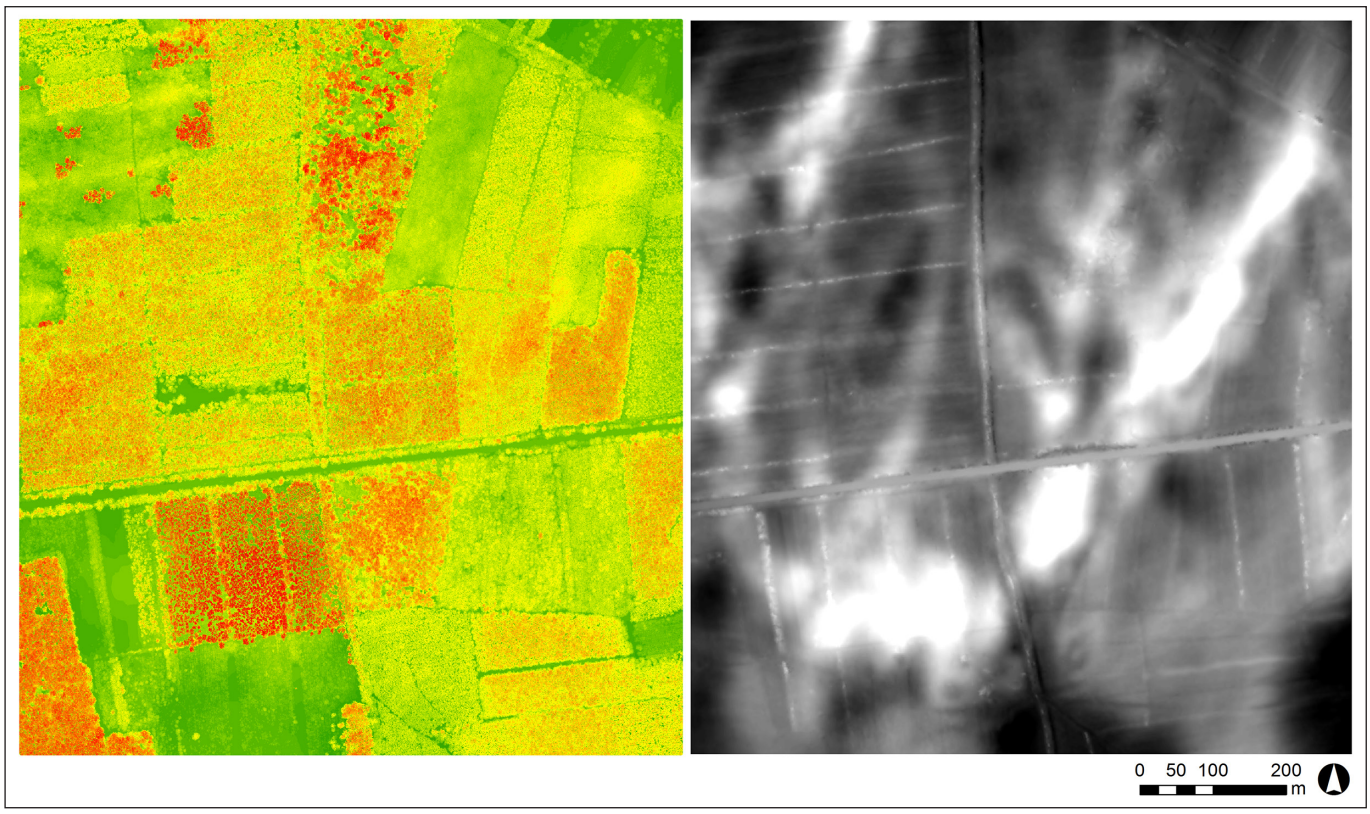

Fig. 4. Surface (on the left) and relief (on the right) models of the aerial laser survey. The Csörsz Ditch is on the middle of the image, running across the territory in a North-South direction. In the case of the surface model, 153-191 meters, while at the relief image, 153-163 meters were measured above sea level. (Figures made by Máté Szabó; the source of aerial-laser data was Eszterházy Károly Egyetem, Gyöngyösi Károly Róbert Campus, Távérzékelési és Vidékfejlesztési Kutatóintézet in all cases.)

[17] Bálint, Marianna: *Hajdúhadház 0253 hrsz-ú ingatlanra vonatkozó* örökségvédelmi *hatástanulmány (Heritage Preservation Impact Assessment for the Property at Land Registry Number 0253 in Hajdúház)* (Hajdúböszörmény: Hajdúsági Museum, 2017). Manuscript, Hajdúsági Museum Archaeological Database.

[18] *The light fantastic. Using airborne lidar in archaeological survey.* English Heritage Publishing 2010. https://content.historicengland.org.uk/images-books/publications/light-fantastic/light-fantastic.pdf/. Most recent download: 06 April 2017.

[19] Balogh, A. – Kiss, K.: Photogrammetric Processing of Aerial Photographs Acquired by UAVs. *Hungarian Archaeology* 2014/spring

cases with various raster visualization techniques,[20] and the charting and interpretation of the features can be performed in light of this. Although both methods provide detailed and precise images, the natural conditions and the method of cultivation in many cases determine the type of equipment that can be employed. Thus, for the surveying of the section of the Csörsz Ditch between Hajdúböszörmény and Hajdúhadház it was only possible – economically – to use aerial laser techniques, since even when the foliage is not present, the dense vegetation obstructs photograph-based passive remote sensing and precise 3D modeling.

For our analysis – which only provides a glimpse of the possibilities for the mapping of the Csörsz Ditch – we have aerial LiDAR data from an area of about one square kilometer.[21] Unfortunately, we have no comparable laser survey data from the area bordering the forest to the north, where there are lots under agricultural cultivation containing much weaker topographical remains of the fortification system. At the

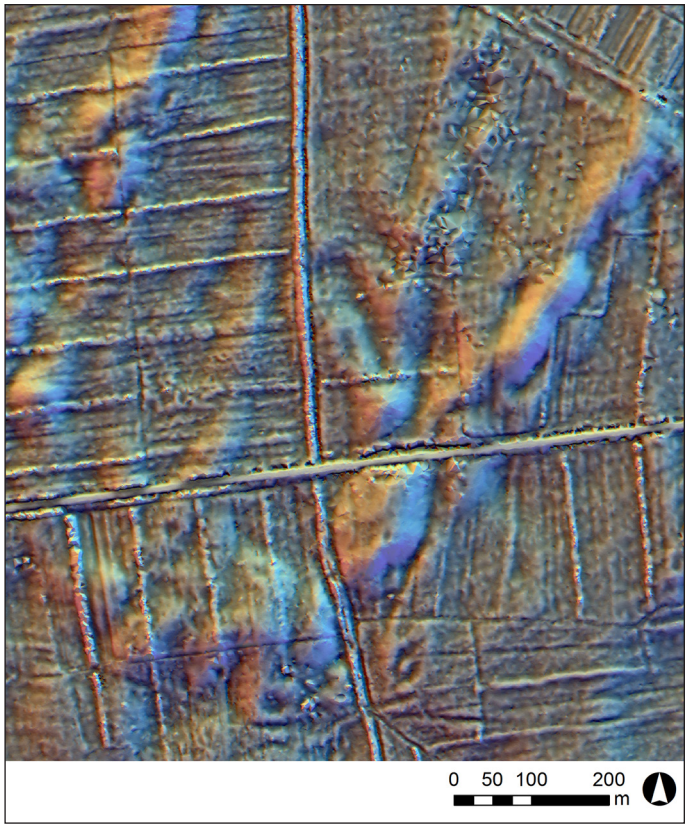

Fig. 5. A combined image of the Local Dominance model generated by relief data (min-max. radius: 10-20 ms; vertical exaggeration: 5×) and the Multi-Hillshade model (Nr. of direction: 16; Sun elevation angle: 25°) (Credits: Máté Szabó)

Fig. 6. Main features mapped on the basis of the relief data. 1 – The causeway of the Csörsz Ditch; 2 – archaeological period ditch; 3 – ditch connected to forestry; 4 – ditch connected to forestry; 5 – sand ridge; 6 – cart-roads crossing the earthwork system; 7 – territory under agricultural cultivation; 8 – slight (archaeological period) rectangular anomaly; 9 – blacktop road (Credits: Máté Szabó)

[20] Kokalj, Ž. – Zakšek, K. – Oštir, K.: Application of Sky-View Factor for the Visualization of Historic Landscape Features in Lidar-Derived Relief Models. *Antiquity* 85 (327), 2011, 263–273; Kokalj, Ž. – Zakšek, K. – Oštir, K.: Visualization of lidar derived relief models. In: *Interpreting Archaeological Topography: 3D Data, Visualisation and Observation*, ed. Opitz, R. S. – Cowley, D. C. (Llandysul, Wales: Oxbow Books, 2013), 100–114; Zakšek, K. – Oštir, K. – Kokalj, Ž.: Sky-View Factor as a Relief Visualization Technique. *Remote Sensing* 3 (2011), 398–415; Hesse, R.: Visualisierung Hochauflösender Digitaler Geländemodelle Mit LiVT. In: Lieberwirth, U. – Herzog, I. (Hrsg.): *3D-Anwendungen in der Archäologie. Computeranwendungen Und Quantitative Methoden in Der Archäologie. 4. Workshop Der AG CAA 2013* (Berlin: Berlin Studies of the Ancient World, 2016), 109–128.

[21] The use of the data for scientific purposes was permitted by the Eszterházy Károly University, Gyöngyösi Károly Róbert Campus, Remote Sensing and Rural Development Research Institute. In particular, we would like to thank Tamás Tomor for his assistance in finding, preparing and accessing the data.

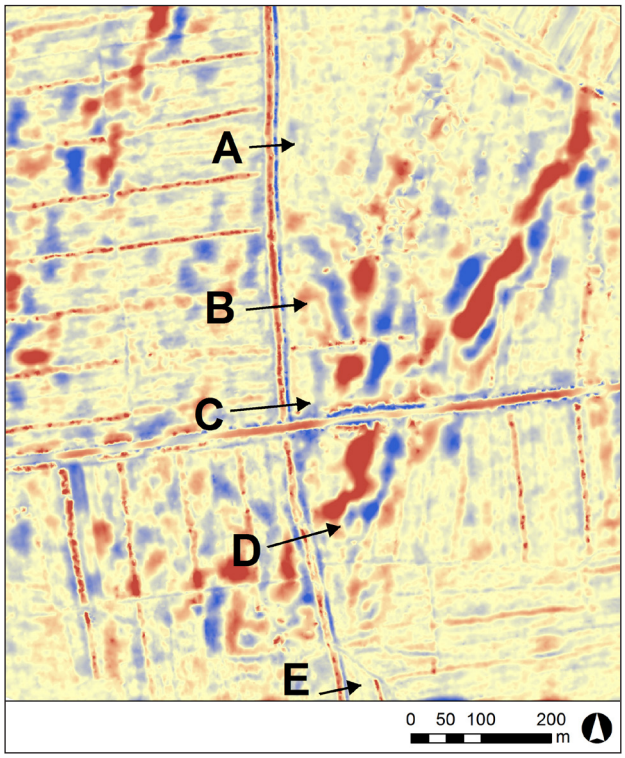

Fig. 7. Local Relief Model generated from the relief model, with 2.75 meters of positive (red) and 1.5 meters of negative (blue) divergences. The arrows show the locations of the West-East oriented profiles (Credits: Máté Szabó)

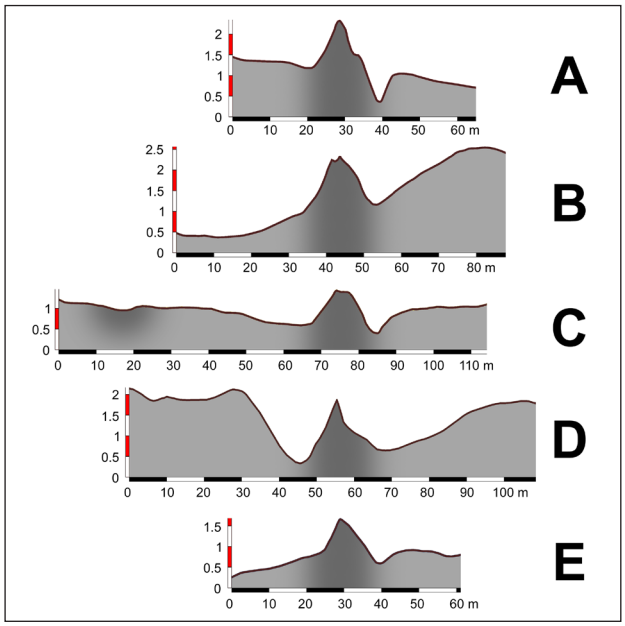

Fig. 8. Profile drawings of the relevant section of the Csörsz Ditch made on the basis of the relief model (the profiles are set in adjustment to the ditch). (Credits: Máté Szabó)

same time, the survey clearly shows the detail in which the archaeological traces running through the locust tree forest can be charted.

According to the surface model from the laser survey, forests of differing ages cover the area, so in places we have relatively little data on the soil surface due to the density of the underbrush or trees. The path of the Csörsz Ditch is covered throughout in vegetation of similar age, so here the quality of the data was affected instead by the extent of the archaeological feature (*Fig. 4.*).

In addition to the east-west running highway, both natural and man-made forms can be seen in the image of the topography. It is possible to detect the embankments bordering the forest management "parcels" that are aligned for the most part with the north-south running Csörsz Ditch cutting through the sandy ridges stretching in a north-by-northeast/south-by-southeast direction. Due to their similarities, it is possible to believe that some of these belong to the archaeological system of fortifications, but due to the dense vegetation the identification and differentiation of these on the ground runs into difficulties. The LiDAR data that uncover correlations provide enormous aid in this respect as well, since in the section under study it can be clearly seen that the Csörsz Ditch is not connected to the vestiges of forest management. At the same time, the interruption of the embankment in the southern section of the image also indicates that the old paths running in the forest cross the Csörsz Ditch, but naturally the topographical model does not provide information on their ages (*Fig. 5–6.*).

According to the LiDAR data, the discernible remains of the fortification system are of differing sizes. In several places at the top of the rampart the "smoothing" from forest management can be clearly seen. The embankment rises 1-2 meters above the surroundings, while the ditch on the eastern side can be identified as about 0.5-1 meter deep. According to the profile drawings, traces of entrenchment on the western side of the embankment also appear regularly, although they are more level and appear in a form that instead shows the location where earth was dug for the rampart as opposed to a defensive ditch (*Fig. 7–8.*).

The data that have been evaluated do not show other any clear archaeological features outside of the path of the rampart and ditch, but in the northwestern section of the highway intersection, the line of a seemingly square ditch appears faintly in the *Local Dominance* image, which can be given more relief when combined with the *Multi-Hillshade* diagram. On the basis of the side lengths of about 50 meters, we might even believe that it is similar to the ditch around a Late

Roman watchtower,[22] but due to the shallow depth of the traces of the ditch and the lack of corroborating data, this can only be considered a hypothesis and a methodological possibility within the LiDAR survey.

Beyond the fact that even today the forest management boundaries essentially align with the Csörsz Ditch, from a landscape utilization standpoint it is much more significant that the sand typical of the area has not buried the fortification system that crosses the sand ridges. It is possible to hypothesize that either continuous use and maintenance for some purpose or vegetable cover that impeded the movement of the sand lies behind this, and the examination of this issue would be important to better understand the archaeological remains.

CONCLUSION

The age and purpose of the Csörsz Ditch contain numerous uncertainties. Perhaps even more importantly, in many sections we cannot even speak of precise mapping that has been surveyed using modern-day techniques. Without this, it will be difficult to answer the scientific questions that arise, and it is conceivable that by putting off this surveying, the opportunity to do so will be lost in the future at sites endangered by cultivation and erosion. In our paper we have only provided a glimpse of the results that can be expected from the utilization of modern equipment and methods, and we hope that we will be able to see their use for the mapping of the entire system in the near future.

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[22] Szabó M.: Eredmények a Ripa Pannonica őrtornyainak kutatásában (Results of the research on the watch towers of the Ripa Pannonica). In: *A Danube Limes program régészeti kutatásai 2008-2011 között (The Danube Limes project archaeological research between 2008-2011)*, eds. Visy Zs., Szabó M., Priskin A., Lóki R. (Pécs: PTE BTK Régészet Tanszék, 2011), 129–138.