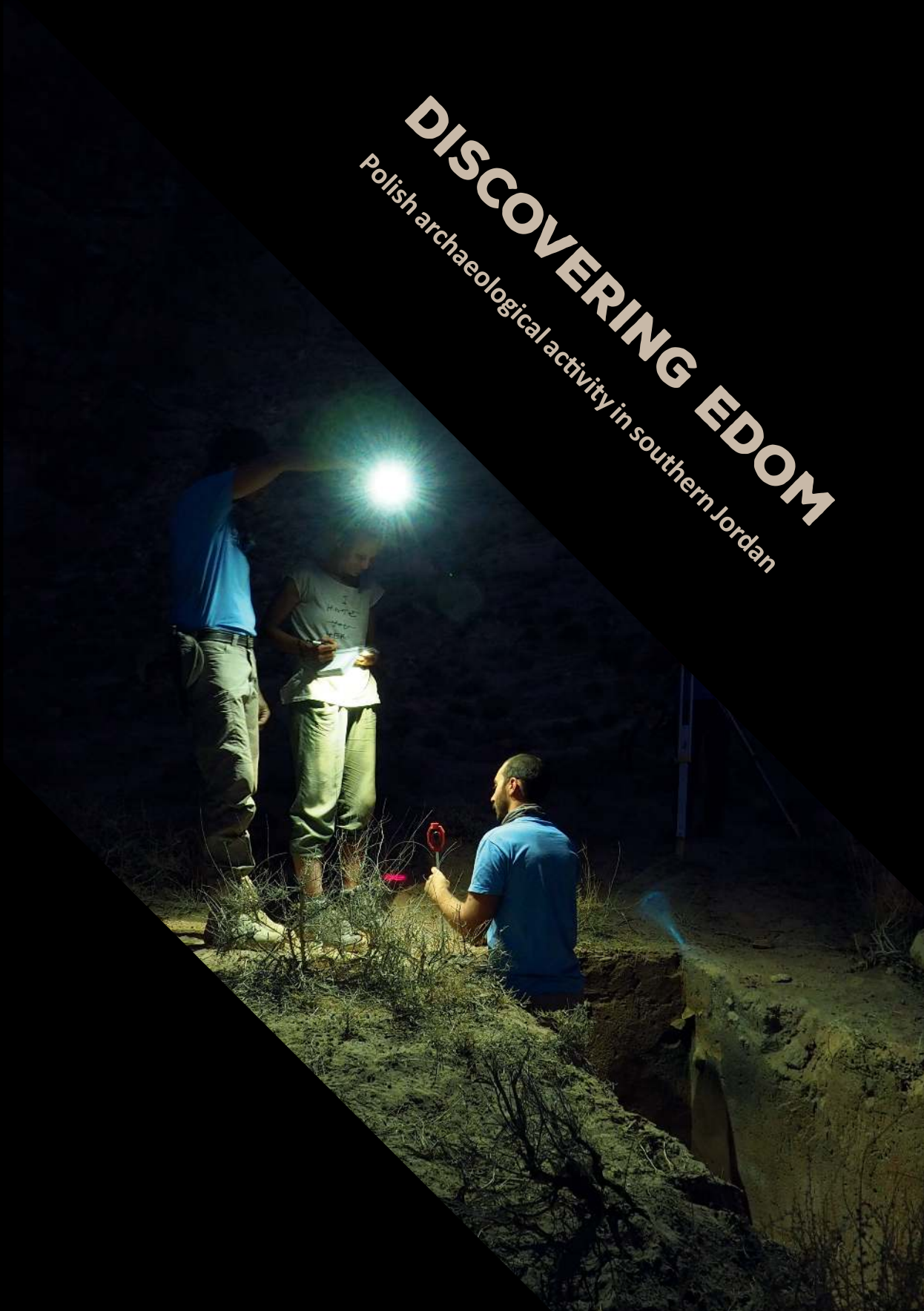
DISCOVERING EDOM

Polish archaeological activity in southern Jordan



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Results of "Archaeological Study of Dajaniya & Tuwaneh" (ArTu:DTu) 2018 survey in Tuwaneh (Tafila-Hesa), Southern Jordan

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Abstract: In November 2018, an archaeological survey was conducted at Tuwaneh (aka at-Tuwāna), Tafila-Hesa district. The main goal of the research was to develop a site plan, to document the architectural remains and looting pits and, lastly, to verify the hitherto established chronology of the site. The documentation was made using laser scanning and close-range photogrammetry and covered mainly the caravanserai complex and its vicinity. Additionally, in order to verify the chronology, a surface prospection was performed.

Keywords: Tuwaneh, Roman Arabia, Arabia Petraea, caravanserai, archaeological documentation, photogrammetry, laser scanning

Introduction

Situated on the *via Nova Traiana*, approx. 5 km south of today's road between Tafilah and Jurf ad-Darawish (Fig. 1), the Tuwaneh[1] archaeological site is identified with *Thana/Thoana* of Ptolemy (V.17) and *Thornia* of the *Tabula Peutingeriana* (Bowersock 1983: 174–75). The site lies on slopes of two hills separated by a wadi along which the *via Nova Traiana* (approx. 2 m above its bottom) run in the past (Fig. 2).

The traces of human settlement are concentrated mainly on summits and slopes of the hills inclined towards the wadi. The structures on the south-eastern hill are

[1] MEGA Number 9824; GPS coordinates: 30.7494 35.7242.

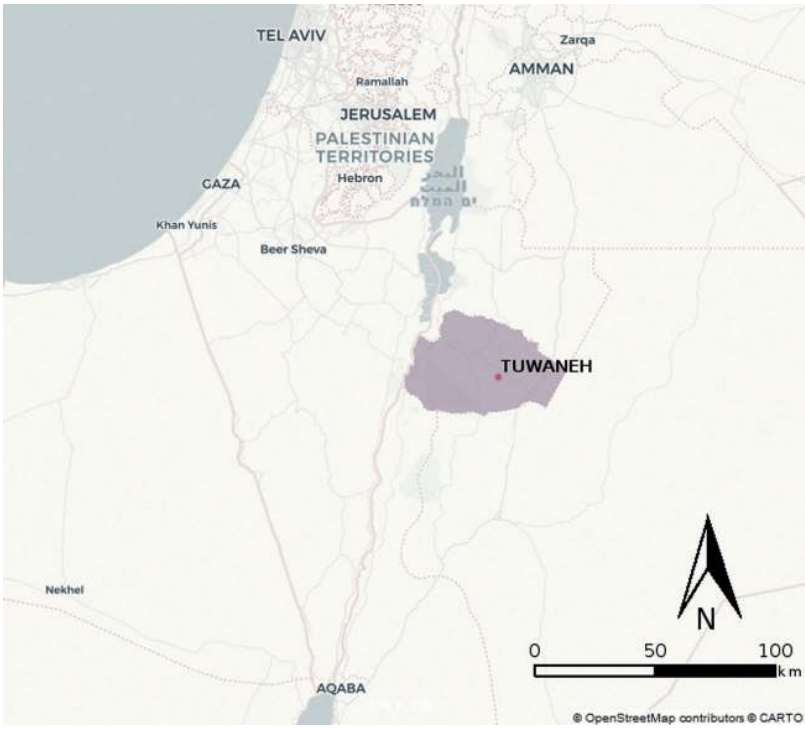

Fig. 1. Map of the region with Tuwaneh's position marked within the Tafila Governorate (source: K. Kopij with the use of ©CARTO)

more monumental, and are likely to have played commercial and representative roles, while those on the north-western hill, probably residential, are more dispersed (Fiema 1997: 314).

The area of the archaeological site may have been occupied by humans as early as in the Iron Age, as suggested by the pottery sherds dated to the period. On the other hand, however, the scarcity of the material indicates that the main phase of human settlement in Tuwaneh fell within the Nabataean through Byzantine periods, when the town was crossed by a trade route connecting, among others, Petra and Syria (Fiema 1997: 313). Substantial amounts of high-quality ceramics from Roman and Byzantine[2] periods and the monumental architecture indicate that the local residents were rather wealthy (Fiema 1993: 549; 1997: 314). Going further, a low amount of early Islamic material and a lack of any mentions in Arab sources suggest that the place lost its prominence in the late Byzantine period (Fiema 1993: 549). Finally, fragments of vessels found on

[2] Preliminary study of the ceramics collected during the survey confirms the observation. More information will be obtained through a detailed study, the results of which are to be published separately.

Fig. 2. Satellite imagery of the site (source: Bing Maps)

the surface indicate that it was probably occupied in the Ayyubid and Mamluk periods (Fiema 1993: 549; 1997: 315; MacDonald et al. 2004: 351–52).

The site has received numerous scholarly visits and surveys by researchers and travellers, including such prominent figures as Brünnow and von Domaszewski (1905, 88–91), Musil (1907–1908, I: 31–32), Glueck (1935: 80–81), Negev (1977: 608), Hart (1987: 340) and Wenning (1987: 87). Between March and May 1992, it was investigated as part of the *Via Nova Traiana* Project, which, among other things, encompassed surface prospection (Fiema 1993; 1997). Another similar study of the site was performed in 2000–2001, under the Tafila-Busayra Archaeological Survey (MacDonald et al. 2004: 348–54).

Perched on the south-eastern hill is structure C14 (named after: Fiema 1993: 549; 1997: 315), believed by Brünnow and von Domaszewski (1905: 89) to have been a Nabataean temple. The German researchers linked it to structures C15A and C15B, which they described as the temple's yard. An architectural analysis conducted as part of the *Via Nova Traiana* Project showed, however, that they were three independent structures, none of which have been used for religious purposes (Fiema 1997: 315). Given the above, Fiema has concurred with Hart's opinion (1987: 340) who considered the building to be a caravanserai. Judging by materials from C14, the structure prospered from Nabataean to Mamluk times, peaking in the Roman and Byzantine periods (Fiema 1993: 549; 1997: 315).

Another prominent feature is the presence of remains of a bathhouse, reported by Fiema (1993: 549). Fine examples of box-flue tiles (*tubuli*) or characteristic ceramic 'tubules' of rectangular cross-section, used for building Roman baths are particularly abundant (cf. Brodribb 1987: 70–83; for Roman Arabia, cf. Harvey 2011).

In the course of surface prospection, Fiema also reported a well-preserved subterranean multi-chambered tomb (Fiema 1993: 549), while members of the Tafila-Busayra Archaeological Survey revealed remains of a possible watchtower on top of the north-western hill (MacDonald et al. 2004: 348).

Season 2018

Objectives

Due to the short duration of the study and limited human resources, we started the development of a site plan and the process of recording architectural remains with documenting several critical points of the town located on the south-eastern hill. First, we performed work within the caravanserai and its neighbourhood (Fig. 3). The caravanserai is the best preserved of all the structures within the site. Determination of its function and chronology will be crucial for understanding the character of the hill on which it is situated and the function of the ancient town in general. The second area surveyed was the area of the *thermae* and its environs. We chose that place not only for its prominent, well-preserved architectural structure, but also because it had been regularly destroyed by looters (Bodzek, Kopij, Miszk 2019: 45–47). Both research areas were also covered by surface prospection. Similar reasons led us to document the visible fragments of a storm drain located directly to the north of the *thermae*, leading from the hilltop to the wadi. Moreover, an unidentified rectangular structure northwards of the top, we documented it as well. Lastly, was began documenting and mapping looting pits, starting with those located on top of the south-eastern hill in the vicinity of the caravanserai.

Surface prospection

Between 10 and 15 November 2018, acting based on Excavation Permit No. 2018/59 issued by the Department of Antiquities, Ministry of Tourism & Antiquities of the Hashemite Kingdom of Jordan, we performed surface prospection of the central part

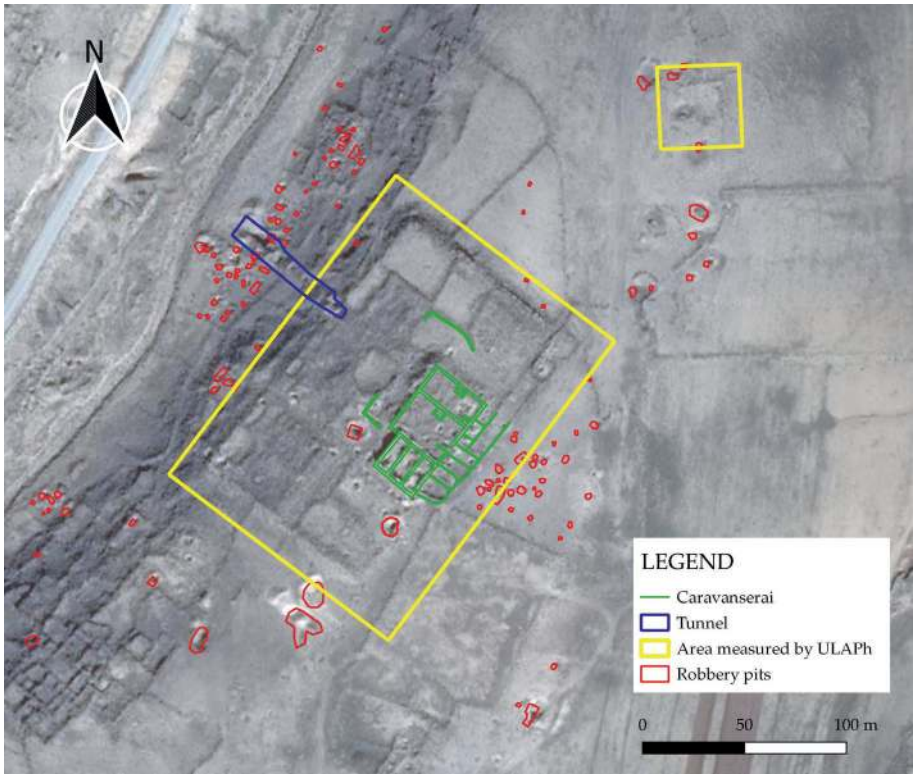

Fig. 3. Areas of activity marked on satellite images (photo by A. Słodowska)

of the site covering the caravanserai complex and its direct vicinity. Additionally, we also performed surface prospection of the *thermae* and environs and collected surface material from several looting pits and their waste piles.

The territory occupied by the caravanserai and its vicinity was divided into 10 smaller areas (Areas 1–10) (Fig. 4). Within Area 1, comprehensive surface prospection was performed, encompassing the entire specified zone of approx. 770 m^2. In addition, material was collected from two looting pits in Area 1 (D.1.1 and D.1.2). From among the remaining designated areas, only four were investigated (Areas 2–5), with focus on collecting surface material from looting pits only (D.2.1, D.2.2, D.3.1, D.3.2, D.3.3, D.3.4, D.3.5, D.3.6, D.4.1, D.4.2, D.5.1). The reasons behind the selectiveness of surface prospection included short duration of the study, small number of researchers and extensiveness of some of the looting pits, as well as the abundance of the material found, which significantly inhibited the work. Quantitative information is presented in Table 1 (exemplary set of pottery sherds, Fig. 5). Similar information on the results of field prospection within the bathhouse is presented in Table 2 (Fig. 6). Additionally,

Fig. 4. Surface-prospected zones organised into distinctive areas where the material was collected (photo by M. Kajzer)

surface material was collected from 14 looting pits in the immediate vicinity of the caravanserai complex and one in the southern part of the site. Quantitative information is presented in Table 3. Results of a detailed analysis of the 'diagnostic' fragments collected during field prospection will be published in a separate study.

Table 1. Quantitative information on material collected during surface prospection of the caravanserai and its direct vicinity. The number of fragments has been specified

	Pottery fr.	Glass fr.	Roof tiles	Bronze fr.	Flint	Stone	Bones*	Other
D.1	3141	-	-	-	2	1	-	-
D.1.1	35	-	-	-	-	-	-	-
D.1.2	40	-	-	-	-	-	-	-
D.2.1	1082	-	2	1	-	-	-	-
D.2.2	41	1	-	-	-	-	x	-
D.3.1	106	-	2	-	-	-	x	-
D.3.2	52	-	-	-	-	-	x	1 (iron nail)
D.3.3	226	-	-	-	2	-	x	-
D.3.4	140	-	-	-	-	2	x	-
D.3.5	55	-	-	-	-	1	x	-
D.3.6	208	1	5	-	-	-	x	-
D.4.1	146	-	6	-	1	-	-	-
D.4.2	125	-	-	-	-	-	-	-
D.5.1	321	1	-	-	-	-	x	-

* for bones, it is only presence versus absence (x means presence).

Fig. 5. Typical set of pottery sherds (photo by Ł. Miszk)

Table 2. Quantitative information on material collected in surface prospection of the bathhouse. The number of fragments has been specified

Pottery fr.	Box-flue tiles fr.	Hypocaustic tiles	Tiles fr.	Stone tiles fr.	Glass fr.	Bronze fr.
44	482	153	158	5	1	3

Plan of the site and 3D model of architectural remains

With a view to starting work on the first site plan, a decision was made to make measurements using methods based on cutting-edge surveying technologies, instead of making any architectural plans directly on site. The ultimate goal was to collect as much measurements and images as possible, for processing after completion of the project. Obviously, another reason was limited time.

The documentation of architectural archaeological remains was prepared using Ultra-Low Altitude Photogrammetry (ULAPh), laser scanning and close-range photogrammetry. All documentary work was performed in connection with the control network established within the site. Coordinates of the control points were computed using GNSS data processed with the use of Precise Point Positioning (PPP) technique and angular and linear data obtained from Total Station.

Fig. 6. Ceramic building material collected during the prospection of the *thermae* (photo by M. Bernaś)

Table 3. Quantitative list of material collected from selected looting pits. The number of fragments has been specified

Looting pit no.	Pottery fr.	Roof tiles	Box shaped tiles	Flint	Stone	Bones*	Other
W.5	152	-	-	-	-	-	-
W.5	33	-	-	-	-	x	-
W.9	155	-	-	-	-	-	-
W.10	462	-	-	1	-	x	-
W.11	200	-	-	-	-	x	-
W.12	504	1	-	-	-	x	-
W.14	193	-	-	1	1	x	-
W.15	91	-	-	-	-	x	-
W.16	97	-	-	-	1	x	-
W.18	546	-	1	-	-	x	-
W.19	278	-	-	-	-	x	-
W.22	40	-	-	-	-	x	-
W.23	409	-	-	-	-	x	1 (architectural detail)
W.24	179	-	1	-	-	-	-
W.236	180	-	-	-	-	-	-

* for bones, it is only presence versus absence (x means presence).

Task number one was to prepare an orthomosaic and a digital surface model (DSM) for the site. At present, such products are usually generated based on images taken by means of Unmanned Aerial Vehicles (UAV). As we could not use UAV-based photogrammetry, an attempt was made to try alternative photogrammetric methods to prepare archaeological documentation. The method we chose was Ultra Low Altitude Photogrammetry (ULAPh), which requires a relatively simple measuring system, composed of an action camera mounted on a five-meter long leveling rod. Before the measurements, survey points were set out, making a square grid, with each square side measuring approx. five meters. Then, oblique images were taken at each point (in eight directions) (Fig. 7). The measurements were made with a GoPro HERO 6 Black, a camera with a wide-angle lens for image resolution of 12 MP. The above method was used to obtain photogrammetric data of an area of approx. 2.5 ha, located in the heart of the site (the caravanserai and its direct neighbourhood). The ground sampling distance (GSD) of data collected was 4 mm. All in all, more than 4,800 images were taken at 600 survey points during the field work. Additionally, 51 control points and 49 check points were established for the purpose of georeferencing and verification

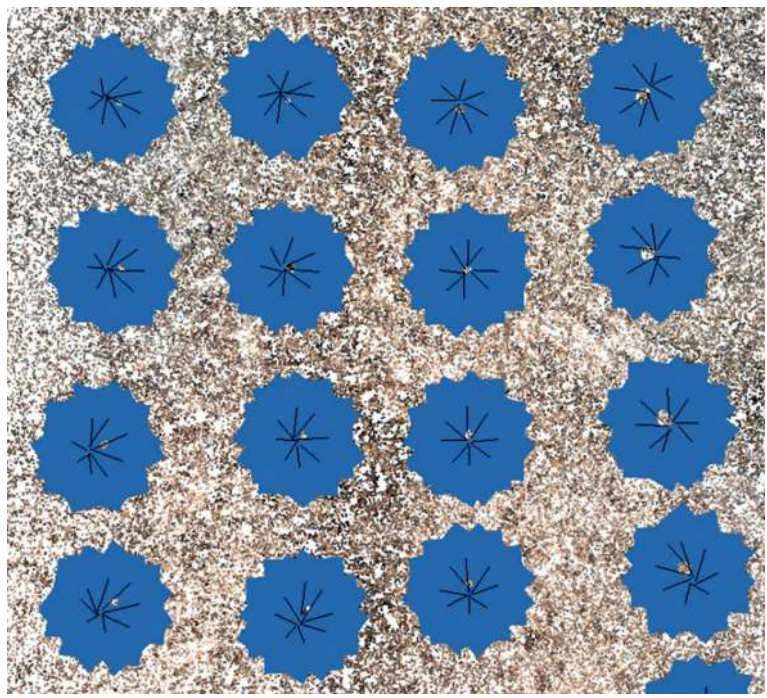

Fig. 7. ULAPh – configuration of measuring points and data collection method (author: P. Ćwiąkała)

of the accuracy of the photogrammetric products, with their coordinates having been determined using the Real Time Kinematic (RTK) GNSS technique with an accuracy of 2 cm. The field work and data collection took three days. The data obtained was processed with the use of Structure from Motion (SfM) algorithm implemented in Agisoft Metashape software. The results yielded an orthomosaic (GSD of 4 mm) and a DSM (GSD of 16 mm) (Fig. 8–9). The accuracy of measurements was assessed to be approx. 3 cm. Nevertheless, it needs to be emphasised that calculations of the height of objects with sharp edges (remains of walls, trenches or large rocks) may be determined with a greater degree of error. Going further, ULAPh was used to develop an orthomosaic and a DMS of a structure located north-east of the caravanserai complex. The area was documented with 288 images. The procedures followed for data acquisition and processing as well as the parameters of final products were the same as those described above. Because of the limited duration of the study, the large area of the site (approx. 55 ha) and the time-consuming method used in season 2018, only the fragments referred to above were documented (the overall area of approx. 2.7 ha).

Detailed documentation of the caravanserai remains was performed with terrestrial laser scanning. A Faro Focus M70 (laser scanner) was used for measurements

Fig. 8. Orthomosaic of caravanserai and its neighbourhood (author: P. Ćwiąkała)

(Fig. 10). During the field work we obtained high-resolution spatial data (point clouds) from 55 instrument stations. The scanning resolution was 3 mm/10 m. With the use of 100 reference targets (with coordinates determined using typical surveying techniques such as satellite and tachymetric measurements), we were able to register scans from different stations and connect the same with a single coordinate system. Finally, the laser scanning and processing of its results produced a spatial model of the building (Fig. 11), characterized by an accuracy of 2 cm, suitable to be used for the elaboration of archaeological architectural documentation

Documentation of the exposed fragments of the *thermae* was prepared based on close-range photogrammetry and hand-held scanning. Photogrammetric measurements of the structure were performed with a Nikon D60, a camera with a 20 mm lens, yielding 223 images (resolution: 24 MP). During field works, 18 control points were established and then measured using typical surveying techniques. The data collected was processed in Agisoft Metashape software to develop a three-dimensional model of the structure with a GSD of 1.5 mm and accuracy of 7.5 mm. Additionally, the very same structure was measured with a hand-held scanner (Faro Freestyle 3D), which allows real-time capturing, automatic processing and visualisation of data. The result of the measurement was a point cloud representing the structure, subsequently

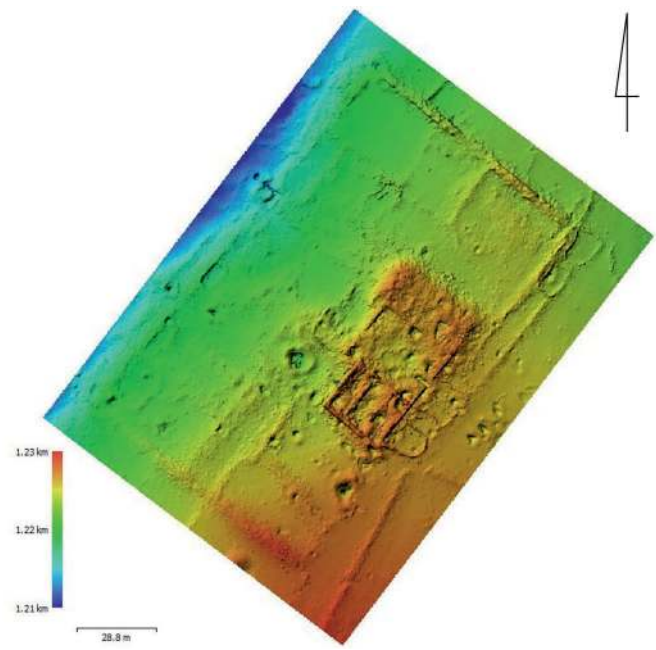

Fig. 9. DSM of caravanserai and its neighbourhood (author: P. Ćwiąkała)

Fig. 10. Faro Focus M70 terrestrial laser scanner in use (photo by M. Bernaś)

subjected to georeferencing (based on the coordinates of control points). The final effect is illustrated in Figure 12.

Close-range photogrammetry was used for developing a 3D model of selected fragments of the storm drain. The measurement was performed using a GoPro HERO 6 Black, an action camera with a wide-angle lens, on a levelling rod, and a Nikon D60, a camera with a 20 mm lens. With the first of the devices we recorded details of the geometry of underground parts of the structure, while the latter was used for photo images of inlets and openings on the surface. Data for six elements of the

Fig. 11. Fragment of terrestrial laser scanning point clouds, representing the caravanserai (author: A. Ochałek, E. Puniach)

Fig. 12. Fragment of a point cloud obtained through hand-held scanning, representing the *thermae* (author: E. Puniach)

drain, accessible for direct measurements, were collected. The images taken and control points measured served as a basis for three-dimensional models of individual fragments of the structure, which were subsequently merged (Fig. 13).

Documentation of looting pits

Next to the area measured with ULAPh, we also managed to develop documentation for 119 looting pits within the caravanserai complex and in its direct vicinity (Fig. 4). The location of each pit was measured by means of Real Time eXtended GNSS technique. Additionally, all looting pits have photo documentation developed, consisting of at least four images for each pit (for examples see Fig. 14).

Conclusions

Due to the short duration of the study and methodological constraints (impossibility to use an UAV), in season 2018 we only managed to develop partial archaeological architectural documentation for the town of Tuwaneh. The main result of the work is the developed measurement and photographic data that us allowed to create:

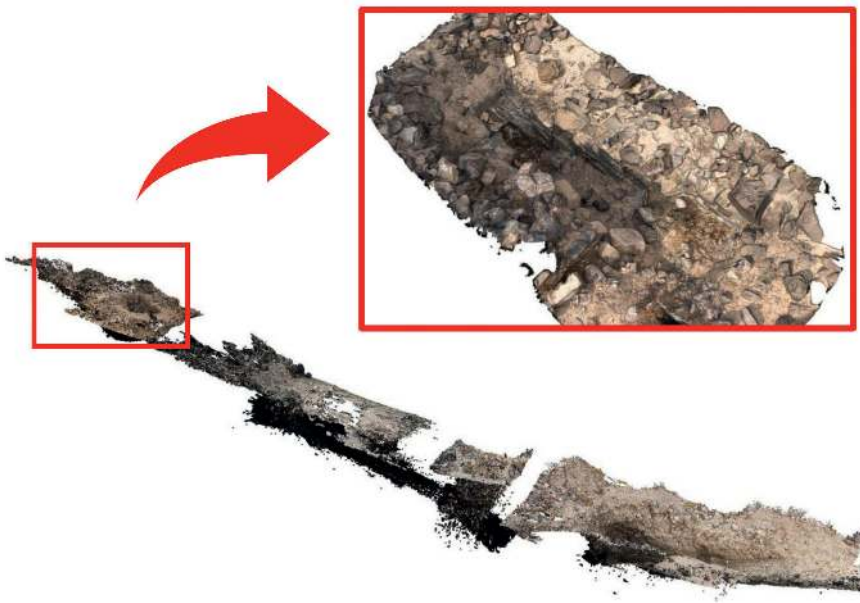

Fig. 13. Photogrammetric point cloud representing six accessible fragments of the stormwater drain (author: H. Dec)

- an orthomosaic, a DSM obtained by ULAPh and point clouds obtained by a laser scanning for the caravanserai and its neighbourhood;
- an orthomosaic, a DSM obtained by close-range photogrammetry and point clouds obtained by a hand-held scanning for the remains of *thermae* visible on the surface;
- an orthomosaic, and a DSM obtained by ULAPh for the rectangular structure to the north of the caravanserai complex (Fig. 4);
- point clouds of storm drain fragments obtained by close-range photogrammetry;
- photographic documentation of looting pits in the central part of the south-eastern hill.

Preliminary investigation of the ceramic material obtained (mainly from looting pits) confirm the hitherto established chronological frames of the site, but more details will be presented in a separate study after examination of the fragments of vessels collected.

Yet another effect of our work was the development of a new methodology for documenting large areas where UAV cannot be used. Time-consuming as it is, Ultra-Low Altitude Photogrammetry or ULAPh is one of the alternatives for preparing DSMs and orthomosaics in conditions like these.

Fig. 14. W14 looting pit: documentary shot (photo by K. Sawicka)

The number of looting pits recorded during the study shows that the site has been regularly falling victim to plunders (as in the case of the *thermae*). Consequently, efforts must be made to protect the site and commence excavation works in order to preserve the information hidden in archaeological strata.

The data obtained will be used as a prelude to further work, with the final effect being a comprehensive site plan, with documentation of the preserved architecture, data about archaeological artefacts, and conservation recommendations in the context of progressing degradation of the site caused by looters.

Acknowledgements
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