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DIGITIZING TO RE-DISCOVER: THE CASE STUDY OF THE ROMAN CITY-GATE IN ALTINUM, ITALY

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Abstract:

Graphic documentation in archaeology has always been a primary tool for scholars, used to record, publish and compare data. The vast majority of it, however, is still bi-dimensional, i.e. plans and sections, mostly because it was produced in the last century. Nowadays, sophisticated recording techniques are diffused and regularly utilized by researchers, and they have proven to be relevant to better record and understand an archaeological context. The case-study of the Roman city-gate in Altinum is exemplary in this regard: a site that has been dug between 1972 and 1994 and has been exposed to the public since. Recently, a research project, carried out by Ca' Foscari and Iuav Universities, aims to further re-think and investigate the architectural and urbanistic aspects of the Roman city using digital tools. Because of this, it was possible to conduct a 3D survey of the archaeological areas, including the one where the city-gate is located, and to ensure the preservation of the data in the future. Preliminary elaborations, aimed at comparing the legacy data available on this site with the point clouds from the digitization campaign, show the potential of these tools, even more when studying contexts that are already known and published.

Keywords: Roman archaeology, digital archaeology, cultural heritage, documentation, 3D digitization

1. Introduction

The current work is part of a more extensive research project that involves both Ca' Foscari and Iuav Universities, which aims to reassess and examine in-depth, with the aid of digital technologies, the urban and architectural history of the ancient city of Altinum, located at the north-eastern margin of the Venice Lagoon.

Amongst the initial steps of this project was the 3D digitization of the archaeological areas open to the public. Documenting the actual state of the structures is crucial in order to obtain an accurate reality-based model for further analysis, but also to preserve its current status for the future.

The digitization of the remains of the ancient city-gate, in particular, offered an occasion to reflect on the practice of archaeological documentation, which is still mostly limited to bi-dimensional representations such as plans and sections. On the other hand, 3D recording techniques are now widespread and used in many excavations all over the world (Russo, Remondino, & Guidi, 2011). While there are extremely sophisticated projects that use 3D data to create complex visualization tools for a more efficient interpretation of the sites (Lercari, Shiferaw, Forte, & Kopper, 2018), it is also common practise to use this data to obtain only 2D outputs (e.g. orthophotos).

In Italy many important excavation campaigns were carried out in the past century; for this reason, the legacy data regarding these sites is often restricted to paper documentation, including technical drawings and photographs.

1.1. The city of Altinum: history and state of research

Today, the territory of Altinum belongs to the municipality of Quarto d'Altino (province of Venice), located near Venice Marco Polo Airport, where its geomorphological setting consists of a complex network of rivers and canals and a central mound formed by archaeological deposits (Mozzi et al., 2016).

Archaeological finds in the area are attested from the Mesolithic; the first permanent settlement originated during the eighth century BC and flourished in the following centuries, becoming an important centre of trade for the *Veneti*, the pre-Roman population that lived in the area during the Iron Age (Gambacurta, 2011).

At the beginning of the second century BC, the expansion of Roman control in the Italian peninsula started the process known as "romanization" and this territory was consequently integrated into the larger network of roads and sea routes, notably the Via Annia that connected the main northern Adriatic cities from Adria to Aquileia, the Latin colony founded in 183 BC (Tirelli, 1999).

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During the first century BC, the city was affected by a systematic re-organization of its natural and hydraulic framework, along with an extensive monumentalization of the urban centre. Altinum maintained its key role of port city (*emporium*), as proven by many archaeological finds related to trade and commerce (Cresci & Tirelli, 2003). The *municipium* flourished significantly during the Roman Empire, but it was abandoned around the seventh century AD, when different factors led to movements of people from the inland to the nearby islands of the lagoon (Tirelli, 2011).

The area remained uninhabited for centuries and was reclaimed only in the 19th century. Up to this day the main features of the landscape are open fields and farms. This means most of the archaeological deposit is still buried and "frozen" at the time of the abandonment.

Archaeological research during the 20th century mostly focused on the funerary areas and monuments located along the main roads connecting the city to other centres of the region. Only few extensive excavations contributed to shed light on the urban centre, revealing a conspicuous part of the new neighbourhood expanded during the Augustan period, comprised of several *domus* and a section of the *decumanus*, and the city-gate which marked the northern limit of the city, used also as landing point (Scarfì & Tombolani, 1985).

In 2007 a major breakthrough occurred in the research, when a remote sensing campaign of the University of Padua produced a set of visible and near-infrared aerial photographs of the territory of Altinum, which showed conspicuous and detailed cropmarks related to the urban structures buried underground (Fig. 1). Thanks to these images and further research, it was possible to identify the monumental sector of the city, including the central forum, its shops, the theatre, an *odeion*, the amphitheatre, large buildings with apses, walls, gates, roads and canals (Ninfo, Fontana, Mozzi, & Ferrarese, 2009; Mozzi et al., 2016).

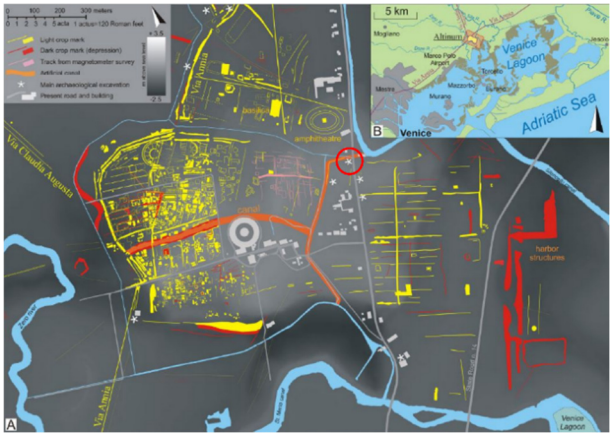

Figure 1: Map of Altinum as visible from the aerial photographs; in the red circle the location of the city-gate (Ninfo, Fontana, Mozzi, & Ferrarese, 2009; modified by the authors).

After this pivotal moment, there was a renewed interest in the urbanization and development of the city, aimed at better understand the complex set of data provided by the aerial photographs. In particular, since 2012 a research group of Ca' Foscari University is investigating the dynamics related to a vast sector of the city known as "località Ghiacciaia" (Sperti, Cipriano, Paveggio, & Delpozzo, 2017).

1.2. The Roman city-gate

The city-gate previously mentioned is one of the best-preserved archaeological contexts in Altinum, and it is open to the public (Fig. 2).

Figure 2: Site of the city-gate (Tirelli, 2011).

The excavations in the area began in 1972, then proceeded between 1980 and 1985, and resumed in 1991 until 1994, to conclude the works necessary to include this sector in the archaeological itinerary for tourists.

The architectural structure, dating to the first half of the 1st century BC, is formed by two square-plan towers, round inside, and a central *cavedium*, with foundations made of sandstone blocks resting on massive wooden poles. The western tower was preserved entirely and measures 7.40 m on each side.

On the northern part of the building, the archaeologists identified the foundations of an *avant-corps*, added later to the structure and slightly offset from it to north-east, interpreted as the southern sector of a bridge: this side of the city-gate, in fact, overlooked a canal, and, because of this, had also the function of landing place. On the opposite side, south to the building, a stone paved road was found, probably the *kardo maximus* of the city. The main structure was conceivably constituted of bricks, as was its architectural decoration consisting in terracotta elements (Scarfì & Tombolani, 1985; Tombolani, 1987; Gambacurta, 1992; Tirelli, 1999; Cipriano, 1999).

Furthermore, in the stratigraphic units attributed to the construction phase, the archaeologists recovered a set of finds interpreted as a ritual deposit related to the foundation of the building, consisting of animal bones, bronzes, and pottery sherds, some of which had dedicatory inscriptions in Venetic, Greek, and Latin (Tirelli, 2011).

It appears that the city-gate had not a defensive function per se, but represented a significant landmark, symbolizing the *pomerium*, the limit between the city and the suburbs (Tombolani, 1987).

2. 3D digitization: tools and methodology

In the summer of 2020, the team of the Laboratory of Photogrammetry of the IUAV University of Venice realized the digitization of the area, using an integration of different

techniques proven to be effective especially for archaeological contexts (Balletti, Guerra, Scocca, & Gottardi, 2015).

A suitable topographical net was set up with a total station, in order to create a local reference system. After setting up the targets, it was possible to acquire seven scans of the area with a terrestrial laser scanner, located in different positions in order to cover the entire area without obstacles. This final point cloud consists of 208,150,760 points.

The area was then covered with a detailed photogrammetric survey using UAVs. The flights were planned based on the scheme most appropriate for each case, essentially sequences of linear strips. Using a DJI Mavic2Pro, a first set of 167 photographs of the city-gate was acquired and then it was decided to implement the survey with two flights covering both archaeological areas, resulting in 336 photographs overall.

Since the eastern part of the remains pertaining to the ancient city-gate is protected by a covering, it was not possible to acquire the geometry underneath with general flights of the area. For this reason, it became necessary to use a smaller drone, able to fit in the narrow space under the covering (Fig. 3). In this case, a DJI MavicMini was used, taking a total of 138 photographs.

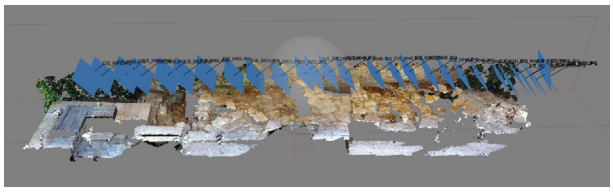

Figure 3: An example of how it was possible to do close-range photogrammetry with a smaller UAV in a narrow space.

After processing the photographs in Agisoft Metashape and georeferencing the models on the targets, selected sets of the point clouds were integrated and merged.

The data were later integrated with the scans obtained with the terrestrial laser scanner, allowing a more complete representation of the geometry of the city-gate.

3. Elaborations and preliminary results

Although the substantial work is still in progress, it was still possible to make some observations about the potential of 3D recording in re-discovering and studying archaeological sites that have been excavated, and therefore documented, decades ago.

Primarily, three-dimensional models, whether point clouds or polygon meshes, allow to instantly extract every measure needed. These metric data are more accurate and precise than the ones in the physical drawings. On the models it is also possible to measure parts of the structure not reachable in person and, besides, having a digital copy of the site allows to generate sections as required, without having to come back to the site every time to extract the data.

Moreover, as mentioned above, the cityscape of Altinum has a peculiar topographical configuration, consisting of higher areas and a complex system of canals (Calaon, 2006), which is why the accurate recording of elevation data is crucial for its study. In this regard, the 3D models offer a significant contribution to the history of the research and they represent a key asset, especially when integrated with stratigraphic and chronological data from other archaeological excavations (Fig. 4).

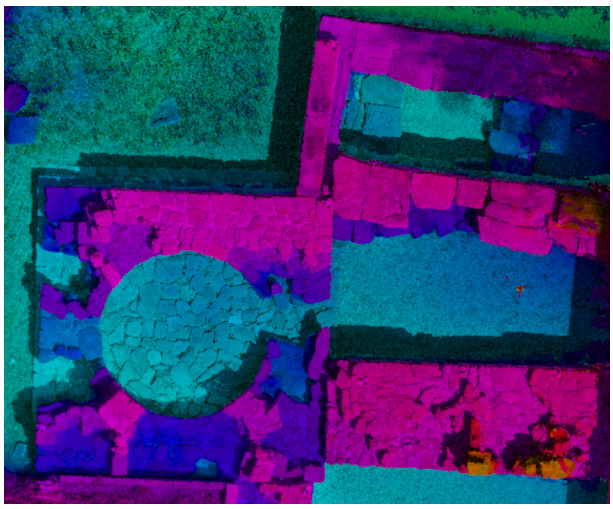

Figure 4: The photogrammetric point clouds combined, with a height shader to accentuate the different elevations of the structures preserved.

Ultimately, the preliminary comparisons between the data acquired on site with digital techniques and the bi-dimensional representations of the city-gate, as manually recorded during the excavations, show a significant error in the measurements (Fig. 5). Integrating different types of documentation representing the same object permits, on one side, to correct the original, handmade plans and sections; on the other side, these can also be used to recover information regarding the conservation status of the building and how it changed from the moment when the drawing was realized to the present day. These plans and sections, moreover, often include details and data which have been lost after the years.

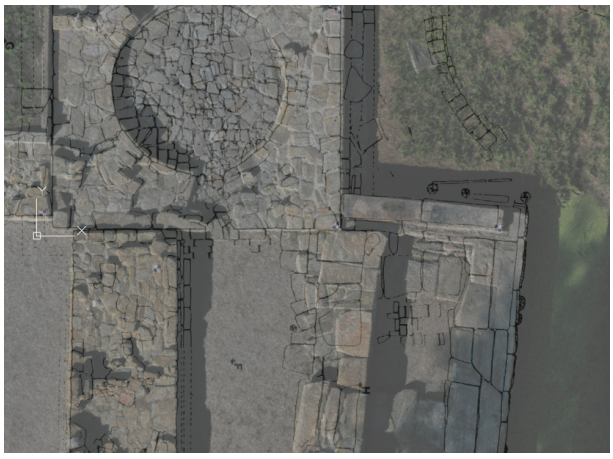

Figure 5: Orthophoto extracted from the photogrammetric survey, overlapping the original plan of the excavation (Gambacurta, 1992).

4. Conclusions and future work

These first results show that modern techniques of digitization can be a significant asset when studying archaeological contexts, including the ones for which the

documentation available is not recent and was realized with traditional methods, i.e. handmade drawings.

One of the main goals for the future is to integrate the 3D models within the 2D GIS system that manages all the data related to the archaeological deposit in Altinum, in order to increase the knowledge base available. Further 3D data are expected to be included as well, such as a high resolution DEM of the territory obtained with a LiDAR survey, which has proven to be a powerful tool in understanding and investigating the landscape (Masini, Coluzzi, & Lasaponara, 2011).

In future developments of the project, the main objective is to implement a BIM system for the semantic annotation of these models. BIM applications for Cultural Heritage have grown exponentially during the past years, offering remarkable case studies and results regarding archaeological heritage as well (Diara & Rinaudo, 2020; Moyano et al., 2020). This solution, integrated with the GIS system previously mentioned, would permit a multiscale approach, capable of managing all the different information regarding the site (Rechichi, 2020); moreover, it could prove useful to manage and monitor any operation on the archaeological site, such as restoration and maintenance.

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