Valentina Vassallo, Giacomo Landeschi & Sorin Hermon
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Digging in Excavation Diaries: Digital Re-Assessment of Stratigraphy in 3D GIS. The Sanctuary of Ayia Irini, Cyprus

Valentina Vassallo
Science and Technology for Archaeology Research Center, The Cyprus Institute
v.vassallo@cyi.ac.cy

Giacomo Landeschi
Lund University
giacomo.landeschi@ark.lu.se

Sorin Hermon
Science and Technology for Archaeology Research Center, The Cyprus Institute
s.hermon@cyi.ac.cy

Abstract

During the last years, numerous research projects focussed on re-examination of past excavations, giving birth to re-evaluation of their documentation and material or to new discoveries. The aim of this paper is to present an ongoing research on the digital re-assessment of the Ayia Irini sanctuary's stratigraphy using 3D GIS, by corroborating published material with data extracted from the original excavation diaries. The project wants to digitally reconstruct the site in order to question the positioning of finds and their setting within the sanctuary, the existence of natural versus human-made features and the possible impact of flooding episodes as proposed by the archaeologists who excavated the site.

Keywords: Ayia Irini sanctuary, terracotta figurines, excavation diaries, stratigraphy re-assessment, 3D GIS

Introduction

Recently, several research projects were devoted to re-examination of past excavations, allowing the re-evaluation of their documentation and material or bringing forth new discoveries. Such boost was given both by the need of digitizing legacy data and by the possibility of re-evaluating such data with digital technologies (De Felice & Fratta 2016; Haggis & Antonaccio 2015).

The combined use of 3D modelling and mixed 2.5/3D analysis, archaeometric investigations, as well as archive data, old drawings, maps and photos, shed new light onto past excavations and new elements were identified. For example, features that were not recorded and published because they were not understood, or elements not visible due to limitations or absence of the past technologies have been acknowledged and used for new interpretations. In some cases, especially in excavations of the 20th century, when the stratigraphic method started to be used in archaeology, some inconsistencies were spotted (Landeschi et al. 2018; Houby-Nielsen 2016). Moreover, the instruments used to document were manual and therefore accuracy (e.g. measures, exact positions) was affected by human errors.

Any excavation, as continuously repeated by archaeologists, is a destructive process (Lucas 2001: 35)[1], therefore it would be impossible to re-produce the original situation in reality. Digital technologies give us the possibility to re-construct past excavations and re-analyse the context, their buildings and artefacts, virtually. The possibility to apply new techniques previously not available help us to possi-

1 An excavation can be also considered a sort of archive that brings along the archaeologist approach and interpretation, as well as his/her biases, and it transforms the record from an objective into a subjective one (Roosvelt et al. 2015).

Figure 1. Map of the sites excavated by the SCE during its activity in Cyprus (see Karageorghis et al. 1977: 6). The Ayia Irini sanctuary is in north Cyprus, currently occupied by Turkish troops (the red line shows the border).

bly simulate all steps occurred during the excavation and to visualize things not seen before. Moreover, digital technologies allow us to take into account large volumes of data at the same time, facilitating a holistic visualization.

Context and Research Aims

The new possibilities given by technologies in GIS and 3D, enabled the flourishing of various projects aimed at solving different kind of problems in the field of archaeology and cultural heritage. 3D GIS systems have been employed for better managing archaeological data and solving issues regarding how to store, retrieve, and eventually analyse them. More specifically, the chance to develop work pipelines that allow the archaeologists to import in GIS conspicuous amounts of 3D data characterized by complex and texturized geometries considerably changed the research approach both in the field and in the lab (Landeschi et al. 2015).

During the last years, the use of 3D GIS supported and enhanced several research lines, bringing new light to the archaeological discussion. At the base of such research projects there is of course the necessity of documentation aimed at the analysis of sites and artefacts, as we have already mentioned as being the boost of the digital technologies use in humanities, with different specific scopes. Poggi (2016) for example, in his contribution presents a documentation workflow aimed at the analysis of ongoing archaeological excavations through the use of an image-based 3D modelling technique. Monitoring, preservation and restoration aims are the main topic of further research: Landeschi et al. (2016a) discuss about the possibility of assessing damage of archaeological sites through the combination of image-based 3D modelling techniques and GIS, while Campanaro et al. (2016) propose 3D GIS as processing knowledge tool for cultural heritage monitoring, restoration and therefore preservation. Finally, the analytical and interpretative part, always present in all the aforementioned projects, are deepen by Piccoli (2016), who suggests an enhancement of GIS with 3D procedural modelling approach for ancient urban interpretation, by Landeschi et al. (2016b) and Richards-Rissetto (2017) both proposing 3D GIS as a platform for visual analysis in different case studies, and by Dell'Unto et al. (2017) who put forward the use of 3D GIS as simulation platforms for supporting field interpretation.

The study presented here fits in this research frame and its major scope is the 3D documentation and re-evaluation of past excavations and their material in order to obtain new information useful to their analysis and interpretation. Particularly, the current paper presents a digital re-assessment of the Ayia Irini (Cyprus) sanctuary's stratigraphy using 3D GIS, by corroborating published material with data extracted from the original excavation diaries. The obtained maps question the positioning of finds and their setting within the sanctuary, the existence of natural versus human made features and the possible impact of flooding episodes. Such a stratigraphic re-assessment is based on the 3D re-alignment of the artefacts found on the site, according to drawings and notes from the original excavation diaries, their

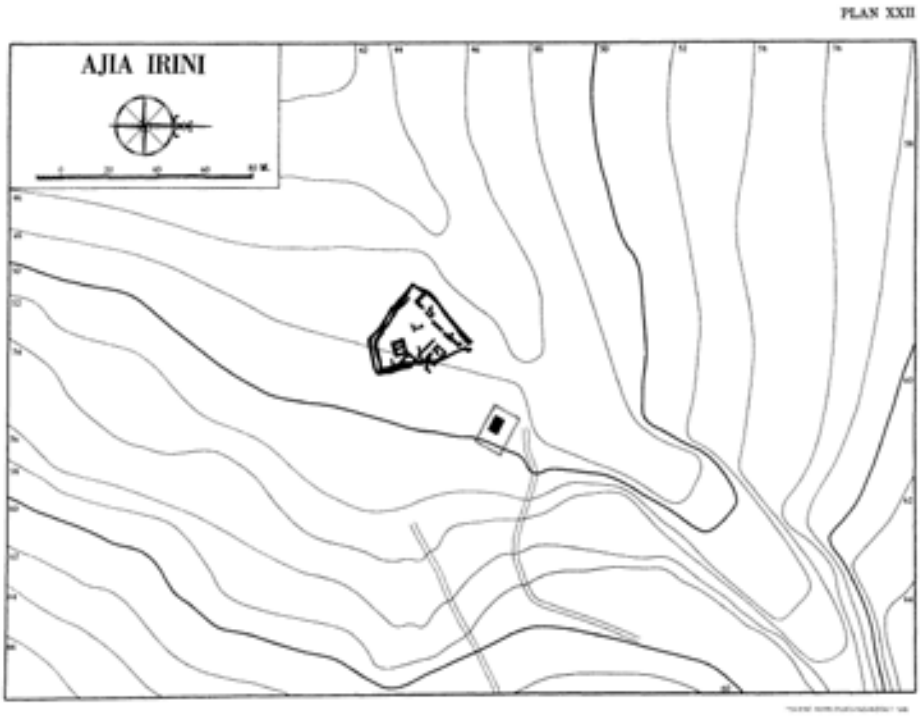

Figure 2. Plan XXII. Scale 1:80 (Gjerstad et al. 1935)

location and orientation related to the other features of the sanctuary and a re-evaluation of the nature of features described in the excavation diaries and related to them.

The Ayia Irini Sanctuary and its Finds

The Ayia Irini (Cyprus) sanctuary was excavated in 1929 by the Swedish Cyprus Expedition (SCE), and seven periods of use were identified, from the end of Late Cypriot III (ca. 1200 BC) to the Cypro-Archaic II periods (ca. 500 BC), with a small revival in the 1st century BC, and suggested that the area was flooded several times. It consists of a temenos with small buildings around an open court where, around the limestone altar and in semi-circular setting, more than 2000 terracotta statues and figurines of humans, animals, chariots, minotaurs, varying in size and shape, were found.

A peculiarity of this famous large archaeological collection is that it was divided between Sweden and Cyprus just after the excavation, and it is currently conserved in five museums. In Sweden, at the Medelhavsmuseet, together with part of the archaeological collection are also conserved the archives of the Swedish Cyprus Expedition: excavation diaries, original plans, drawings and around 10,000 photographic negatives that document the four year archaeological activities carried out by the group all over Cyprus.

The Ayia Irini sanctuary was excavated in October 1929 and in a few months was brought to light. The site is situated near the modern village of Ayia Irini, in the Morphou district in northwest Cyprus. The sanctuary is situated in an open field near the coast on rocky ground gradually sloping towards the sea. The site is in the area under Turkish military occupation since 1974 and thus inaccessible to further archaeological investigations (Figure 1). Scholars have been focussing, therefore, on reviewing published and unpublished excavated material and analysing artefacts for a better understanding of the site's stratigraphy and related chronological sequence (Houby-Nielsen 2015; Houby-Nielsen 2016; Bourogiannis & Mühlenbock 2016; Mühlenbock & Brorsson 2016).

Issues identified

Some issues have been identified after the analysis of the excavation material, of the publications and of the previous scholarships on the topic.

As previously mentioned, the Swedish Cyprus Expedition had a great importance for the Cypriot archaeology history. During the four years of activity in the island (1927-1931), the expedition conducted

systematic and extensive excavations of numerous archaeological sites with the intention of establishing a chronology for the prehistory and early history of Cyprus. The SCE team consisted of Einar Gjerstad, the director of the expedition, two other archaeologists Erik Sjöqvist and Alfred Westholm and the architect John Lindros. Thanks to this group's composition, it was possible to carry out the field work at the simultaneously in different places, while Gjerstad travelled around in order to supervise and the architect Lindros to document with drawings, plans and photographs the excavations.

The first issue, already highlighted by other scholars, is the fact that the Ayia Irini's excavation was published by the SCE leader, Gjerstad, and not by the archaeologist who excavated the site, Sjöqvist. This situation could cause some inconsistencies in the interpretation of the site. The official results of the Ayia Irini excavation were published in 1935, almost six years after, and some revisions and adding to the results were published in 1948 and 1963 (Gjerstad et al. 1935; Gjerstad 1948; Gjerstad 1963). In fact, a first text regarding Ayia Irini, different from those already cited, was published in 1933 by Sjöqvist (Sjöqvist 1933). Different opinions regarding the "floods" stratigraphy emerged from the publications of Sjöqvist and Gjerstad: they respectively talk about two and four flooding events. Additionally, inconsistencies can be identified between the material published and the unpublished one: for example, the arch. Lindros' drawings present elements that are not reported in the published maps, some sections are published wrongly (e.g. in reverse), not all original maps and sections are conserved in the archives, and some layers are not identified in all parts of the site (Houby-Nielsen 2015; Houby-Nielsen 2016).

Some lack of accuracy can be detected in the maps used to identify the exact position of the sanctuary in the modern landscape. The relative reference measurement system used by the SCE is not related to any geographical coordinate system, causing difficulties in the reconstruction of the site respect to the modern landscape. Also, some inconsistencies can be identified in the maps regarding the terracottas' position. Finally, the area of Ayia Irini is not accessible for further archaeological investigations; moreover, today the archaeological remains are covered and they are not visible anymore.

Digital Re-Assessment of the Ayia Irini Stratigraphy through Published and Unpublished Material

The ongoing project presented in this paper is part of a doctoral research project: the methodology of the reconstruction and some preliminary results are reported here.

The research includes the re-positioning of 3D models of the finds' in a 3D GIS environment of the sanctuary, reconstructed through the extrusion of the 2D plans and drawings created and published by the Swedish Cyprus Expedition (Gjerstad et al. 1935), in order to have a unified access of the collection and a holistic vision of the archaeological discovery. This involves the digitization of the excavation documentation, in order to spatially contextualize the collection and to give access to data (and related metadata).

The digital re-assessment of the site's stratigraphy is performed through 3D GIS, by corroborating published material with data extracted from the original excavation diaries. The obtained maps question the positioning of finds and their setting within the sanctuary, the existence of natural versus human made features and the possible impact of flooding episodes. Such a stratigraphic re-assessment is based also on the 3D re-alignment of the finds, according to drawings from the original excavation diaries, their location and orientation related to the other features of the sanctuary and a re-evaluation of the nature of features described in the excavation diaries and related to the archaeological material.

A GIS project has been planned and built for the scope. For its creation, ESRI ArcGIS Pro 1.3 software package, has been employed. The choice of this software is due to the fact that it is able to manage 3D geometrically complex models and specific tools that at the moment are not available in other software. The first step consisted of gathering all available material useful to the construction.

A Digital Elevation Model (DEM) provided by the Department of Land and Survey, Cyprus, with a resolution of 1:25 m has been imported to be associated with an imagery of the island of Cyprus, provided by Esri, and used as a basemap to create the model of the current elevation. Successively, to better visualize the terrain, hillshade calculation has been performed. The hillshade was needed to

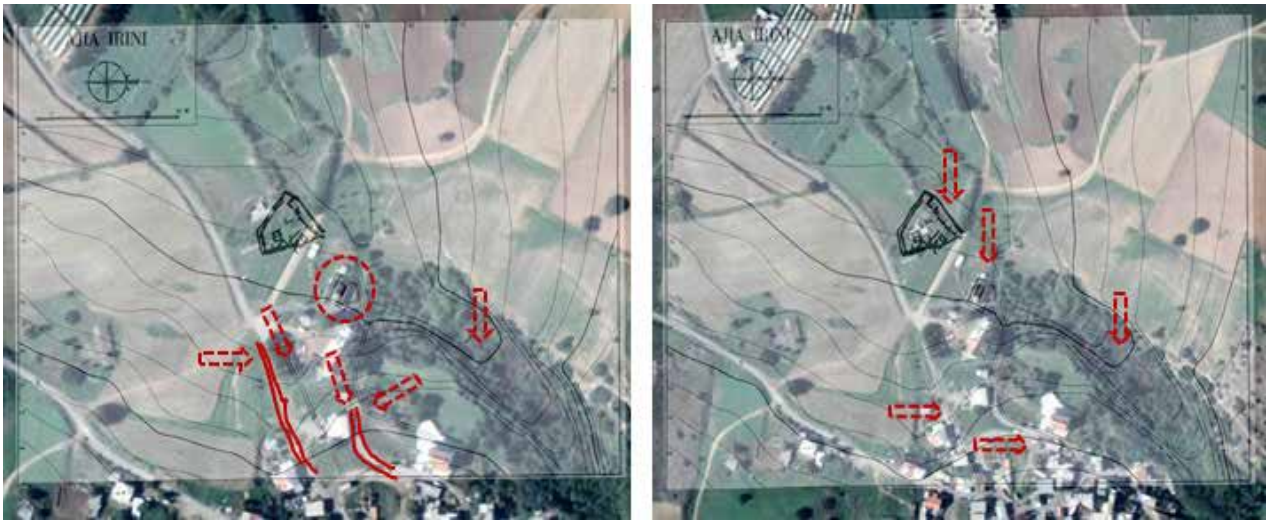

Figure 3. Georeference tests for finding the exact position of the sanctuary. The procedure brought to light the presence of measures' issues in the SCE plans (Vassallo©).

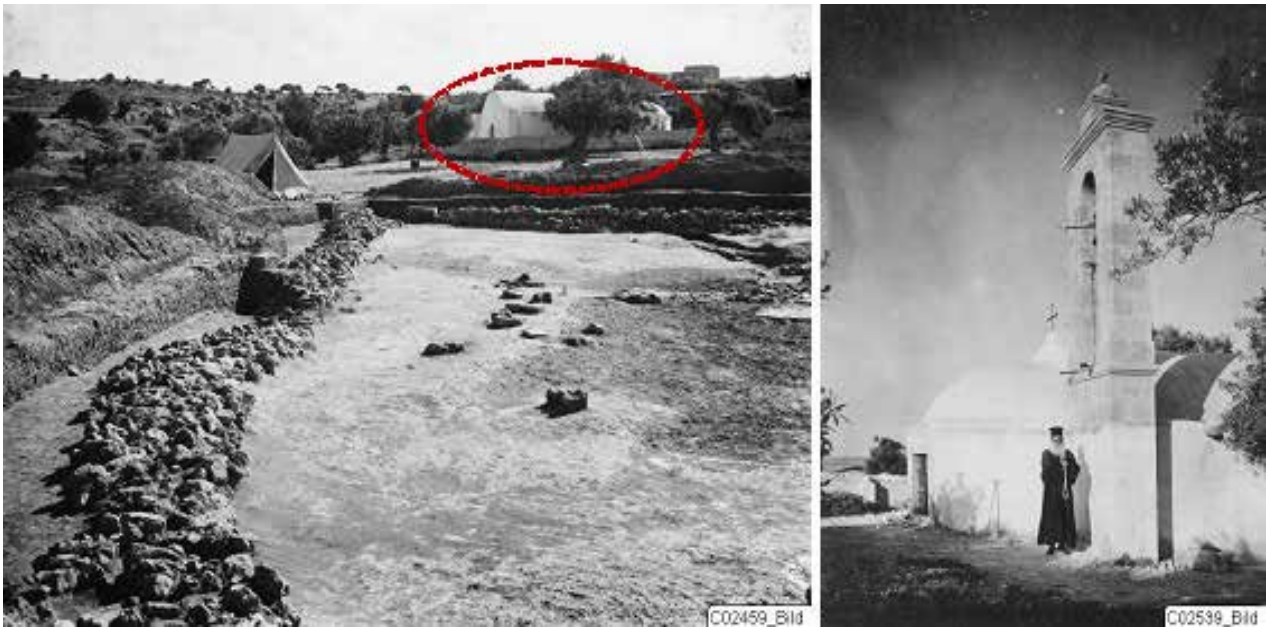

Figure 4. View from the sanctuary of the small Ayia Irini church (C02459 http://collections.smvk.se/carlotta-mhm/web/object/3924483) and Papa Prokopio on the back of the church (C02539 http://collections.smvk.se/carlotta-mhm/web/object/3926565).

emphasize the topographical discontinuities of the terrain surface, making easier to identify landscape features (possibly ground anomalies?), and to calculate how steep the terrain is. Specifically, this calculation has been made to visualize the shape of the ground and compare it with the isolines represented in the plan created by the SCE (Gjerstad et al. 1935: 643, Plan XXII; Figure 2 in this paper). Although the hillshade visualization is built on the resolution of the DEM (1:25), the slopes of the terrain became much more visible and they helped us to better position the plan during the georeferencing process.

A substantial part of the project consists, therefore, of georeferencing all architectural plans, excavation maps and images available, in order to position the sanctuary and its finds in the geographical space, and successively visualize and analyse them together.

The first question coming forward regarded the exact position of the sanctuary in relation to the modern landscape. In order to determine its position, the Plan XXII by the SCE (Gjerstad et al. 1935)

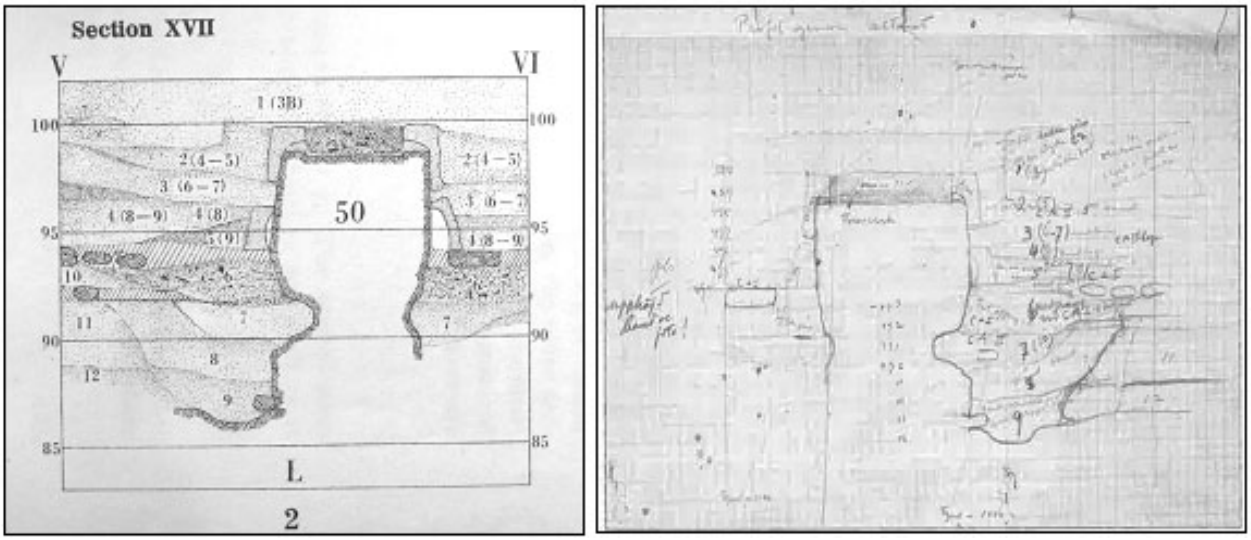

Figure 5. Wrong publication (and interpretation?) of some sections: Section XVII as published in Gjerstad et al. 1935 (left) and the same section as retrieved in the excavation diaries (13950D, http://collections.smvk.se/carlotta-mhm/web/object/3991070) (right).

(Figure 2) had to be georeferenced, since it is the only and official information regarding the location. Some issues came out from this phase of the reconstruction. The georeferencing was done trying to overlap all elements of reference drawn in the map: the slopes of the terrain, the stream bed position, the two small roads, and the church building with its enclosure. Issues concerning the scale and the elements' measurements (e.g. the church and the roads)[2] have been identified in the Plan. Unfortunately, this is something very common when it comes to old maps created with manual instruments. Some dimensions do not correspond to reality and most probably there are small errors in the position of the elements and with the scale of the plan. The errors became evident while overlapping the drawn elements of the Plan XXII on the real elements of the DEM: the process caused their distortion and consequently change of the measures.[3] To avoid that, the decision was made to georeference the plan trying to keep the measurements of the raster image stable by introducing a frame built in CAD to the map (Figure 3). This solution was employed also for the other maps to be georeferenced, in order to keep the measurements and the elements' positions stable, since it appeared that errors were going to be present in other plans and this would have brought to an increase of the error.

Old photos and photographic documentation can help archaeologists in reconstruction projects of past excavations better identify parts of the landscape (e.g. slopes and rivers), human artefacts (e.g. modern and ancient buildings) and relative distances between those elements, or in the whole reconstruction of ancient landscapes. There are many examples that demonstrate how the archaeological interpretation can be supported by archive data and can benefit from its use (Burke 2001: 224[4]): consultation of old photos and drawings for virtual reconstruction of ancient structures and their decorations (Forte 2007), use of aerial photographs and old photos for archaeological landscape reconstruction (Clark & Casana 2016).

In this vein, the old photos from the SCE archive are used to get further information regarding the location of the sanctuary and the position of the finds. For what concerns the identification of the sanctu-

2 Measuring the elements represented in the map, it appears that the church does not present real measures: the church should measure circa 14 meters, while the one drawn in the map is almost half (ca. 8 m). The measure of the church enclosure seems instead to be more precise but still not accurate.

3 An uncertainty of 2 meters from the historical plan is identified on an absolute distance of 60 meters, taken at clear identifiable points on the landscape map.

4 As underlined by Januarius and Teughels, "Peter Burke's book on the uses of images as historical evidence has brought an authoritative contribution to a theoretical and historical approach to visual material. Published in 2001, it is still very influential today. Burke evaluates different types of visual material, stressing both their strengths and their pitfalls as research subjects. Although he raises the idea that photographs bring the historian face to face with history, he also underlines the potential of visual sources as traces of the past in the present" (Januarius & Teughels 2009: 668-669).

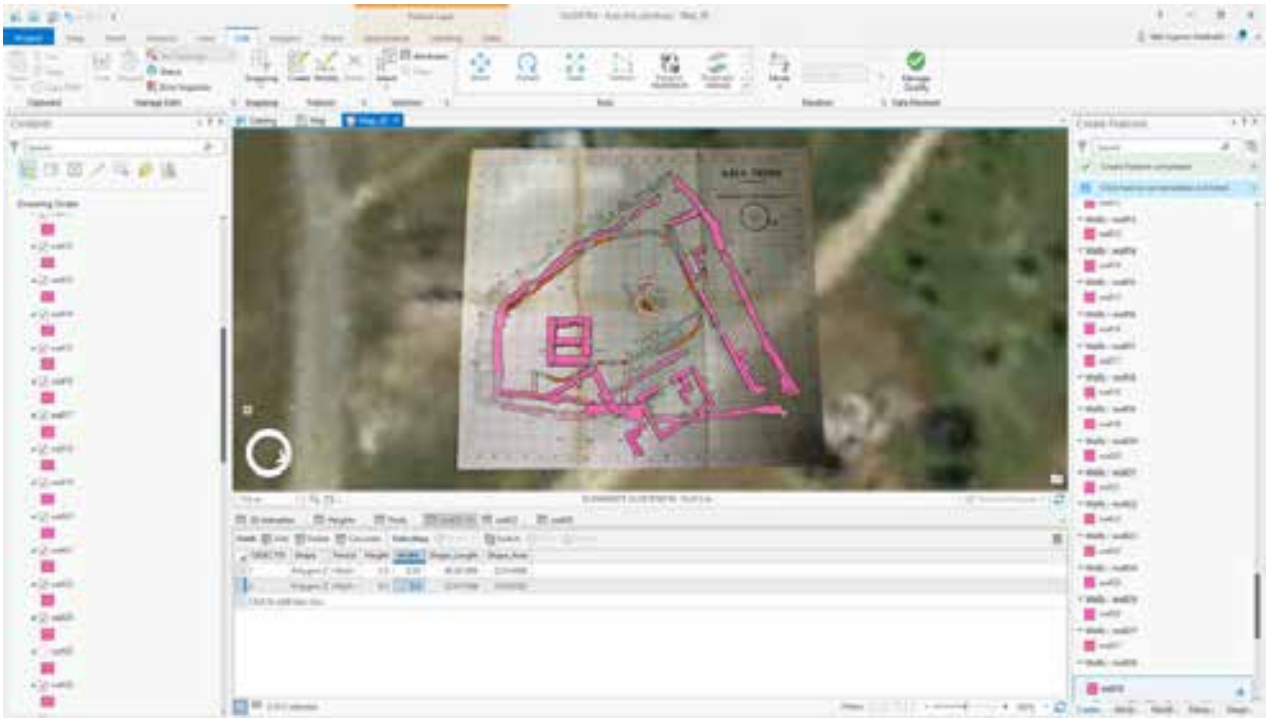

Figure 6. 2.5D reconstruction of the structures: the geodatabase contains information about the heights and widths of each wall (Vassallo©).

ary's position, we could see that some of the old pictures show the view of the small Ayia Irini church from the ancient site during the excavation; others depict Papa Prokopio, the priest who SCE cites as the first one finding a statue in his fields, next to the church (Gjerstad et al. 1935: 642)[5]. The position and direction of the church, the position of the bell tower and of the apse in respect to the ancient remains in the pictures, was compared with the Plan XXII and the DEM and it helped us locate and put in a better direction the ancient sanctuary, no longer visible today (Figure 4).

Recently, a surface recognition of the area has been performed.[6] The survey allowed us to identify the presence of some remains (most probably to be related to the sanctuary) that have been taken into consideration to better locate the site.

The successive step for the reconstruction of the Ayia Irini archaeological site consisted of the integration of the more detailed plans with sections created by the SCE, both published and unpublished. In fact, beyond the measurements issues identified in the previous step, differences between the published material and the excavation diaries data were highlighted. As Houby-Nielsen underlines in her analysis of the SCE archive, although numerous section plans were published, only some of the originals are still conserved in there. Furthermore, some inconsistencies can be detected between the excavation photos compared with the original drawings of the arch. Lindros with the published one: some sections were published in reverse[7] (Figure 5); other plans present missing parts, most probably not understood and therefore eliminated in the final publication, or changed and integrated as to better show parts that were missing or not preserved (Houby-Nielsen 2016).

Another issue regards the fact that not all the layers were identified in all parts of the site. In 1935 Gjerstad published the stratigraphy of the site with a documentation of eighteen section drawings, covering different parts of the excavated area (Gjerstad et al. 1935: 653-663). The results of the publication

5 It is interesting to highlight how the presence of the church confirms the continuity of use of the area as a religious one.

6 In spring 2018 a surface recognition of the sanctuary and of the neighbouring areas was performed by the first author for the doctoral thesis' aims.

7 Moreover, according to Houby-Nielsen none of the originals and of the published sections give sound proof of the floods' existences (Houby-Nielsen 2016).

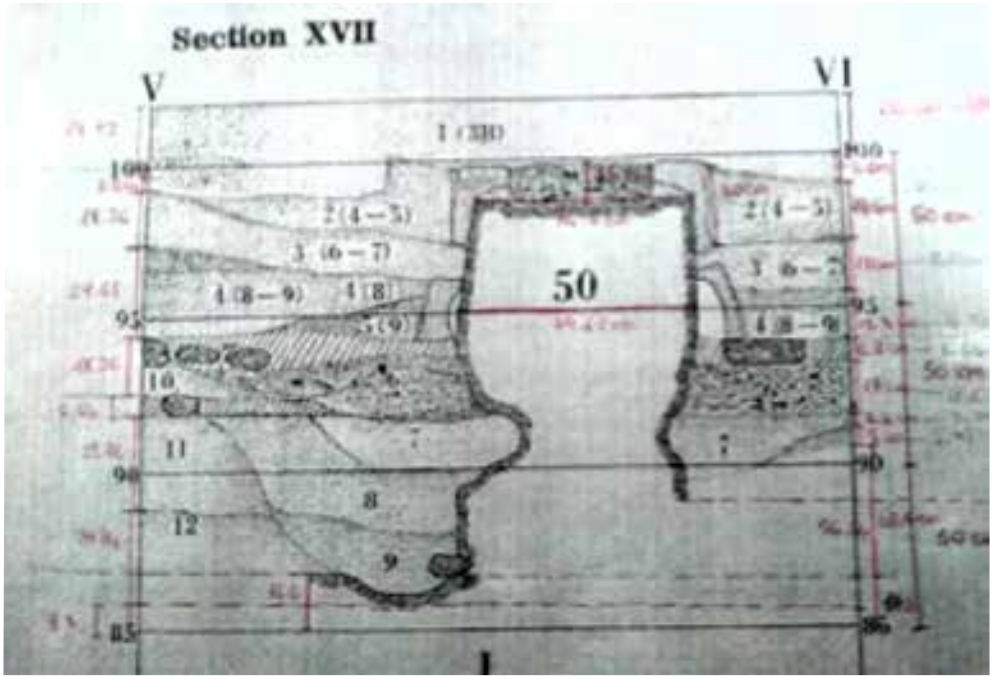

Figure 7. Calculation of the layers depth in relation to the levels published by the SCE in Section XVII (Vassallo©).

document the presence of twelve layers, which could not be identified in the whole area, associated with seven different periods on the site.[8]

All these problems in the documentation made us question if they could affect the interpretation of the stratigraphy and part of the site, and if a combined 2.5/3D visualization and analysis could contribute to the archaeological discussion. For this reason, the original section drawings, together with some redrawn maps have been integrated into the 3D environment to analyse them together with the published ones. To do so, a previous reconstruction of the architectural remains was needed. The remains are underneath the ground and not visible, therefore it was impossible to digitally document the walls directly (e.g. with laser scanner or photogrammetric technique). The only solution was to reconstruct the walls as they were at the moment of the excavation with the help of the measurements and of the heights' points provided by the SCE, respectively documented in the published material and in the arch. Lindros' original drawings.

The integration of the whole information available aims at understanding the relations between the structures, the levels and the finds. The absolute heights and thickness of the sanctuary walls have been stored in the geodatabase in order to be used to extrude polygon's features in the 3D georeferenced environment (Figure 6). Despite extrusion can be technically defined as a 2.5D operation to vertically reproject a vector polygon based on fixed z values, being the object to be extruded a wall in this case, in which typically the thickness has a constant value, the final result provided an acceptable approximation of the original volume of the standing structures observed at the time of the excavation.

This step included also the reconstruction of the structures' position compared to the modern landscape. That was the most problematic step so far, since any SCE document reported information about the datum point. Information regarding the estimated depth of the archaeological layers and the height position of the walls respect to the current terrain level has been inferred transforming the levels' point reported by the SCE to a relative reference system where our level 0 coincides with the SCE level 100. The level 100 was chosen as a reference because it is clearly documented in the Section XVII respect to the altar, at the centre of the area, from which the excavation started.

Every depth's layer has been calculated in order to create a database of the measurements for the successive reconstruction of the volumetric stratigraphy (Figure 7). In fact, the successive step consists of positioning the section plans in the exact places (as the original drawings) and from that building the

8 This interpretation was further confirmed by Gjerstad in his supplementary notes to the SCE publication (Gjerstad 1963: 4).

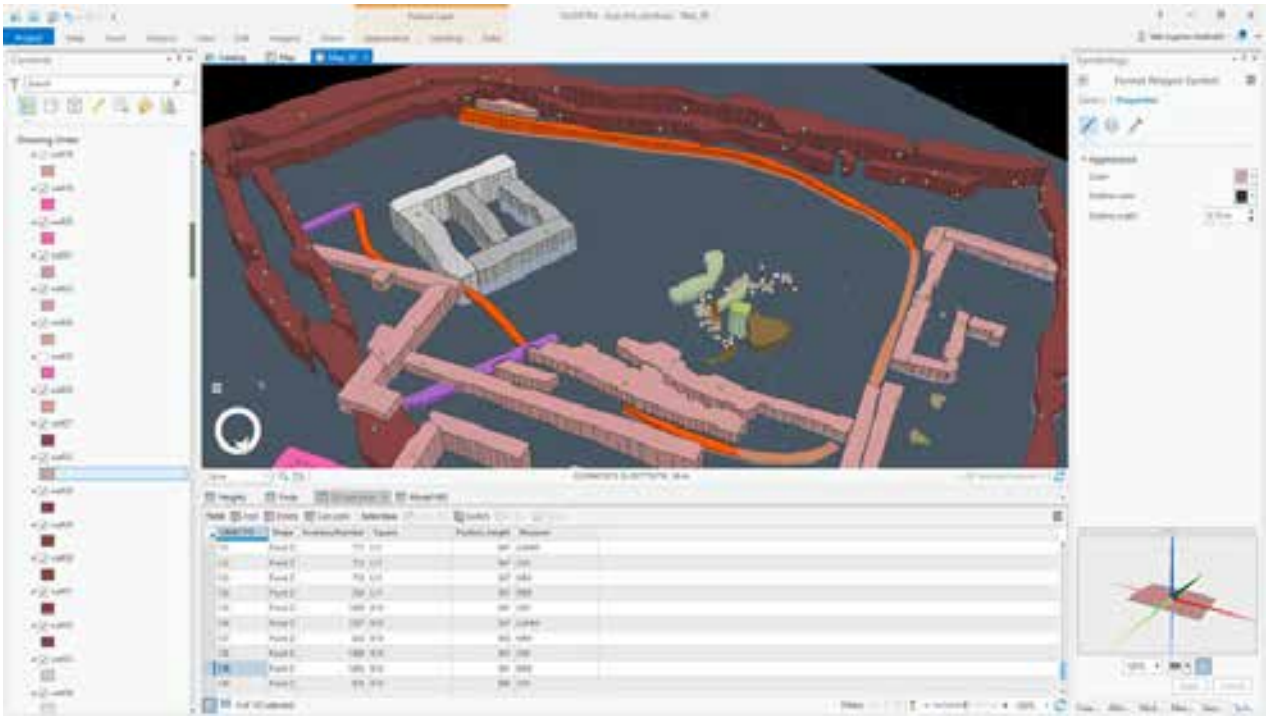

Figure 8. Reconstruction of the excavation: 3D layers and positioning of the 3D finds (Vassallo©).

3D volumes of the layers, where the finds will be integrated and analysed.

Currently, the digital reconstruction of the volumetric layers together with the positioning of the 3D features representing the finds is ongoing (Figure 8). The integration of all this data wants to provide a reconstruction of the original setting in order to better visualize their positions and clarify the different scholars' opinions regarding the presence of natural flooded (how many?) or man-made settings identified/assumed within the excavation.

A recent effort (Vassallo 2016; Vassallo 2017) focuses on 3D semantic and shape based analysis of a sample of finds representing small terracotta statuettes. For that scope, 103 3D models of the artefacts were generated through laser scanning and computer vision.[9] The 3D models of these finds have been imported in the geodatabase together with the other data in order to be visualised and analysed in the virtual environment (Figure 9). For what concerns the rest of the finds, which are not digitized yet[10], we are working at the position of their shapes in the space after the 3D extrusion of their volumes (the SCE provided measurements, positions and height's points for all the material excavated) in order to simulate the space occupied and the interaction with the other elements.

The aim of this work is to reconstruct and visualize the exact position of the finds, in order to visualize their layer more clearly; this would help to get a better view of the number of floods occurred on the site and to understand if they affected, and to what extent, the position of the artefacts. In fact, the archaeological querelle focuses on the existence of two or four floods and the different interpretations of the archaeologists regarding this issue and the stratigraphy in general. As previously mentioned, already among the archaeologists of the SCE there were at that time different options: two floods according to Sjöqvist who excavated the site and four floods according to Gjerstad who published and finally interpreted it.

The SCE archaeologists provided information

9 The 3D models were generated respectively through a NextEngine laser scanner and through the PhotoScan Agisoft software (Verhoeven 2011). The use of the two techniques was done at the beginning for the integration of the two kind of models for a major accuracy. Eventually, after a test it came out that during the 3D shape analysis the different models were able to show different results, all useful to the interpretation of their technical production.

10 Possibly, such work could be realized in the view of a prosecution of the research for a more complete study of the site and its collection.

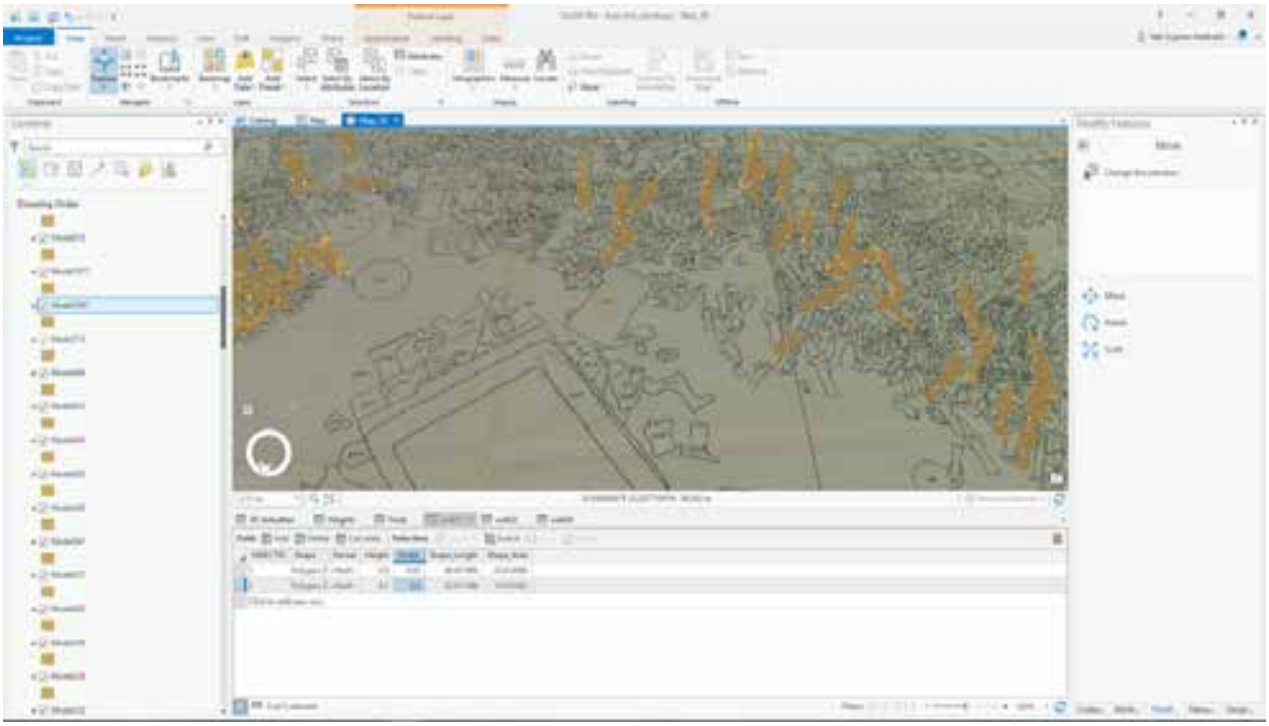

Figure 9. 3D import of the finds in the geodatabase (positions and heights' points have been documented) (Vassallo©).

about the position of each find. The arch. Lindros in his drawings took note of the heights' points of the walls while in the excavation's text the heights' points of each find is given. In the documentation it is not specified where the point of each find is taken (on top of the find? On the terrain where the find laid on?). This is something that we will analyse in the 3D geographical system: the different simulations could help us to visualize the different alternatives.

It is important to highlight that after a closer analysis the SCE Plan XXVIII ('Plan of finds in situ') revealed to be a 'hybrid' between a geometrical plan and an artistic sketch. Indeed, although the altar has the right measurements and position and the finds are documented as belonging to the squares which the excavation was divided into (all these elements have been used to georeference the plan for the integration in the project), many finds do not present exact measurements, they are roughly represented in terms of inclination and in some cases they do not represent the inventoried object.[11] Moreover, the plan is drawn from a frontal perspective. Therefore, if we look at it from another viewpoint, we can see differences in the inclination of the artefacts respect to the terrain and to the other finds.

Another issue is that the arch. Lindros arrived on the site after the excavation of the votive statues and documented them as one assemblage (Westholm 1994: 7-21). Sjöqvist identifies only two floods: one before the artefacts were put in place and another after; he, therefore documents the votives as one assemblage, not disturbed by intermediary floods. This might also be the reason why the plan was taken at the end of the statues' excavation, without any partial plans of the dismantling of the stratified statues. Gjerstad, instead explains the stratification and the periods as a consequence of four floods. In his view, after every flood the older votives were left in situ half covered by the debris, while the newer figures were added on the more recent floor levels, giving evidence of different time periods (Gjerstad et al. 1935). The comparison of all data, such as the inventory numbers list, the old photographs and the plans, will help us to better understand the situation at the moment of the excavation.

A preliminary calculation of the height points of the finds has been performed. This was done to see if a preliminary analysis regarding the relation between the 103 sampled statuettes and the layers' heights could provide any results in the identifi-

11 Like for the interpretative study of the material, more importance is given to the big statues respect to the small ones.

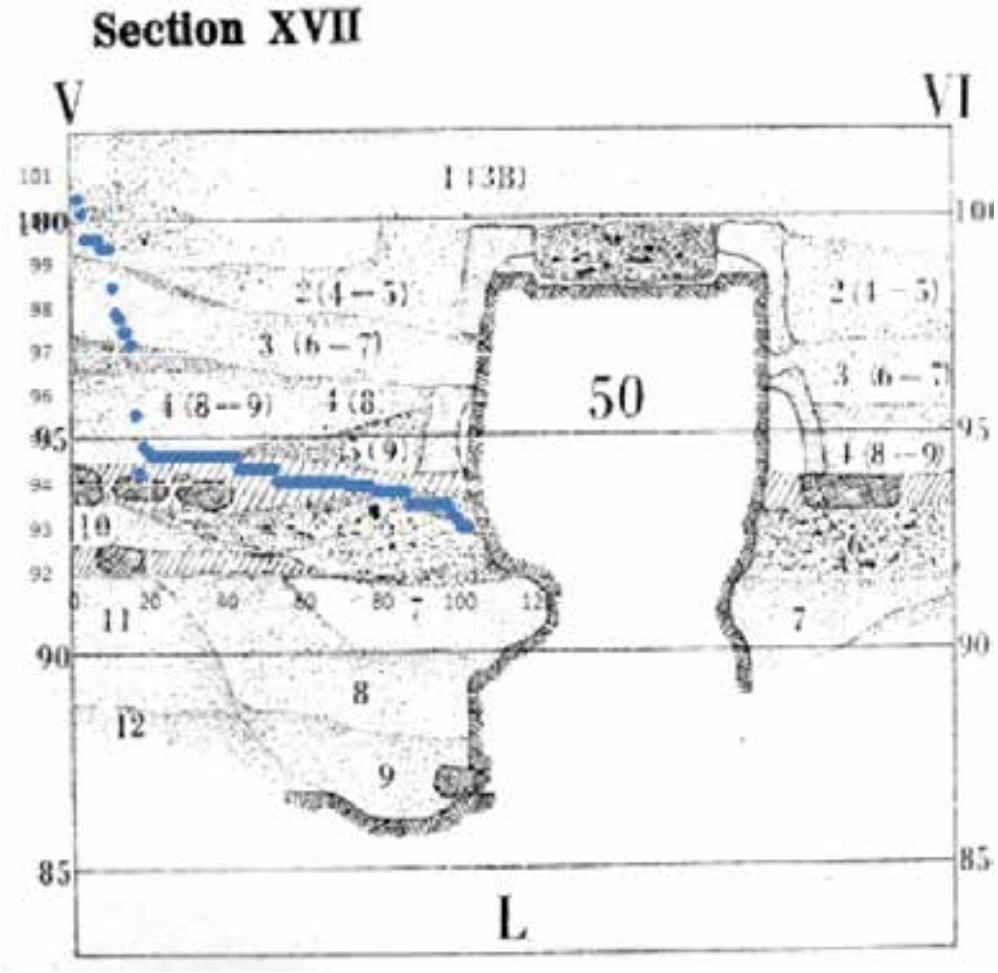

Figure 10. Superimposition of the spatial vertical location of the sampled statuettes on Section XVII (Vassallo©).

cation of specific material settings. It is important to underline that this is a partial calculation and, therefore, a partial reconstructive hypothesis since the test is taking into consideration only the sampled artefacts. On the base of the previous calculation performed on Section XVII (Figure 7) to reconstruct the depth of each layer, the overall archaeological depth is 150 cm; therefore, each unit is equal to 10 cm. The 103 sampled statuettes are included between the height's points 93.1 and 101.0, a space equivalent to 80 cm[12]. A calculation of how many statuettes were found in each unit and their spatial vertical location has been performed. Figure 10 shows the overlap of the resulting statuettes' spatial vertical location on top of the Section XVII, in order to show their distribution within the area considered.

If we look at Figure 10, we notice the following. The z axis distribution of the sampled figurines shows that the vast majority (N=86) are located within a 20 cm range, between relative heights of 93.1 and 94.9. Another possible group of figurines is noted within the range 97.2 and 99.6 (N=13). According to this analysis, we can suggest a main layer of human activity located at the relative height of 94 and apparently a second one, of a much smaller intensity, located ca. 40 cm higher, at the relative height of 98.4.[13] This analysis is made on a partial number of statuettes respect to the whole, but what we can see is the presence of two main archaeological events, which interval is represented by the Layer 4, the only one explicitly identified by the archaeologists as made 'of alluvial sand' respect to the others described as mixed with sand and therefore not clearly and surely identifiable with flooding events (Gjerstad et al. 1935: 663). Additionally, a rarefaction in the positioning of the small statuettes

12 The statuettes measure from a minimum of 20 cm to a maximum of 27 cm.

13 It is important to note that in this assumption no calculation regarding other rotation axis has been done.

Heights' points range	Number of statuettes
100.1 – 101.0	2
99.1 – 100.0	7
98.1 – 99.0	1
97.1 – 98.0	5
96.1 – 97.0	0
95.1 – 96.0	1
94.1 – 95.0	55
93.0 – 94.0	32

Table I: Calculation of the heights' points range on the base of their space occupation and number of the statuettes

towards the more recent periods can be detected.[14] The subdivision seems to suggest therefore two major stratifications that, if not a proof of floods (to be further investigated in the 3D GIS), might advocate for a stratification (chronological or human-based).

Conclusions and Further Steps

The current paper presents the methodological approach, the workflow and the preliminary results aimed at the diachronic reconstruction of the Ayia Irini sanctuary and its finds within a 3D GIS system. The last step of the project regards the reconstruction of the volumetric layers on the base of the Swedish archaeological expedition documentation and the completion of the re-position of the 3D finds within the 3D GIS environment of the sanctuary.

Unfortunately, many archaeological sites excavated in the past suffered of not being sufficiently documented due to different reasons, such as limitation in the technologies or human errors. So far, the analysis in the 3D GIS system made us to identify several issues: inconsistencies within the maps, maps errors, and lack of measurements. Such methodology can help us to overcome such issues and it showed how digital technologies can enhance the overall archaeological process.

The preliminary calculation on the base of the sampled artefacts' distribution seems to show two main human/archaeological events separated by a more natural/geological interval, possibly to be identified with a flood, finally covered by another natural event that caused the abandon of the site.

The final integration of all the volumetric elements and of the finds, beyond serving for the 3D analysis and the final re-assessment of the stratigraphy, it will also work as a main virtual access of the collection for a holistic vision of the archaeological discovery: a 3D spatial context that will give access to the digitally re-unified collection. Since the collection is divided and exhibited in different museums of two countries and the site is currently inaccessible, the 3D space will virtually re-unify the finds and it will be a solution for the context re-interpretation. This can be possibly done thanks to the use of the software package employed: the layers can be easily exported as kmz or kml files that in turn can be viewed by any users (e.g. also general public) in Google Earth. Moreover, it is also easy to transform the resulting map using ArcGIS Online into an app for people to explore online or on their mobile phones, also incorporating historic photos, original scans of field notes, plans and profiles. Therefore, such technical choice on the one hand supports the management of 3D geometrically complex models, and on the other hand opens up options for sharing the resulting data both with other researchers and the public interested to digitally explore the site.

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14 Moreover, the analysis of the statuettes shows a change of typologies towards the upper level of the assemblage respect to the previous ones. Further investigations will help us to understand if the setting of the statuettes follows a chronological pattern. In fact, according to Houby-Nielsen (2016) the setting could also follow a deposition order decided by other criteria than time, such as clusters of similar objects according to different social status or ethnical origin of the worshippers and places of display.

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