



Laser scanner surveys on the Island of Capri. The contribution of a metrological approach to the understanding of ancient architecture

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ABSTRACT

The CNR, within the “Masgaba” project, contributes to the archaeological mapping of Capri. This initiative involves survey activities, historical-architectural studies, and the creation of detailed graphic documentation integrated into a Geographic Information System (GIS). Surveys employ advanced technologies, such as laser scanning and photogrammetry. The resultant 3D models contribute to site documentation and analysis. This study advocates the use of a methodological approach reliant on precise measurements and thorough planimetric surveys achieved through instrumental techniques to investigate and comprehend archaeological remnants with a high degree of certainty. By combining this with careful examination of walls and construction techniques, historical phases and space functions can be defined. The examination of three archaeological sites in Capri, Grotta dell’Arsenale, Villa of Gradola, and Villa of Damecuta, exemplifies this approach.

Section: RESEARCH PAPER

Keywords: Archaeological survey; archaeological map; laser scanning; roman architecture; grotto; roman villa

Citation: G. Caratelli, C. Giorgi, Laser scanner surveys on the Island of Capri. The contribution of a metrological approach to the understanding of ancient architecture, Acta IMEKO, vol. 13 (2024) no. 2, pp. 1-9. DOI: [10.21014/actaimeko.v13i2.1827](https://doi.org/10.21014/actaimeko.v13i2.1827)

Section Editor: Fabio Leccese, Università Degli Studi Roma Tre, Rome, Italy

Received February 28, 2024; **In final form** March 22, 2024; **Published** June 2024

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Funding: This work was supported by the municipalities of Capri and Anacapri, Italy.

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1. INTRODUCTION

In the context of the “Masgaba” project, which involves creating the archaeological map of the island of Capri, the contribution of the Institute of Heritage Science (ISPC) of the National Research Council (CNR) includes survey activities, historical-architectural study of archaeological evidence on the island, and the production of new scientific content and detailed graphic documentation to be integrated into a dedicated Geographic Information System (GIS).

The main objective is to acquire knowledge about the actual extent of the archaeological heritage of the island by locating its remains and exploring their original dimensions and functions.

The creation of the archaeological map of the island represents the most suitable tool to meet various scientific, operational, and technical needs. It will facilitate actions aimed at the protection and enhancement of cultural heritage and provide a correct understanding of the evolution of the territory, a

fundamental prerequisite for reconstructing the historical events of the area and guiding land planning decisions.

Most of the archaeological sites in Capri are mentioned and mistakenly interpreted between the 18th century and the first half of the 19th century when erudite individuals began to provide the initial brief descriptions, sometimes accompanied by metric references [1]. This is typically followed by various inspections conducted by scholars, who often carry out earthworks rather than archaeological excavations, driven by the desire to rediscover ancient Roman remains, stripping them of decorative coverings and archaeological finds that were discovered [2].

Only in the first half of the 20th century we have the first analyses of ancient monuments carried out by Amedeo Maiuri [3], who started excavations and published archaeological reports, often assisted by Paolino Mingazzini [4]. The site plans drawn up at that time are still largely used today, as they are often the only graphic representations of Capri’s archaeological sites. Subsequently, apart from small but significant analysis and excavation [5], only at the end of the 1990s was the island the

subject of a comprehensive study that merits collecting all the information and historical sources regarding archaeological findings [6]. In this publication, sites were described through sheets associated with an island map indicating their general location. Although it represents an important work, points on a cartographic level symbolically identify the archaeological sites. For this reason, the “Masgaba” project included a field investigation to verify their actual existence, exact location, and extent.

The research work presented here is initially published at an International Conference held in Capri in 2021 [7], and partly in the Conference “Metrology for Archaeology and Cultural Heritage” in 2023 [8]. The research establishes a methodology of investigation involving a study of the state of the sites from a historical and regulatory perspective, surveys integrated with the most innovative technologies available today, analysis of acquired data, and observations of the structures. This approach aims to achieve results that provide new historical interpretations and simultaneously make archaeological sites more accessible to both specialists and the general public.

In Section 2, the phases of the work initiated, those currently in progress, and those planned by the project are described, outlining the objectives and innovations of the research. Section 3 lists the sites subject to survey and outlines the methodological choices employed. The subsequent sections highlight the results of the survey and the consequent historical-archaeological interpretation, with particular attention to the original compositional scheme, ancient construction methods, metric systems, and architectural proportions. These ancient choices, if appropriately identified and evaluated, offer an authentic and more objective understanding of the functions of the buildings and the individual spaces that compose them. Identifying a plan scheme that explains the distribution of spaces corresponds to rediscovering an artistic and architectural language that was intended to be very clear in the Roman world.

2. THE ARCHAEOLOGICAL MAP

The archaeological map, that we intend to create through this research project, represents the first archaeological map of the Island of Capri in a modern sense and the first systematic study at the territorial level. While in the past, attention was focused only on a few famous monuments, today the goal is to produce a series of maps at various scales of representation, where all the sites on the island are graphically and accurately geolocated.

In particular, archaeological surveys are conducted on all monuments that require an update of graphic documentation or that lack it. Similarly, site plans of those recently studied and documented with the latest surveying systems will be included. This operation aims to describe the sites not only through point localization but also by mapping their actual planimetric development and detailing the individual traces and wall structures that constitute them. The archaeological analysis shows more detailed site plans, highlighting ancient construction types, historical phases, and reconstructions resulting from the final interpretation.

However, the research activity is not limited to graphic and cartographic representation but also focuses on constructing a Geographic Information System (GIS) for the island where data of various kinds converge (historical information, information on mobile finds discovered on the island and now dispersed or stored elsewhere, historical and recent graphic and photographic documentation, aerial photographs, etc.).

The research work has completed a series of activities, such as the census of known sites, the study of historical cartography, the creation of a map with the positioning of areas subject to archaeological restraints, and some archaeological surveys. It showed that the areas protected by regulatory restraints constitute only about 3 % of the entire island territory (Figure 1). This data is surprising when reflecting on the significant role the island played in Roman times, chosen even as a residence by the Emperor Tiberius. Archive records recount numerous finds in the territory, attesting to a constant and systematic occupation of the island through the construction of numerous villas, productive activities equipped with water storage systems and food reserves, as well as areas specifically designated for recreation and leisure, such as monumental nymphaeum, scenic walks, and much more.

3. THE ARCHAEOLOGICAL SITES

The archaeological sites to be presented in this contribution all share a landscape element that has influenced their design, function, and fate: the sea. In fact, both the Grotta dell’Arsenale and the villas of Damecuta and Gradola, the latter located near the famous Grotta Azzurra, are situated along the coast of Capri, characterized by rocky cliffs that often drop steeply into the sea (Figure 1).

The first is a natural limestone cavity, further excavated and built in Roman times, overlooking the southeastern slope of the island just a few meters from the coastline and likely accessible only by sea. The two villas, on the other hand, are situated along the northwestern slope of the island, in a panoramic position. Interpretations of the site types have been controversial and often incorrect. This is the case with the Villa of Gradola, whose structures were initially identified as a series of road substructures [9], and the Grotta dell’Arsenale, which over time has been variously interpreted as a boat storage [10], a temple [9], [11] a grand bathhouse, or a maritime rocky nymphaeum [12], [13], [14].

These monuments have been brought to light without conducting stratigraphic excavations, and aside from sparse archaeological reports published at the time of the investigations, there are no comprehensive and extensive publications. These sites have never been documented with sufficient precision, and their measurements, site plans, and sections sometimes date back to the first half of the twentieth century. In fact, the only existing site plan of the Grotta dell’Arsenale dates back to 1955 when the inspector of the Superintendent, P. Mingazzini, decided to have it drawn up to accompany the archaeological description of the monument he inspected during the excavation led by A. Maiuri in 1930 [12], [14].

After him, scholars who gradually mentioned the cave simply reiterated his observations and sometimes published his site plan, perhaps due to the challenges associated with accessing the cave. However, from the survey carried out as part of the “Masgaba” project, it is evident that the orientation, spatial distribution, measurements, and interpretations of the wall structures are often incorrect.

Another emblematic example is the Villa of Damecuta, also excavated and surveyed in the 1930s and 1940s by A. Maiuri [3]. Despite being considered, along with Villa Jovis and “Palazzo a Mare”, one of the most important imperial residences in Capri due to the abundance and extent of the emerging ruins, it has not been surveyed or subjected to any other type of measurement since then [15].

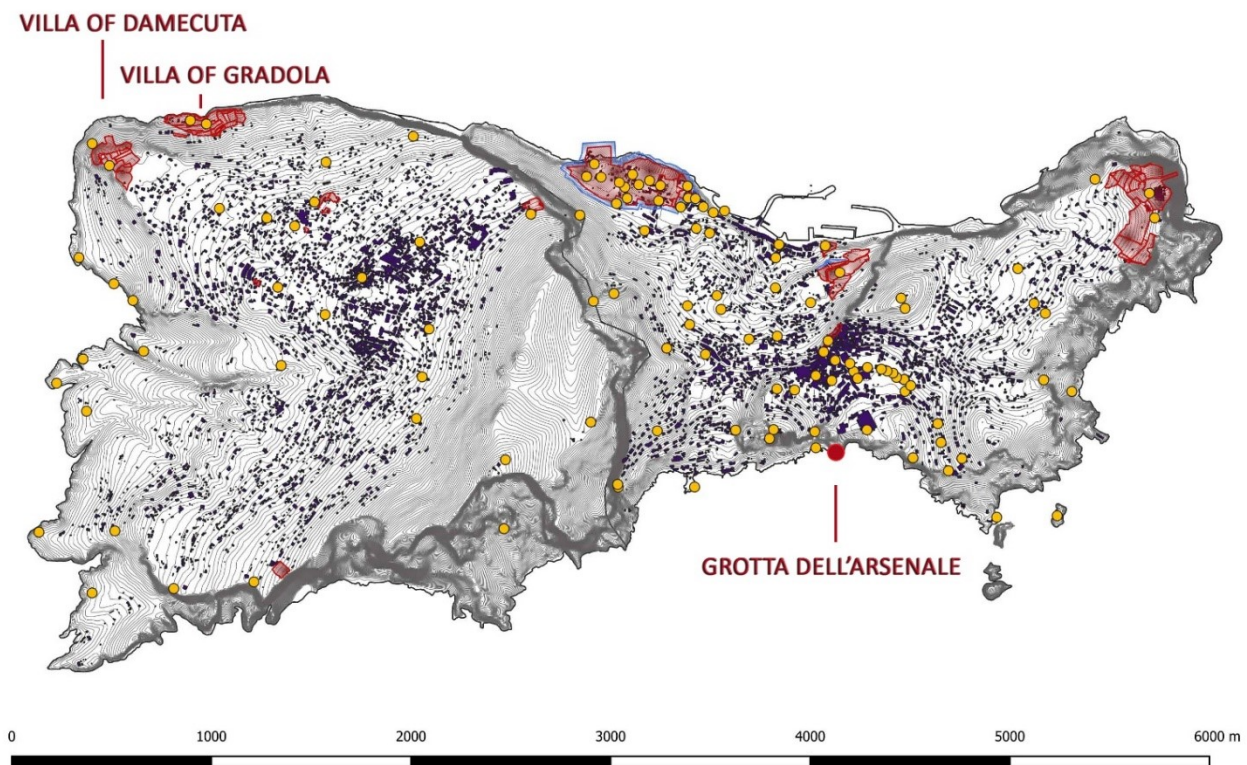


Figure 1. Capri island, general map with the location of archaeological sites surveyed, the indication of the known archaeological findings (in yellow) and the areas with archaeological and landscape constraints (respectively in red and blue).

The last case examined is the Villa of Gradola, the only site among those listed subject to recent planned excavation [5], during which the easternmost area, now completely buried by vegetation, was brought to light. The comparison between the laser scanner survey of CNR and the published site plan highlighted the limitations and errors of the previous graphic documentation, such as the misalignment of various wall structures or the incorrect sizing of two symmetrical semi-circular structures. This circumstance leads to reflections on the new opportunities for knowledge that can arise from a survey conducted accurately and utilizing the latest technologies.

4. THE SURVEYS

After a thorough archaeological cleaning aimed at bringing ancient traces to light and analysing them in detail, the research group of CNR-ISPC has scheduled archaeological surveys of the sites listed in Section 3.

The surveys conducted so far have been aimed at producing site plans to be included in the archaeological map of the island. Using the FARO CAM2 phase-shifting laser scanner, 25 scans were acquired in the Grotta dell'Arsenale, 47 in the Villa of Gradola, 4 to document the surviving wall in the area leading to the Grotta Azzurra, and a total of 123 scans in the Villa of Damecuta.

After aligning and processing all the scans, eliminating excess points, disturbances, noise, and areas of non-interest, comprehensive high-resolution point clouds were generated, with a density of approximately 1 point every 5 mm.

Furthermore, each laser scanner survey was appropriately integrated with the technique of image-based three-dimensional photogrammetry. Ground photographs were taken using semi-professional DSLR cameras, capturing high-definition images of

the wall surfaces and decorative coverings. Additionally, a Remotely Piloted Aircraft System was employed to document the crest of the walls, floor plans, and the environmental and landscape context.

The total station was used for measuring specific points, marked in the field and defined as targets or GCPs (Ground Control Points).

The generated 3D models, equipped with photorealistic textures, were analysed and utilized for creating numerous architectural sections, choosing specific cutting planes and orthogonal projection. Subsequently, animations of the 3D models were processed using specific software that effectively managed data from the laser scanner and photogrammetric surveys (Cinema 4D, MeshLab). Through a series of established paths and virtual cameras, it was possible to create exportable videos at various resolutions and in common formats.

The video animations were created with the dual purpose of fully documenting monuments that are difficult to preserve due to the nature of the locations, while also enhancing and making them accessible through virtual tours, which may be explored online in the near future.

For example, in the case of the Grotta dell'Arsenale, a virtual animation was useful to recreate the experience of visiting a cave that is currently difficult to access. Another case was represented by the Villa of Gradola, which is currently covered in vegetation, awaiting an approved restoration and maintenance project. The georeferencing of surveyed archaeological sites was approached by integrating official topographic bases, such as the Regional Technical Map, municipal cadastral maps, and satellite images. The positioning in the WGS84 reference system, along with the reprojection of geographic layers expressed in different coordinate systems, was facilitated using the open-source software QGIS, widely used in geographic support today.

Finally, the archaeological analysis of the sites was conducted, initially examining data from surveys, followed by observation of the structures and decorative coatings, identification of Wall Stratigraphic Units and their relationships, and concluding with archaeological interpretation.

5. THE RESULTS OF SURVEYS AND ANALYSES ON-SITE

5.1. Grotta dell'Arsenale

From the examination of the survey carried out, it is possible to accurately describe the geometric layout of the spaces as they were originally conceived, and correctly interpret the original plan scheme (Figure 2).

The cave, developing in a NE-SW direction, overlooks the southern side at about 5 meters above the current sea level, from which it is currently 30 meters away from the coastline.

The docking facilities, therefore, had to be facilitated by a series of interventions, of which today only a few but significant traces remain. These include a water channel that extends eastward, ending in a pointed shape, with a relatively flat bottom, which probably served the mooring, at least temporarily, of boats. A second, more noticeable recess is carved into the rock towards the cave, and its inclined plane fills the gap between the sea and the opening of the cavity. This ramp, approximately 37 meters long and 19 meters wide, has a sloping surface and still

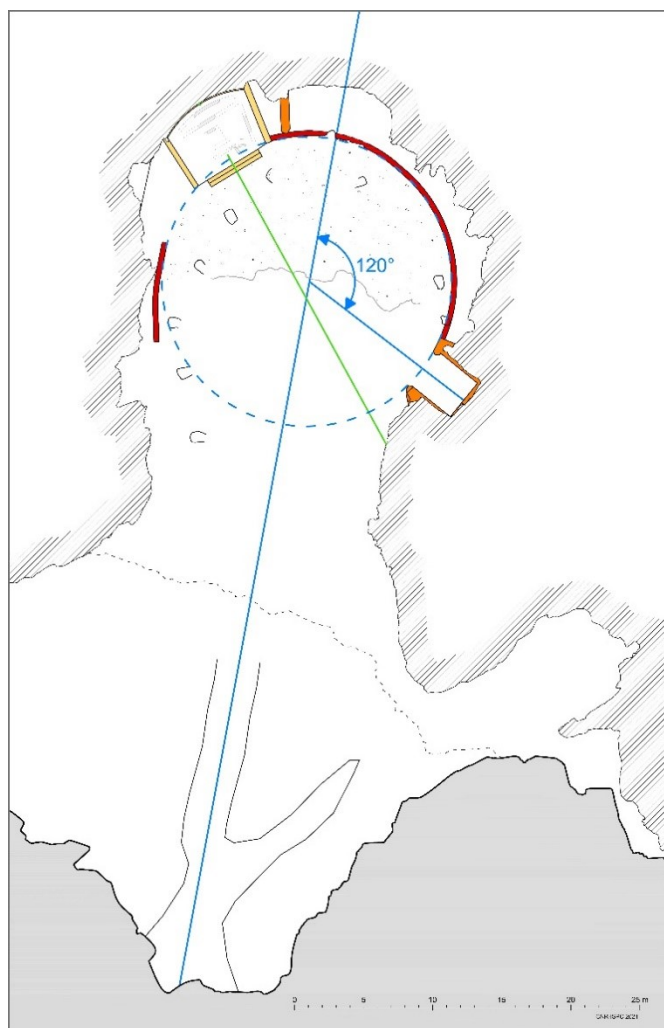


Figure 2. New planimetry of the Grotta dell'Arsenale, indicating the compositional scheme and construction technique (red is *opus incertum*, orange is *opus reticulatum*, yellow is *opus latericium*).

shows traces of cement conglomerate with limestone flakes today. It likely served as access to the cave.

The access corridor led to a large central circular space delimited by a low wall in *opus incertum*. Radially positioned to this semicircle are three rooms. The central one is the largest, carved by chiselling the natural rock of the cave, featuring a wall in *opus reticulatum* to support the western one. A second room, trapezoidal in shape, curved at the bottom, located just west of the central one but not contiguous to it, is constructed with walls in *opus latericium* and access is gained by descending three steps. The last room, situated to the east of the access corridor and excavated from the natural rock, has a barrel vault with exposed natural rock and is delimited by walls in *opus reticulatum* with angular joints in *opus latericium*.

From the analysis of the new planimetry, numerous discrepancies with the previous available and published graphic documentation by P. Mingazzini have emerged [14]. In addition to the evident inaccuracy of the small cave that appears on the right, it is precisely the arrangement of the spaces that is incorrect with respect to the cardinal points. Furthermore, some marine concretions have been mistakenly interpreted as walls.

The new analysis has revealed that the central room aligns with the access ramp, indicating its belonging to the site's initial construction phase and emphasizing its particular importance due to its centrality. Additionally, a specific compositional scheme is recognized, with a second room located southeast, whose center is exactly 120 degrees from the central one. It is still unknown whether there was another symmetrical space to this one. On the other hand, the third room was constructed in a later phase, as evidenced by the construction technique used and its position, effectively falling outside of this plan scheme.

The direct predecessor of the Grotta dell'Arsenale is the Tiberius Cave in Sperlonga, with which it shares dimensions, access methods, and floor plan scheme. However, unlike the Tiberius Cave, in the Grotta dell'Arsenale there are no traces of hydraulic systems that would suggest the presence of water elements. The latter, in this case, seems to be more integrated at a landscape level, as it could be admired from inside the cave, given its opening towards the sea.

A very rare feature found in the Capri cave is the presence of nine recesses distributed along the perimeter of the circular space and at the height of the natural vault of the cave. Various hypotheses have been put forward over time regarding their function, such as housing for ceiling beams, or cavities for coffers or decorative purposes. The recent survey has refuted these hypotheses and highlighted their inclination towards the floor level and the irregularity in their distribution and shape. Instead, a possible function related to the artificial lighting of the interior space is proposed, considering their downward inclination of approximately 20-30 degrees relative to the vault plane, and the directions of each recess that seem to be aimed at evenly distributing light within the circular space.

Unfortunately, it seems challenging to find comparisons with any lighting systems in ancient caves, mainly due to the poor preservation of the vaults. However, it is noteworthy to recall a square-shaped recess in the cave of Sperlonga, possibly related to the lighting system composed of marble theatrical masks, from whose mouth and eyes light emitted from the rear lamps [16].

Despite receiving various interpretations over the decades, based on its planimetry and construction type, the cave can be considered as one of those natural spaces that the Romans knew how to exploit for coolness and relaxation, simultaneously enjoying a panoramic view of the sea.



Figure 3. Villa of Gradola. New planimetry from CNR survey indicating the construction technique (in orange *opus incertum*, in blu *opus reticulatum*, in yellow *opus incertum and reticulatum*, in purple post-ancient walls, in light blue dotted *opus spicatum*, in green dotted *cocciopesto*).

5.2. Villa of Gradola

Arranged along the northwestern slope of the island, the remains of the Villa of Gradola occupy an area located precisely above the Grotta Azzurra. Taking into account the undeniable challenges arising from visibility conditions not always optimal, currently at least three floor levels can be identified, of which two (the upper and the intermediate) are definitely coincident with the remains of ancient floor plans (Figure 3).

The lower level, characterized by the use of *opus incertum* limestone, followed, from a certain elevation, by the *opus reticulatum* of tuff, features a thick supporting wall with a rear cavity. Emerging from the centre of this wall is a semicircular forepart or hemicycle (the outer diameter just exceeds 15 meters), divided into three rooms covered with barrel vaults.

Externally, the hemicycle has two semicircular niches (with a diameter of about 3.30 meters), symmetrically arranged on either side of the longitudinal axis of the central substructure room. Finally, another niche, nearly rectangular (approximately 4 x 2 meters), wider and deeper than the lateral ones, opens exactly in the center of the hemicycle. It is closed on the front side by a narrow wall in *opus reticulatum*, following the curvature of the hemicycle, and may have served the purpose of delineating a basin for a fountain, housed within the same niche.

The purpose of the three substructure rooms of the hemicycle remains uncertain, often interpreted as cisterns [5].

One of them, still accessible by a non-ancient flight of stairs, has been partially and summarily restored at an unspecified moment in its history to be used as a shelter for animals or tools. Inside, through an opening in the back wall, it is possible to access another substructure room, still filled with *pozzolana* up to the base of the vault and probably inaccessible since the original phase.

At the end (going up) of the non-ancient flight of stairs, there is a corridor, paved in *opus spicatum* and *cocciopesto*, with kerbs on three of the four sides (the fourth side is not visible, as it disappears into the thick vegetation). On the south side (facing uphill) of the corridor, there is an almost circular opening (perhaps a window), which originally would have illuminated and ventilated the substructure room behind, and a channel for draining rainwater or accommodating a supply pipe is visible.

The upper level is characterized by the presence of at least three substructure rooms, two of which are still used as cisterns, in addition to the one facing the south side of the corridor just mentioned. On the extrados level of these rooms and further

south, directly on the limestone bedrock, some orthogonal walls in *opus reticulatum* are constructed, occasionally showing remnants of the covering plaster. At least three rooms are confidently identified, oriented NW-SE, and one larger room, directly abutting against the slope, which appears to develop orthogonally to the first three.

As we have already reported elsewhere [8], [17], the new survey activities conducted by CNR-ISPC have allowed a significant advancement in the framework of knowledge related to the Roman villa of Gradola (Figure 4).

Indeed, all the structural walls can reasonably be framed within a modular grid, based on a minimum interval of 3 Roman feet, exactly coinciding with the thickness of the *opus incertum* walls of the hemicycle or with the width of the cavities inside it. The geometric construction of the hemicycle itself also finds interesting correspondences within the same compositional scheme. In fact, the radius of the outermost circumference is 27 feet, while that of the inner circumference is 18 feet. The centre (P) of the angle determining the opening (E-F) and the inclination of the side walls of the central niche is perfectly inserted into the modular grid. Furthermore, the same geometric construction also determines the division into three rooms of the projecting structure (E-F = e-f). Finally, the width and position of the side niches (A-B = C-D) are determined by the intersection between the outer circumference and the same modular grid, with an interval of 9 feet (a-b = 9 feet = 3 modules), which recurs elsewhere as well (overall width of the semicircular wall of the hemicycle and width of room 13 in Figure 4).

Moreover, based on some known measurements, it is possible to attempt the reconstruction of the planimetric development of the still unexplored areas. For example, concerning the series of rooms behind the hemicycle, we know the exact dimensions of at least a couple of them (numbers 10 and 14 in Figure 4). These rooms have the same depth but a different width, which can sometimes be reasonably hypothesized. If, indeed, we assume that the dividing walls had the same thickness as those of the hemicycle (3 Roman feet), the space between rooms 7 and 10 could be filled with two additional rooms of identical dimensions (numbers 8 and 9), as the dividing walls would have a very similar thickness to the one assumed. Alternatively, a single room with an exactly square plan, with a side equal to 18 Roman feet (equal, therefore, to the smaller radius of the apse), could also be inserted.

Rooms 1 and 6, like their specular counterparts (numbers 5 and 11), are entirely hypothetical, but they could have had a width equal to that of the side rooms of the hemicycle (numbers 2 and 4). Furthermore, concerning the substructure rooms 12 and 13, currently inaccessible as they are still used as cisterns, considering the width of the room in *opus reticulatum* above room 13, the available space can be filled in various ways. As a hypothesis, it seems preferable to imagine a room 12 with a width similar to that of rooms 7 and 10 or slightly wider. Finally, regarding the rooms in the southernmost sector, directly founded on the bedrock, some traces remain only in correspondence with room 15, but it is preferable to suspend any attempt at reconstruction due to the scarcity of available data.

5.3. Villa of Damecuta

Perched on a commanding position overlooking the Gulf of Naples, the Villa of Damecuta occupies a vast limestone plateau (150 meters above sea level), facing the Punta dell'Arcera, possibly partially flattened artificially.

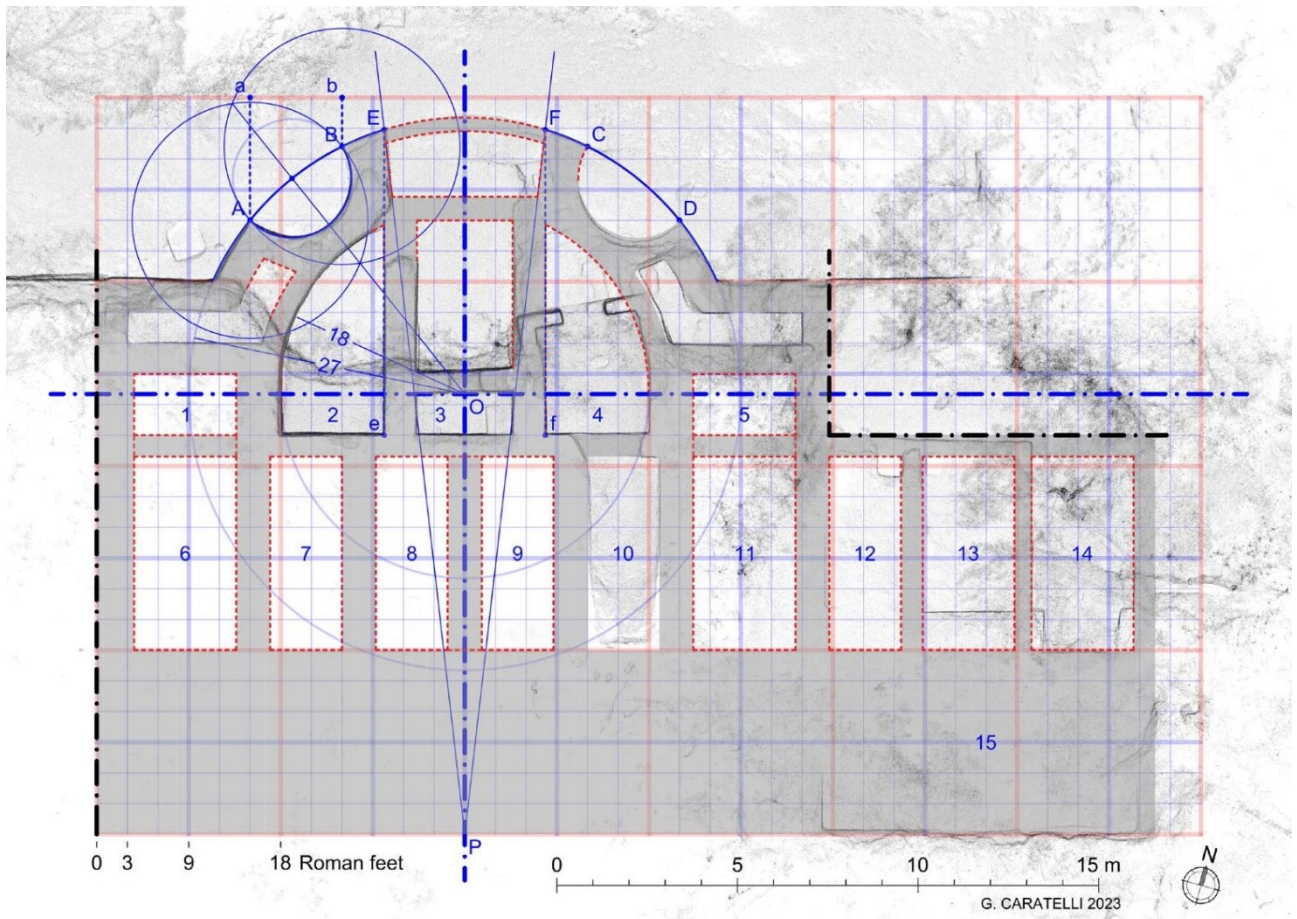


Figure 4. Villa of Gradola. Modular grid and planimetric reconstruction hypothesis.

The remains, extensively restored in recent times (and therefore, at times, poorly or challenging to read), pertain to an extensive substructure system. These remains, as is common in the case of maritime villas, are arranged in a festoon-like manner along the northern and western edges of the plateau. From a planimetric perspective (and consequently functional), at least three sectors can be distinguished. One of those is the western sector, featuring a large hemicycle (the so-called “rotonda del belvedere”) and a southern appendix of different orientation. The second one is the central sector, characterized by a long panoramic walkway (*ambulatio*) with an open portico facing the sea and *exedrae* on the opposite side. Finally, there is the eastern sector, unfortunately inaccessible for safety reasons, which stands out for a small cluster of rooms clinging to the edge of the promontory, interpreted by A. Maiuri as the residence quarter of Emperor Tiberius [3].

Skipping the latter sector due to the inaccessibility, and also the central one, which seems not to pose particular difficulties of interpretation, the western area, as previously mentioned, continues to raise doubts and uncertainties despite being of major interest (Figure 5).

It features an extensive and intricate substructure structures characterized by a forepart of semicircular shape on the northern side. The substructure function is performed to a wall made of *opus incertum* with limestone, often 90 cm thick (3 Roman feet), against which a dense series of small rectangular (along the straight sides) and trapezoidal (corresponding to the semicircular forepart) rooms are juxtaposed. The preservation state of these rooms, which sometimes still retain traces of the original

covering, is poor. However, in the sector with the hemicycle, some construction details can still be highlighted.

The dividing walls are constructed with a very coarse *opus incertum*, while the outer curved wall, where the entrance openings are located, has a facing of difficult classification (perhaps because it results from extensive restoration work). It is made with limestone *cubilia* arranged either randomly (*opus incertum*) or orderly (*opus reticulatum*, and in a small portion, even *opus vittatum*). The presence of hydraulic plaster in some of the rooms overlooking the western side, along with the front closure wall, suggests that at least some of them were intended for cisterns. The height of these rooms varies based on the terrain’s morphology and reveals the original intent to create architecture



Figure 5. Villa of Damecuta. New planimetry from laser scanner survey.

capable of adapting to the environmental context rather than imposing itself.

During the latest survey campaigns in 2022 and 2023, the western and central sectors of the villa were surveyed using laser scanning and photogrammetric technique, also using a Remotely Piloted Aircraft System. Like other sites and monuments in Capri, these sectors awaited verification and an updated planimetry since the 1940s [3]. The availability of this data finally allows for a new planimetric analysis of the monument (albeit limited to the sector with a hemicycle). The theme, following Frederick Rakob's report [18], has already been addressed on multiple occasions by Clemens Krause, who has spent years surveying and studying Villa Jovis [19], [20], a residential complex of secure imperial ownership characterized, like the villas of Damecuta and Gradola, by one of these rare hemicycles, recently defined as "hemicycle with a view" [21].

From a strictly metrological point of view, almost all the wall structures of the Villa of Damecuta can be framed within a modular grid, based on a minimum interval of 2 Roman feet, which also corresponds to the thickness of most walls (Figure 6). This circumstance implies that many of the rooms have dimensions (expressed in Roman feet, equivalent to 29.6 cm) divisible by the number 2. However, the observation of the presence of four concentric circles has led to an unexpected discovery. It appears that the western sector of the Damecuta Villa was designed based on the planimetric scheme suggested by Vitruvius in *De Architectura* for the sizing of the Latin theatre (see Vitruvius 5, 6, 1-6). Overlooking some inaccuracies due to the

lack of perfect symmetry (as well as the interpretative problems affecting the Vitruvian text, for which reference is made to [22]), and overlaying this geometric scheme on the villa's planimetry, numerous coincidences are noticeable, which can hardly be considered a result of chance. For example, most walls with a N-S orientation within circle B can be traced using the intersection points between the sides of the triangles inscribed within the same circle (see the sides passing through points 3-11, 4-10, 5-9). Additionally, starting from these points or using other easily identifiable ones, it is possible to determine the dimensions of many rooms. Moreover, it can be ascertained the orientation of entire sectors, such as the southern appendix of the western sector (see the line passing through the centre O and point 15) or the long ambulatory with a portico and *exedrae* on the eastern side (the direction is the one passing through points 7 and 13 or 7 and 14). Finally, even if the larger circle (D) were used as a starting point for tracing the Vitruvian scheme, the coincidences between the scheme and the walls would remain extremely convincing in any case.

6. CONCLUSIONS

In conclusion, employing a methodological strategy reliant on accurate measurements and a thoroughly surveyed planimetric base, achievable solely through instrumental surveying, provides an avenue for investigating and, at times, comprehending archaeological remnants with a considerable degree of certainty. If we add careful observation of the walls and its construction

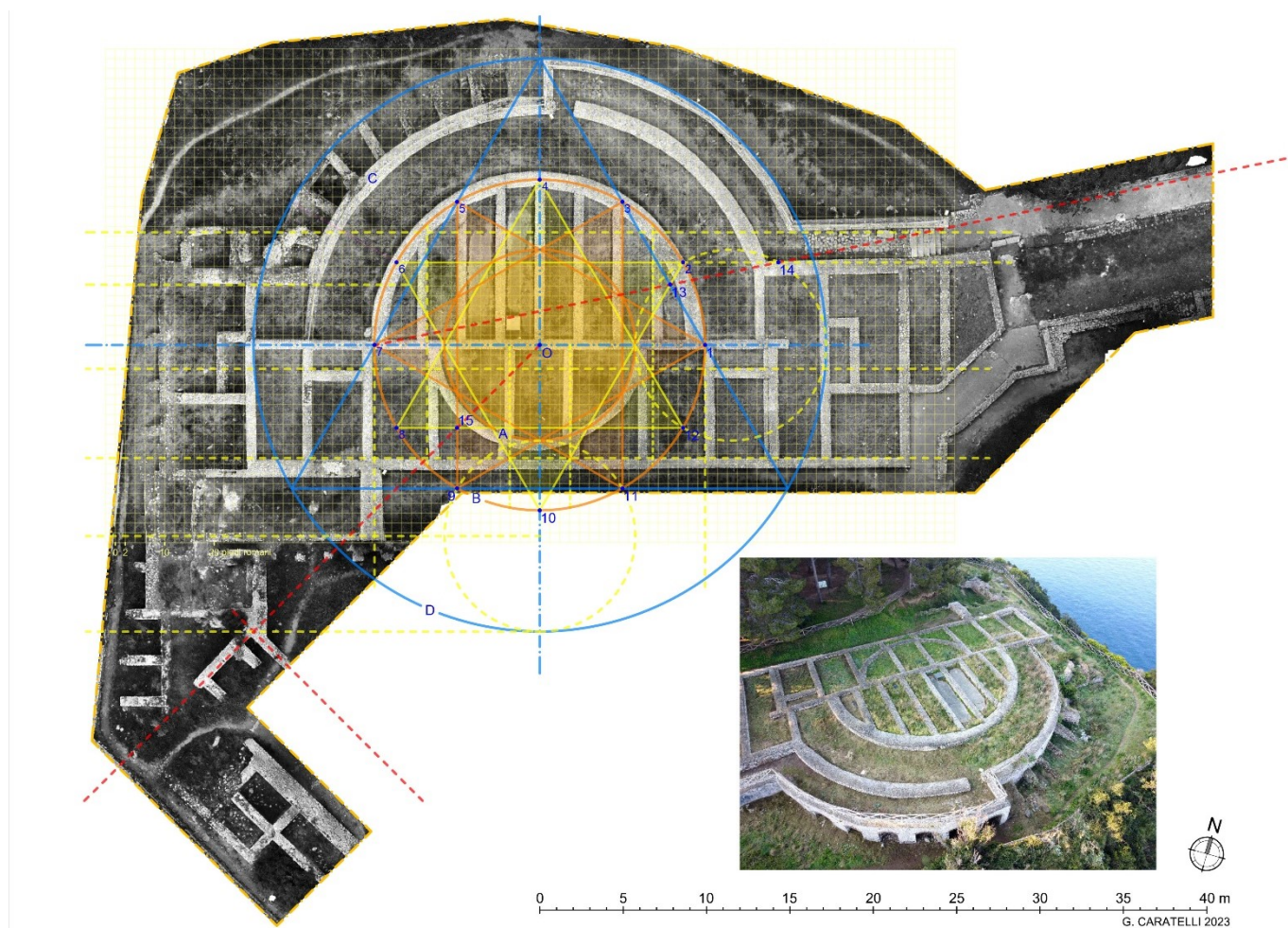


Figure 6. Villa of Damecuta. Planimetry from photogrammetric survey and comparison with the Vitruvian scheme for the Latin theatre designing.

techniques to this, we can define historical phases and the function of the spaces. In this context, the examination of three archaeological sites in Capri has provided illuminating exemplars.

For instance, the Grotta dell'Arsenale appears to have been designed with a tripartite division of available space, as indicated by the 120-degree angle between the rear chamber and the small southeastern room. On the other hand, despite the restricted visibility of its remnants, concealed by the abundant island vegetation, the Villa of Gradola has unveiled a meticulously designed layout founded on traditional principles of axiality and symmetry. This revelation allows for conjectures concerning the arrangement of presently inaccessible areas. Furthermore, doubts surrounding the existence of a hemicycle on the front side of the villa, occasionally contested but stemming from an overly cautious approach [15], have been dispelled. This semicircular feature, perhaps the most distinctive aspect of the entire architectural complex, has recently been identified as a "hemicycle with a view" in analogous contexts [21]. The Villa of Gradola can now be added to the limited list of residences (mostly assumed to be imperial property) characterized by the presence of a hemicycle [23], although ongoing discussions persist regarding whether it served as a covered or open space and, consequently, its precise function.

Lastly, with regard to the Villa of Damecuta, which awaits a comprehensive survey and in-depth analysis of its remnants, the initial outcomes stemming from a renewed metrological approach, incorporating systematic and extensive laser scanning, are notably promising. The potential application of Vitruvius's suggested scheme for sizing the Latin theater to the visible remains may introduce fresh perspectives for interpreting a site that, given current limited knowledge and challenges posed by mediocre preservation or significant alterations from modern restorations, remains enigmatic and challenging to comprehend.

Regarding the construction of Geographic Information System (GIS), initially, the creation of a local GIS was undertaken using the open-source software QGIS, which allowed for the generation of a series of basic cartographic layers (by connecting to the WMS and WFS of local authorities and web mapping resources available online), the inclusion of areas subject to archaeological restraints and the geometries of sites surveyed so far, and the linking of alphanumeric data set managed in tabular form. A phase is now starting concerning the management and usability of the data, and WebGIS seems the best solution, also considering some applications that could be useful for field activities. The geo-database with its corresponding DBMS (Database Management System) being developed includes historical-archaeological observations of walls, information and images from the examination of historical and current archives, connections to archaeological finds discovered on the island but stored elsewhere, aerial photographs, historical and recent, and 3D models created. Since WebGIS is capable of storing and managing data of different natures, it will be possible to query the database and display the data on a map (the so-called data viewing), select values and compare them, exploiting the advantages offered by graphical visualization, conduct spatial analyses, and create thematic maps, from which it will be easier to grasp, analyze, and resolve critical situations related to the historical and regulatory evaluation of assets. The potential of the designed system is not limited only to graphical visualization and the countless maps that can be constructed but also concerns reporting and graphs generated from alphanumeric information entered into the database (consider, for example, the various types of cataloguing sheets or graphs dynamically linked to the

map to represent complex tabular information). From the processing and analysis of data set will arise the interpretation of archaeological contexts, thanks to the creation of a conceptually designed model to provide the expected responses from the implementation of the system itself.

ACKNOWLEDGEMENT

The research was realised in the frame of the project "Masgaba" with the contribution of the Municipalities of Capri and Anacapri, the scientific direction of the Soprintendenza Archeologia, Belle Arti e Paesaggio per l'Area Metropolitana di Napoli and the collaboration of the Cultural Association Apragopolis.

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