Original Study

Francesco Belfiori, Stefano Floris*, Melania Marano

"Sacra Tharrhica Project": Preliminary Results of 3D Virtual Reconstruction of the Punic-Roman Sacred Areas of Tharros, Sardinia

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Abstract: The "Sacra Tharrhica Project" was started by the University of Bologna in cooperation with the University of Cagliari in 2017. The aim is to obtain a 3D virtual reconstruction of all temple structures of the Punic settlement of Tharros on the central west coast of Sardinia, starting from a systematic architectural and archaeological study of the Punic and Roman phases of the buildings. The project has firstly focused on the "Monumental Temple" or "Doric half-columns Temple". This Punic sacred area was probably monumentalized between the late 4th and 3rd centuries B.C. After the Roman conquest, it was rebuilt between the 1st century B.C. and the 1st century A.D.

Keywords: Tharros; Punic-Roman temples; "Monumental Temple"; laser scanner; 3D reconstruction

1 Introduction

The Punic-Roman site of Tharros[1] is located on the central west coast of Sardinia (Fig. 1 a), between San Giovanni hill, Su Murru Mannu hill, and the Oristano Gulf coastline (Fig. 1 b). The site was systematically excavated between 1956 and 1964 by the Archaeological Superintendent of Sardinia, Gennaro Pesce (Pesce, 1966). Subsequently, annual archaeological campaigns were conducted in the area of Su Murru Mannu hill by the *Alma Mater Studiorum* – University of Bologna, CNR (Centro di Studio per la Civiltà fenicia e punica) and the Archaeological Superintendence of Cagliari and Oristano until 1998 (Bultrini et al., 2000)[2]. In addition, in recent years the archaeological fieldwork resumed in the northern necropolis by University of Cagliari (Del Vais, 2017 and previous bibliography) and in the southern necropolis by the *Alma Mater Studiorum* – University of Bologna (Fariselli, 2013; Secci, 2014–2015; Fariselli, Silani, & Vandini, 2017; Fariselli, 2018), and this is still ongoing. In particular, the sacred areas of the site were discovered since 1958 (Barreca, 1958; Pesce, 1961, 1966; Marano, 2014; Floris, 2014–2015, 2016; Marano, in press) and study of

1 About the archaeological area, see Del Vais (2015), Fariselli (2018).
2 See also Fariselli (2015) and previous bibliography.

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***Corresponding author: Stefano Floris,** Department of Humanities, Ca' Foscari University of Venice, Dorsoduro 3484/D, Calle Contarini, Venezia, 30123, Italy, E-mail: stefano.floris@unive.it
Francesco Belfiori, Department of Cultural Heritage, University of Bologna, Ravenna, Italy
Melania Marano, Laboratory of Punic Archaeology – Public Archaeology, Department of Cultural Heritage, University of Bologna, Ravenna, Italy

them has continued until now through analysis of the historic documents and through new archaeological fieldwork activities[3] (Acquaro, 1983, 1991; Floris, 2014–2015; Fariselli, Boschi, & Silani, 2016; Floris, 2016).

Figure 1. The position of Tharros on Sardinia's satellite picture (a) (from Google Earth Pro, modified) and an aerial view of the ancient site (b).

Because of the reuse of Punic buildings in Roman period and Late Antiquity and the considerable dismantling after the abandonment of the city about 1000 A.D., it has been difficult to achieve complete knowledge of these structures so far. For this reason, the "Sacra Tharrhica Project" was started in 2017 by the Departments of Cultural Heritage-DBC and History and Cultures-DiSCi of the *Alma Mater Studiorum* – University of Bologna (Coordinators: A. C. Fariselli, E. Giorgi, R. Secci, M. Silani) in cooperation with University of Cagliari (Coordinator C. Del Vais). The aim of the project is to obtain a 3D virtual reconstruction of all temple structures of Tharros[4], for supporting a new systematic architectural and archaeological study of each phase. Achieving an exhaustive architectural re-reading of the Punic phase is one of the aims of the "Sacra Tharrhica Project" and a review of the data in the light of the new methodologies available is in progress.

The project has firstly focused on the sacred area known as "Monumental Temple" or "Doric half-columns Temple" (Figs. 2–3), located in the central area of the site. The sacred building is located South of the *decumanus maximus*, North of "Court Temple of Semitic type", West of the street leading from Bath n. 1 to Bath n. 2 and East of areas nn. 39–53 (Fig. 2). The area under consideration was probably enclosed by a street along the southern side, where part of a sewer is preserved; the western side, instead, shows some walls and two cisterns, so that a street was probably only in the South-West corner, allowing movement into the southern part of the adjacent sector (Marano, 2018, in press).

3 About the Roman sacred areas in Sardinia, see Tomei (2008).

4 The sacred areas involved in the project are "Monumental Temple" or "Doric half-columns Temple" and "Court Temple of Semitic type" in the central quarter, "Temple K" in western sector and "Temple of Demetra" located on Su Murru Mannu hill.

Figure 2. Aerial view of the central area of Tharros, where the "Monumental Temple" is located (in red in the picture) (from Google Earth Pro, modified).

Figure 3. View of the "Monumental Temple", from North-West.

1.1 The "Monumental Temple" from Punic to Roman Era: A Diachronic Overview

According to traditional reconstructions, the "Monumental Temple" underwent three building phases (Pesce, 1961; Acquaro, 1991; most recently Floris, 2014–2015). In its first phase, dating from the beginning of the Middle Punic Age (480–300 B.C.)[5], the core of the sacred area was a natural rocky spur encircled by a *temenos* of large squared stones. The upper surface of the rocky core was carved by an uneven series of funnel-shaped holes interpreted as *cupulae* for receiving ritual or votive offerings (Pesce, 1961, pp. 340–343). In the second phase, dated in the 4th–3rd centuries B.C., the rocky core was carved into a platform with an access ramp and decorated with shafts of a Doric pseudo-portico crowned by an Egyptian gorge cornice on the three sides (Pesce, 1961, pp. 343–402; Acquaro, 1991). The platform was the support for an Egyptian style *aedicula* according to Gennaro Pesce (Pesce, 1961, pp. 390–395, grafico XIII) (Fig. 4 a) or an altar according to Enrico Acquaro (Acquaro, 1991, p. 549, fig. 8)[6] (Fig. 4 b).

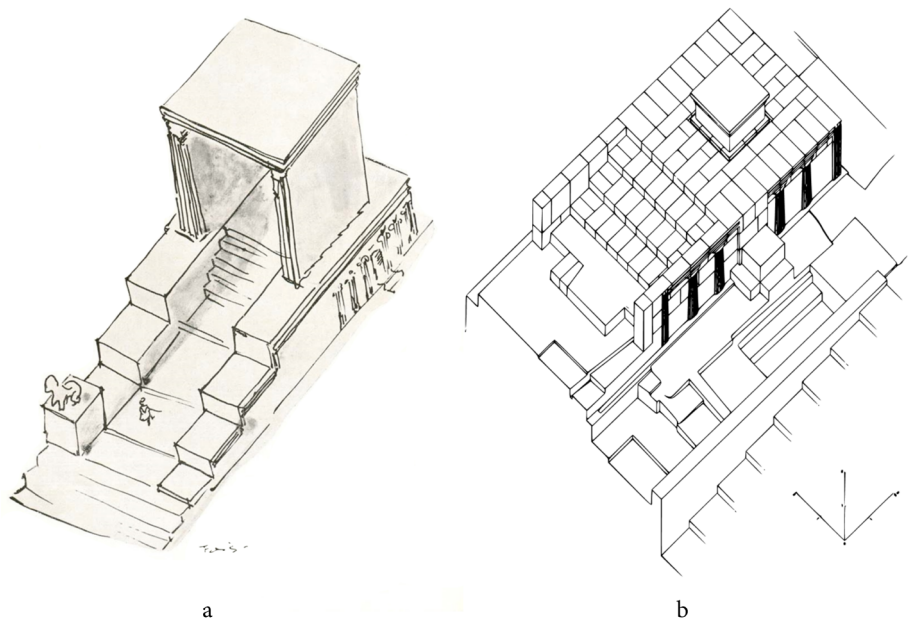

Figure 4. The Punic phase of the "Monumental Temple" according to G. Pesce (1961) (a) and E. Acquaro (1991) (b).

Between the 1st century B.C. and the 1st century A.D., the previous Punic temple was dismantled and its architectural elements were reused in the foundations of the new Roman temple (Fig. 5 a). According to Pesce, the area was organized like a sacred "labyrinth" with an altar in the middle and a small prostyle temple built on the quadrilateral structure erected at the base of the Punic temple ramp (Pesce, 1961, pp. 402–419)[7].

Based on the review of both Pesce's edited and unpublished archive data, a new hypothesis of reconstruction of the structural restoration of the temple known from the Roman period has recently been proposed (Floris, 2014–2015). According to this reading, a new structure erected in the Roman Era followed the limits of the previous Punic Temple. A Doric capital and two large Egyptian gorges found inside the Roman cistern testify that the new building retained its hybrid architectural style, as shown in

5 See Maraoui Telmini, et al. (2014, pp. 116–117, table 7.1).

6 See also Fariselli (2018, p. 115). For the possibility that the well-known inscription from Tharros celebrating some architectural interventions in the temple of Melqart in *Qrtḥdšt* – probably the same Tharros – may refer to the second building phase of the "Monumental Temple" see most recently Fariselli (2018, pp. 110–118), with updated bibliography.

7 A more recent hypothesis proposed by Dolores Tomei accepted Pesce's idea that a small prostyle temple was erected on the quadrilateral structure but proposed that the area was arranged as an "artificial wood", proposing to identify the third phase building with the *templum* dedicated by the *disp(ensator)* of *Fundan(ia) Galla*, whose construction and inauguration are mentioned in an epigraph from Tharros (Tomei, 2008, p. 126).

the hypothesized graphic restitution proposed in the mentioned study (Floris, 2014–2015, pp. 51–61, fig. 21–25) (Fig. 5 b–d).

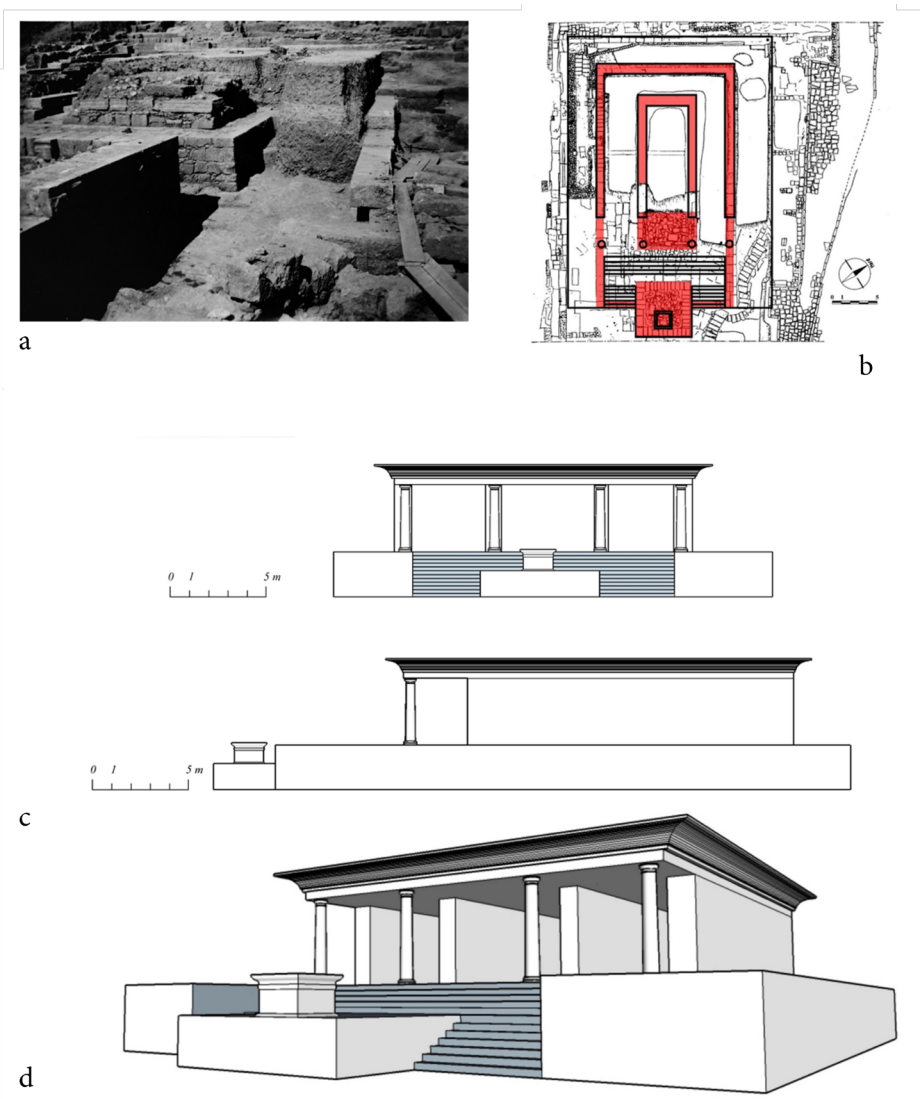

Figure 5. The Roman phase of the "Monumental Temple", view of the foundations (a), and virtual reconstruction according to S. Floris (2014–2015) (b–d).

2 Methods

The preliminary phase of the fieldwork concerned the planning of a new framework of topographical vertices around the areas of the main temples of Tharros, for obtaining the absolute geographic positioning of all new surveying activities. This operation was carried on through differential GPS and total station (Boschi & Silani, 2014, pp. 43–45).

In a second stage, the "Monumental Temple" complex (Temple Ramp, Platform, Quadrilateral Building, the *bagnarola* Cistern and all the space delimitated by the *temenos*) was detected for the first time with laser scanning technology.

The application of laser scanning within a topographical survey allows the measurement of millions of points in an all-around view across space and the generation of a point cloud of surveyed objects (Remondino & Campana, 2014; Giorgi, 2009, pp. 253–256; Silani, 2017, pp. 29–36). In the field, several scans are collected from different points to cover the whole planimetric and architectural development of the structures.

In the "Monumental Temple" topographical survey, the complete coverage of monument surfaces was guaranteed by the acquisition of 73 scans with a Faro 3D Cam2 Laser Scanner (with a scan detail equal to 6 mm to 10 meters) equipped with a high-resolution ISTAR Fusion HDR spherical camera. Faro 3D Cam2 is a shift-phase based Laser Scanner that allows the recording of data with high detail, so it is particularly suitable for measurement of objects and surfaces at close range distances and for architectural survey. On the other hand, this laser is characterized by a lower range of acquisition if compared to other instruments, such as time-of-flight type laser scanners.

Subsequently, the raw data collected in the field were processed with dedicated software (ReCap by AutoDesk) and different scans were recorded and joined through a specific workflow: a first phase of pre-alignment consists in the identification of targets or homologous points between pairs of scans or pairs of groups of scans (*cloud to cloud alignment*); in a second phase, the software, through application of *ICP* algorithm (*Iterative Closest Point*), compares the scans, reduces the differences between homologous points and creates constraints between single scans (Silani, 2017, pp. 29–36). The texturing of the points took place through the internal camera of the laser scanner or in association with the NcTech ISTAR spherical camera to obtain a better colour balance of the photographic sockets. By *recording* all scans previously processed, at the end of this post-processing workflow, a single cumulative, texturized and georeferenced point cloud of the whole "Monumental Temple" of Tharros was created.

3 Results and Discussion

Topographic mapping instruments and very high precision lasers are ensuring a detailed record with different levels of analysis (Fariselli, Boschi, Silani, & Marano, 2017, pp. 322–324). The topographical survey of the temple through the application of laser scanning technology enables an updated 2D documentation (plans – sections and cross-sectional views). In fact, the final point cloud (Fig. 6) represents the base product for extrapolating plans, sections and perspective drawings of the buildings, produced with *Computer Aided Design* software (CAD) through the elaboration of horizontal or vertical *slices* of the cloud.

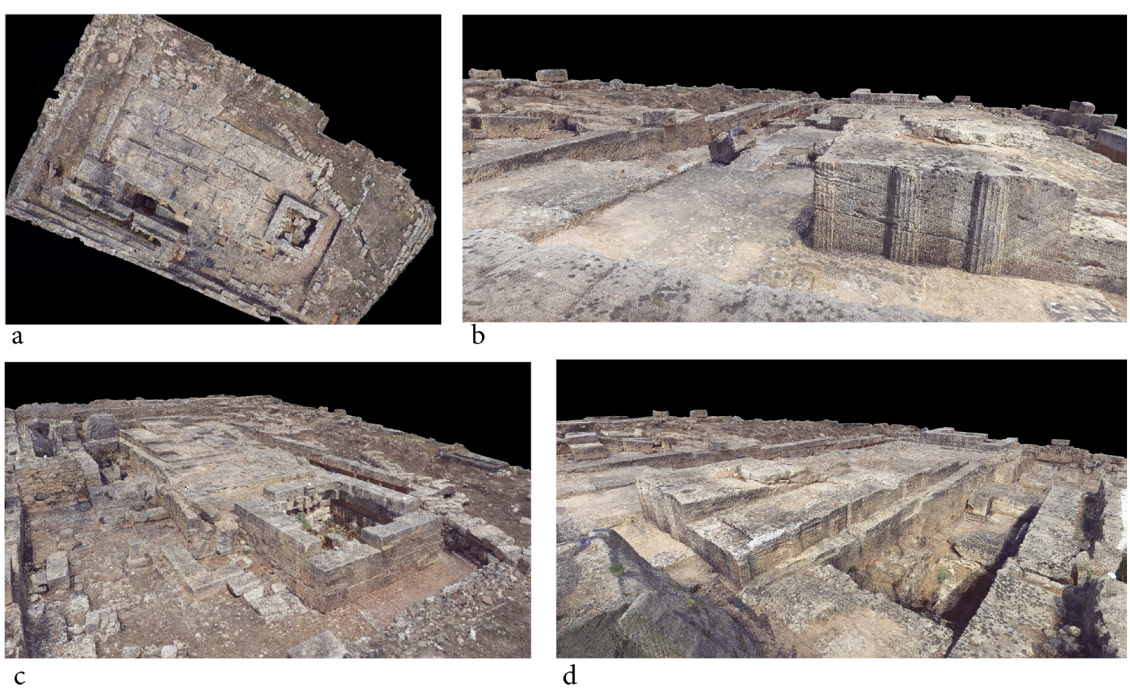

Figure 6. Four different point cloud views of the "Monumental Temple" (data processing by F. Belfiori, S. Floris, M. Marano).

First results of this phase of work on the Tharros "Monumental Temple" or "Doric half-columns Temple" comprise updated plans of the structures (Fig. 7) and new perspective drawings of the whole sacred area (Fig. 8), according range of precision and accuracy – thanks to the use of Faro 3D Cam2 Laser Scanner – never previously achieved in the topographical documentation of monumental buildings of Tharros.

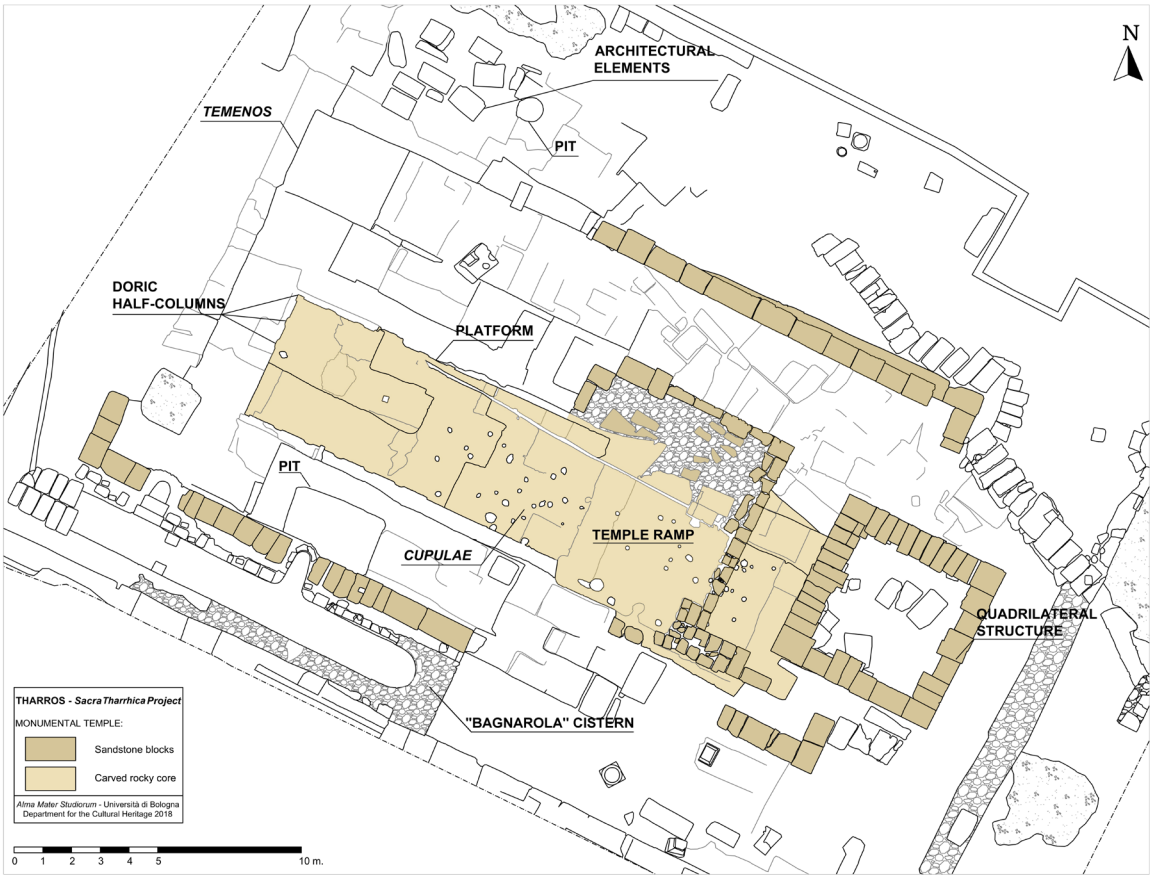

Figure 7. New plan of the "Monumental Temple" (drawing by F. Belfiori, S. Floris, M. Marano).

Considering the lack of similar archaeological and topographical documentation for the Tharros sacred spaces and sites, this methodological approach – applied for the first time to the "Monumental Temple" – is able to support the analysis of the wall stratigraphies and to achieve complete knowledge of the monument: its original planning, its different building phases and its monumental development between the Punic and Late-Roman periods as well as the ritual use of the spaces.

Meanwhile, in 2018 we worked in the temple beside the "Doric half-columns Temple", the so-called "Court Temple of Semitic type" using the same methodological approach. In 2019 the "Sacra Tharrhica Project" will carry on with the topographical survey of two more sacred areas, "Temple K" and the so-called "Demeter Temple", but using a time-of-flight laser scanner, in order to acquire wider range measurements, useful for the survey and for the reconstruction of the urban and environmental context of the temples, but also to compare different technologies and approaches to the field-work.

The topographical survey of the temples by the application of laser scanning technology will also enable the creation of 3D models. The "Monumental Temple's" point cloud will be processed in order to obtain 3D models of the buildings: each point will be interpolated to create surfaces (*mesh*) and volumes that will be texturized with spherical images collected during the survey on the field, using laser integrated camera or external High Definition cameras, made coaxial to the laser scanner instrumental centre. Apart from historical and archaeological study, the resulting model aims to be useful for the conservation and modern

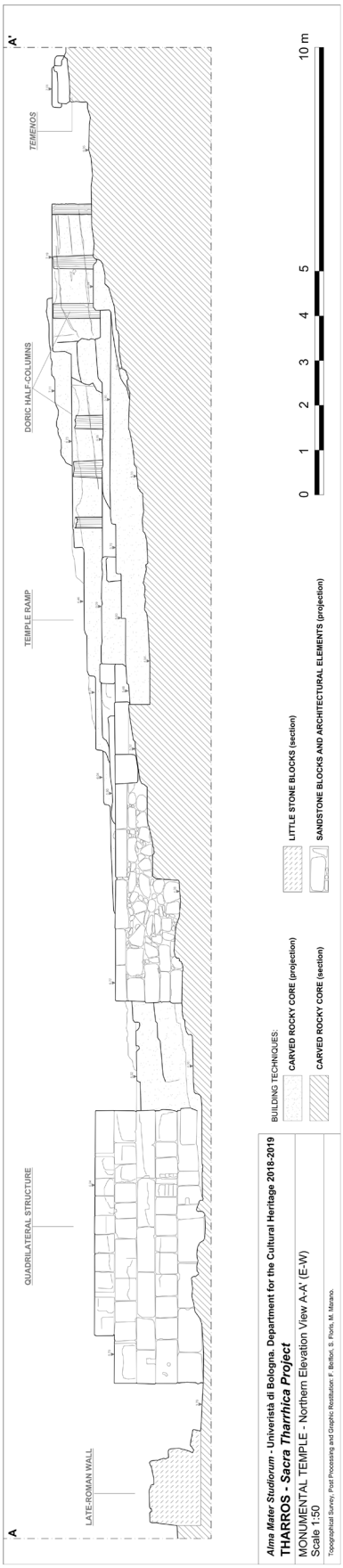

Figure 8. Elevation of the North-East façade of the "Monumental Temple" (drawing by F. Belfiori, S. Floris, M. Marano).

management of the archaeological area, giving a basis for the analysis of the archaeological monument's structural aspect and its health in order to facilitate restoration and securing projects, as well as to foster the public fruition of the whole archaeological area of Tharros.

Authors' Contributions: Francesco Belfiori contributed to sections 2 and 3. Stefano Floris contributed to sections 1.1 and 3. Melania Marano contributed to sections 1 and 3.

References

Acquaro, E. (1983). Nuove ricerche a Tharros. In *Atti del I Congresso Internazionale di Studi Fenici e Punici (Roma, 5-10 novembre 1979)*. Collezione di Studi Fenici, 16 (Vol. 3, pp. 623–631). Roma: Consiglio Nazionale delle Ricerche.

Acquaro, E. (1991). Tharros tra Fenicia e Cartagine. In *Atti del II Congresso Internazionale di Studi Fenici e Punici (Roma, 9-14 novembre 1987)*. Collezione di Studi Fenici, 30 (Vol. 2, pp. 547–558). Roma: Consiglio Nazionale delle Ricerche.

Barreca, F. (1958). THARROS (S. Giovanni di Sinis, Cagliari) – Scoperte a Capo S. Marco. *Notizie degli Scavi*, 8, 12, 409–412.

Boschi, F. & Silani, M. (2014). La necropoli fenicia e punica di Tharros – Capo San Marco: nuove ricerche per la ricostruzione di un paesaggio funerario in 3D. In A. C. Fariselli (Ed.), *Da Tharros a Bitia. Nuove prospettive della ricerca archeologica nella Sardegna fenicia e punica. Atti della Giornata di Studio Bologna 25 marzo 2013*. DiSCi Archeologia, 3 (pp. 33–51). Bologna: Bononia University Press.

Bultrini, G., Campisi, L., Chiozzini, G., Cotza, E., De Caro, T., Del Vais, C., Francisi, M. T., Galeffi, C., Gaudina, E., Ingo, G. M., Manfredi, L. I. & Secci, R. (2000). Tharros XXV. *Rivista di Studi Fenici*, 28, 129–215.

Del Vais, C. (2015). Tharros. Storia di Tharros. In C. Del Vais & S. Sebis (Eds.), *Il Museo Civico "Giovanni Marongiu" di Cabras* (= *Sardegna archeologica. Guida e itinerari*, 59) (pp. 39–44). Sassari: Carlo Delfino editore.

Del Vais, C. (2017). Nuove ricerche nella necropoli settentrionale di Tharros (Cabras-OR): gli scavi nell'Area A (2009-2011, 2013). In M. Guirguis (Ed.), *From the Mediterranean to the Atlantic: people, goods and ideas between East and West, 8th International Congress of Phoenician and Punic Studies, Italy, Sardinia, Carbonia, Sant'Antioco 21th-26th October 2013*. Folia Phoenicia. An International Journal, 1 (Vol. 1, pp. 314–320). Pisa-Roma: Fabrizio Serra editore.

Fariselli, A. C. (2013). Nuove ricerche nella necropoli settentrionale di Tharros (campagne 2010-2011): l'Area B. *ArcheoArte. Rivista elettronica di Archeologia e Arte*, 2, 335–336.

Fariselli, A. C. (2015). Il *tofet* o "santuario dei fanciulli". In C. Del Vais & S. Sebis (Eds.), *Il Museo Civico "Giovanni Marongiu" di Cabras* (= *Sardegna archeologica. Guida e itinerari*, 59) (pp. 44–48). Sassari: Carlo Delfino editore.

Fariselli, A. C. (2018). Alla ricerca della "Cartagine di Sardegna": considerazioni storico-archeologiche attraverso i nuovi scavi. In A. C. Fariselli & R. Secci (Eds.), *Cartagine fuori da Cartagine: mobilità nordafricana nel Mediterraneo centro-occidentale fra VIII e II sec. a.C. Atti del Congresso Internazionale (Ravenna, 30 Novembre – 1 Dicembre 2017)*. Byrsa. Scritti sull'antico Oriente mediterraneo, 33–34 (pp. 109–132). Lugano: Agorà & Co.

Fariselli, A. C., Boschi F., & Silani, M. (2016). Santuari costieri e strutture di segnalazione nel Mediterraneo fenicio e punico: nuove indagini geofisiche sul Capo San Marco (penisola del Sinis – Or). In A. Russo Tagliente & F. Guarneri (Eds.), *Santuari mediterranei tra Oriente e Occidente. Interazioni e contatti culturali, Atti del Convegno Internazionale, Civitavecchia – Roma 2014* (pp. 367–371). Roma: Scienze e Lettere.

Fariselli, A. C., Boschi, F., Silani, M., & Marano, M. (2017). Tharros – Capo San Marco in the Phoenician and Punic Age. Geophysical investigations and virtual rebuilding. In S. Garagnani & A. Gaucci (Eds.), *Knowledge, analysis and innovative methods for the study and the dissemination of ancient urban areas. Kainua 2017. Proceedings of the KAINUA 2017 International Conference in Honour of Professor Giuseppe Sassatelli's 70 Birthday (Bologna, 18-21 April 2017)*. Archeologia e Calcolatori, 28.2 (pp. 321–331), Firenze: All'Insegna del Giglio.

Fariselli, A. C., Silani, M., & Vandini, M. (2017). Ricerche a Capo San Marco (penisola del Sinis-OR). Nuove indagini dell'Università di Bologna nel quartiere funerario meridionale di Tharros fenicia e punica. In M. Guirguis (Ed.), *From the Mediterranean to the Atlantic: people, goods and ideas between East and West, 8th International Congress of Phoenician and Punic Studies, Italy, Sardinia, Carbonia, Sant'Antioco 21th-26th October 2013*. Folia Phoenicia. An International Journal, 1 (Vol. 1, pp. 308–313). Pisa-Roma: Fabrizio Serra editore.

Floris, S. (2014–2015). Architettura templare a Tharros – I. Il Tempio monumentale o Tempio delle semicolonne doriche fra tarda punicità e romanizzazione. *Byrsa. Scritti sull'antico Oriente mediterraneo*, 25–26/2014, 27–28/2015, 39–79.

Floris, S. (2016). Architettura templare a Tharros – II. Il "Tempio a pianta di tipo semitico" e il "Tempio di Demetra". *Ocnus. Quaderni della Scuola di Specializzazione in Beni Archeologici*, 24, 47–64.

Giorgi, E. (2009). *Groma 2. In profondità senza scavare. Metodologie di indagine non invasiva e diagnostica per l'archeologia*, Bologna: BraDypUS Communicating Cultural Heritage.

Marano, M. (2014). L'abitato punico-romano di Tharros (Cabras-OR): i dati di archivio. In A. C. Fariselli (Ed.), *Da Tharros a Bitia. Nuove prospettive della ricerca archeologica nella Sardegna fenicia e punica. Atti della Giornata di Studio Bologna 25 marzo 2013*. DiSCi Archeologia, 3 (pp. 75–94). Bologna: Bononia University Press.

Marano, M. (2018). Urbanistica cartaginese a Tharros? Il sistema viario e i quartieri residenziali tra età punica e romana. In A. C. Fariselli & R. Secci (Eds.), *Cartagine fuori da Cartagine: mobilità nordafricana nel Mediterraneo centro-occidentale fra VIII e II sec. a.C. Atti del Congresso Internazionale (Ravenna, 30 Novembre – 1 Dicembre 2017)*. Byrsa. Scritti sull'antico Oriente mediterraneo, 33–34 (pp. 195–221). Lugano: Agorà & Co.

Marano, M. (in press). *I quartieri abitativi punico-romani di Tharros. Indagine architettonica e urbanistica*. Scritti sull'antico Oriente mediterraneo, 1. Lugano: Agorà & Co.

Maraoui Telmini, B., Docter, R., Bechtold, B., Chelbi, F., & Van de Put, W. (2014). Defining Punic Carthage. In J.C. Quinn & N.C. Vella (Eds.), *The Punic Mediterranean: identities and identification from Phoenician settlement to Roman rules* (pp. 111–145*)*. Cambridge: Cambridge University Press.

Pesce, G. (1961). Il tempio punico monumentale di Tharros. *Monumenti antichi dell'Accademia Nazionale dei Lincei*, 45, 333–440.

Pesce, G. (1966). *Tharros*. Cagliari: Editrice Sarda F.lli Fossataro.

Remondino, F. & Campana, S. (2014). *3D Recording and Modelling in Archaeology and Cultural Heritage: Theory and best practices*, Oxford: BAR International Series.

Secci, R. (2014–2015). Nuovi tipi tombali nella necropoli meridionale di Tharros (campagna di scavo 2015). *Byrsa. Scritti sull'antico Oriente mediterraneo*, 25–26/2014, 27–28/2015, 185–202.

Silani, M. (2017). I prodotti del nostro lavoro. In Sassatelli G. & Giorgi E. (Eds.), *Pompei Intra-Extra. Archeologi dell'Università di Bologna a Pompei. Archaeologists from the University of Bologna at Pompeii* (pp. 29–36), Bologna: BUP – Bononia University Press.

Tomei, D. (2008). *Gli edifici sacri della Sardegna romana: problemi di lettura e di interpretazione*. Studi di Storia Antica e di Archeologia, 5. Ortacesus: Nuove Grafiche Puddu.