Lighting a Funerary Interior. The Roman Tomb N83 at Cyrene in a 3D Perspective

Anna Santucci – Paola Lassandro – Marina Zonno

Abstract

The lighting in a funerary space assumes different values and functions. At Cyrene, the Roman rock-cut tomb N83 offers a controlled case study to analyse the quantity and quality of the lighting performance in a 3D perspective. Starting from the archaeological and historical reconstruction of the recently published context, the 3D model will simulate the interior lighting of the tomb using virtual prototypes of ancient clay oil lamps. The 3D models contribute also to developing interpretive virtual models for valorising and promoting the cultural heritage.

Lighting a Funerary Chamber: Demetria Tomb/N83 at Cyrene as Case Study

Archaeological research concerning natural and artificial lighting systems in ancient Greek and Roman architecture has mainly investigated domestic spaces. This has produced important information on the functional uses of rooms connected with indoor human activities during the day- and/or night time.[1] Conversely, the utilitarian role of light in funerary spaces has received less attention until now,[2] especially when compared with the studies on the symbolic and ritual meanings of light in pagan and Christian tombs.

Although domestic and funerary spaces shared substantially the same lighting devices and systems, we may expect different concepts of artificial (and natural) light. In the house, artificial light was mostly used during the night, accompanying the different activities of their inhabitants from sunset to sunrise. On the contrary, in tombs it accompanied activities and practices performed essentially during the daytime, serving for both utilitarian and ritual purposes.

Archaeological finds regarding artificial lighting in the tombs are scarce. Some evidence for bronze lanterns come from Roman hypogea in Tripolitania, namely at Leptis Magna, Oea and Gigthis. Furthermore, the Flavi's hypogeum at Gasr Gelda gives us an idea of their placement: hanging from the vaulted ceiling of the chamber on which the burials opened.[3]

The sight of the real lighting devices – torches, candelabra, chandeliers, lamps, lanterns – combined with the painted or sculpted ones would have created an illusionary scenario to the visitors of the tomb chambers. For example, in Tomb C of the Vicolo dei Cristallini at Naples, the lower chamber had two fine candelabra painted on both sides of the entrance, while a bronze double-nozzle lamp was hanging from the ceiling.[4]

Published in: Maria Elisa Micheli – Anna Santucci (Eds.), Luce in contesto. Rappresentazioni, produzioni e usi della luce nello spazio antico / Light in Context. Representation, Production and Use of Light in Ancient Spaces, Panel 3.17, Archaeology and Economy in the Ancient World 19 (Heidelberg, Propylaeum 2021) 115–127. DOI: *https://doi.org/10.11588/propylaeum.638.c10483*

Fig. 1: Libya, Shahat. The area of the Tomb N83 in the Northern Necropolis of ancient Cyrene.

The arrangement of the artificial lights in this space depends on their own forms. It is then possible to imagine lighting sources hanging from ceilings, placed into niches or shelves on the walls, displayed on the floor or on benches, or placed on tables and other kind of supports. Any type of arrangement was also thought to allow for the easy management of the lamps, to top up the fuel in a reservoir or to turn them on/off.

It is uncertain how long the lighting devices[5] could be left on, considering the risks of burning and damages potentially connected with an unattended flame, although it was weak. The artificial lights were probably used only during the visit to the tomb.

Tomb N83 at Cyrene (Shahat, Libya) offers an interesting case study for contextualizing the discussion on the above-mentioned questions.[6] The tomb was cut into the northern slope of Gebel Akdar (fig. 1), and has numerous architectural phases from the Hellenistic to the Late Antique period. Until the present day it also has suffered reuse phases and was completely robbed and manipulated, as usually happens elsewhere in the ancient necropolis of Cyrene. The monument is also known as Demetria's Tomb because of a late antique inscription painted on the wall to the left of the entrance. It mentions

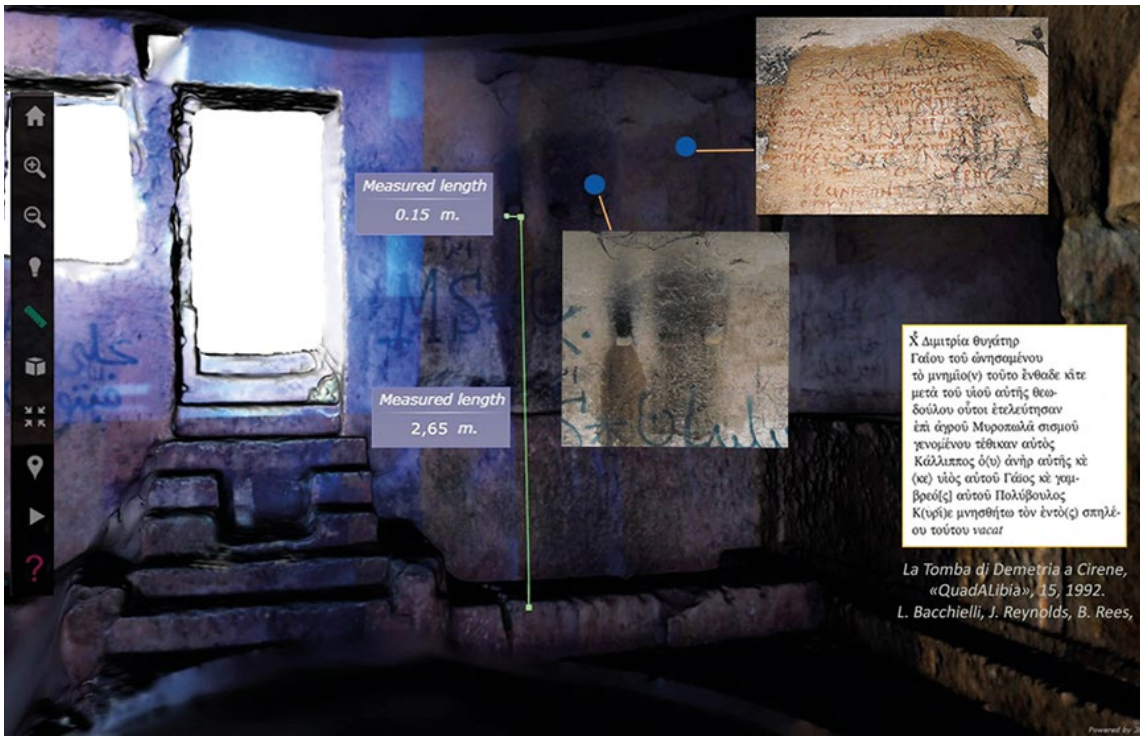

Fig. 2: Interactive Web 3Dmodel through the 3DHOP viewer with a hotspot linked to information about the tomb and the wall painting.

Demetria and her son Theodulos, both deceased during an earthquake that probably happened in 365 AD[7] (fig. 2).

The tomb has at least three principal phases between the middle and the late Roman period, the most important of which dates to the late 2nd–early 3rd century AD. In this period, a funerary chamber with arcosolium burials was realized; after a few decades, the burial to the right of the nearby entrance received the first and more interesting wall painting decoration. It represents a floral garden peopled by Erotes, birds and garlands, as well as a carpet-style motif and semi-circular garlands. Later, probably during the 4th century AD (not necessarily in the same period of Demetria and Theodulos), a new painting with unidentified motifs was applied on the lower front of this burial and covered the semi-circular garlands. Today it is in a very degraded state. The other walls and the ceiling of the chamber seem to never have been plastered, considering that the Demetria inscription and those on the rear wall of the tomb were painted and engraved directly onto the natural rock-walls.

Despite its poor archaeological condition, the rock-cut tomb allows for the analysis of some components of its indoor lighting. The funerary chamber received natural light from the entrance door and the nearby small opening, which is a window that originally served as the entrance to the Hellenistic tomb. Both openings were decentralized to the right of the tomb plan. As a result, the natural light was projected substantially onto the

Fig. 3: Interactive Web 3Dmodel through the 3DHOP viewer with informative hotspots and measurement tools.

right part of the interior, crossing tangentially across the painted arcosolium near the entrance. Nevertheless, it would be wrong to presume a direct relationship between the wall painting's position and the lighting source. Another tomb of the northern necropolis of Cyrene (Good Sheppard Tomb/N241) attests in fact the opposite arrangement: the painted arcosolium lies in the less-lighted part of its funerary chamber.[8] The reasons for these different behaviours remain unclear, and maybe were influenced by cultural and religious factors too.

In Tomb N83, various forms of artificial light had to be used, among which were three clay oil lamps placed in many small and rectangular niches (cm h. 14–17 × w. 14–15 × d. 11). These were carved into the wall to the left of the entrance[9] (fig. 2). The niches may be referred to the late antique phase of the tomb, since their position appears connected with the Demetria inscription. The niches are rather high from the floor[10] (around 2.65 m from it), and tools such as a perch and/or a wooden ladder were necessary for moving and turning the lamps on/off, especially considering the encumbrance of the Demetria and Theodulos grave at the bottom of the same wall. Even if the stone slabs and blocks composing the coffin are lost, the 19th century drawings by Smith and Porcher[11] allow for its reconstruction.

Other considerations concerning the functioning of these lamps can be proposed according to the architectural details of the tomb, more precisely the entrance.

Assuming the late antique entrance of the tomb was closed by a stone-slab that was difficult to remove, such as the so-called false-doors mostly used in the Greek period, the lamps had to be lighted only during the short time of the funeral ceremony for Demetria and Theodulos.[12]

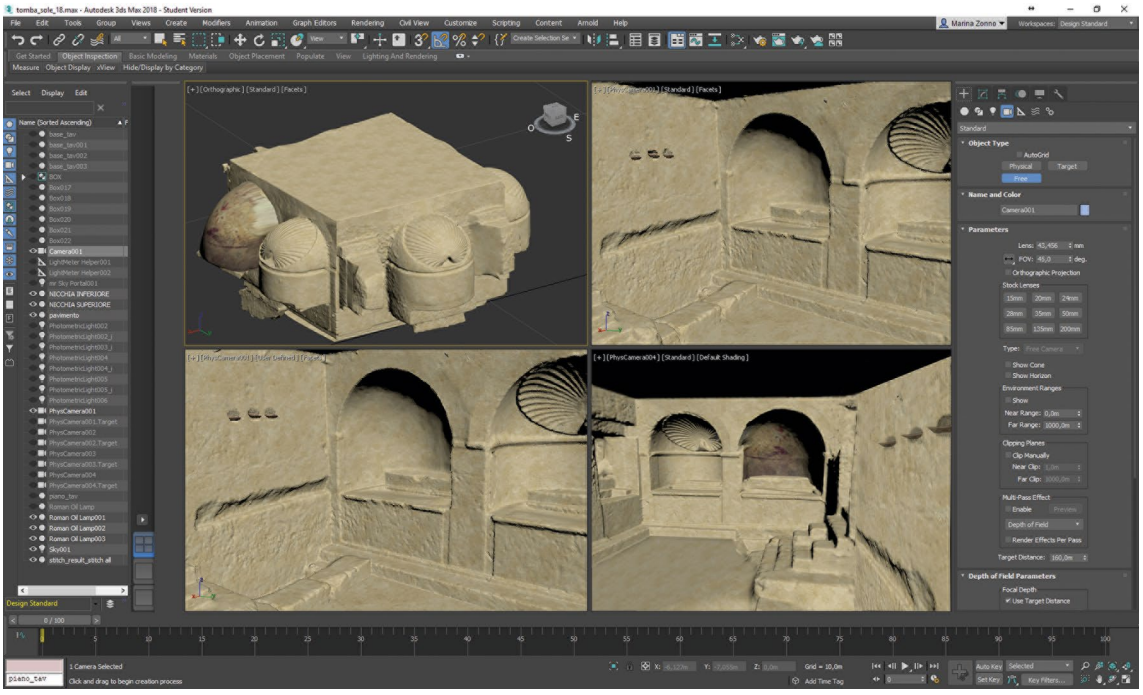

Fig. 4: 3D model of the Tomb N83 created by 3DStudio Max software.

In the case of a wooden door, the lamps could be lit when needed. Further investigations are expected to answer this question.

Looking at the remains of the inner space of the chamber, other points of artificial light can be supposed. Cut into the rock ground almost in the middle of the tomb is a visible square hollow. Probably it was for inserting a squared limestone or marble element, an altar,[13] or the pedestal of a trapeza, on which funerary offers, firstly lamps, could be left (fig. 8).

A. S.

3D Model and Lighting Analysis of the Tomb N83

A 3D model of the rock-cut Tomb N83 was created to carry out the virtual analysis of the quantity and quality of the lighting performance.

The starting point for the reconstruction of the three-dimensional model of the tomb was the survey carried out by Arch. Donato Palumbo in June 2009[14] through a laser scanner topcon gls 1000, an instrument with a field of view (FOV) of 360° × 70°. The produced point cloud is the result of combining 8 partial laser-scans, conducted by different survey points. Each scan covers an angle of 45° × 70° and then joins the points into a single cloud. The instrument, equipped with an integrated camera, performed the photographic images from each station, colouring the vertices to highlight the materials and the wall painting.

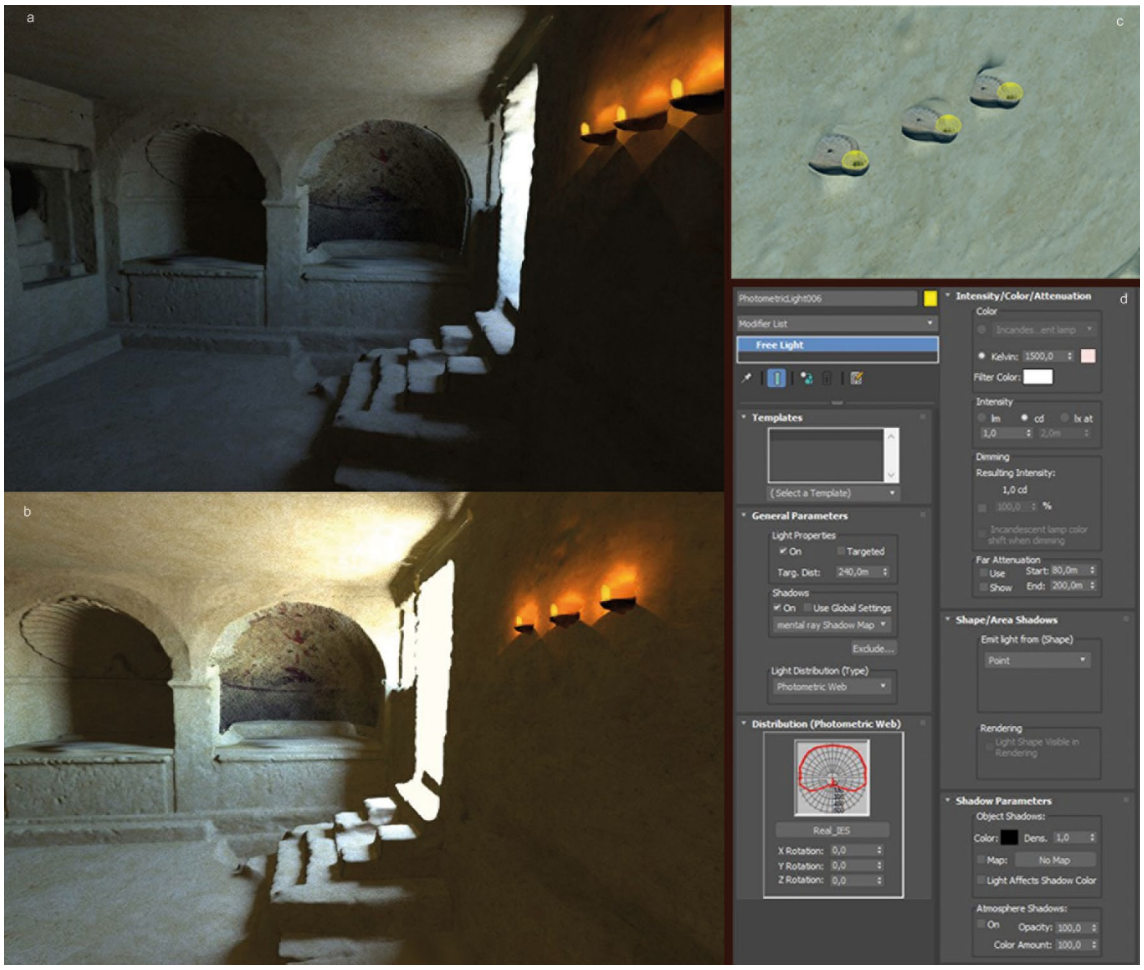

Fig. 5: Scenario with combined daylight and artificial light in summer at 7:00 a.m (a) and at midday (b), detail of the three lamps (c), and photometric setting of oil lamp in 3DMax (d).

Direct investigations on site with the laser scanner are crucial to detect metric characteristics, formal aspects, as well as the materials and their state of deterioration.[15] Despite the lack of information about the ceiling and flooring, the analysis of photographs from previous publications[16] made it possible to reconstruct the whole model by transforming the point clouds in the mesh. It was also possible to supply the small missing areas inside the arcosolia by comparison with the contiguous walls and the homogeneity of the rock into which the funerary chamber was cut.

Then, the model was imported into 3DHop (3D Heritage Online Presenter) in order to manage, measure, and visualize the tomb online.[17] 3DHop is an open-source visualization software package developed by the ISTI institute of the CNR for creating interactive web presentations of high-resolution 3D models. It is oriented to the Cultural Heritage field and to the integration of 3D and other contents (e.g. texts and multimedia forms).[18]

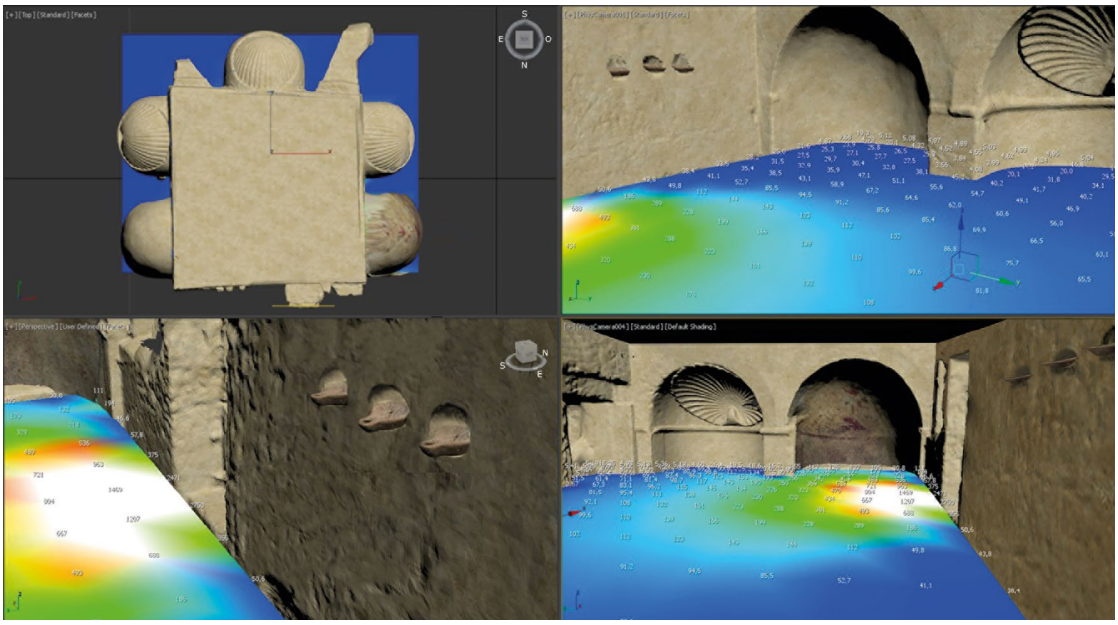

Fig. 6: Distribution of natural and artificial light on the horizontal visual plane.

In fact, this model in 3DHop can be used as a tool for the knowledge of the tomb, thanks to the insertion of informative clickable hotspots in different colours. These recall historical documentation in the form of texts, images, and external links (fig. 2). It also shows the state of degradation induced by numerous acts of vandalism, such as writings on the walls (including on the painted ones).

This interactive model also was useful to analyse the architectural features remotely in order to verify the precise position of the three niches close to the Demetria inscription. The black smoke spots[19] on these contribute to the simulation of the original position of the lamps.

From the model in 3DHop, it is also evident that the natural light in the tomb spreads from two openings (the entrance door and the nearby window); due to their asymmetrical position, the left side is in low light conditions (fig. 3).

Starting from the model created by laser scanning, the Autodesk 3D studio Max software was used for modelling the tomb, in order to simulate the lighting conditions within the reconstructed environment (fig. 4). Both the characteristics of the materials related to the lighting analysis (reflectance, colour, type of surface finish, etc.) and the system of daylight were inserted. This software geometrically models complex spaces and creates lighting scenarios with natural, artificial, or combined light, and analyses the luminance levels. These tools are customised to the needs of lighting designers.[20] For the reconstruction of the artificial light, the standard model developed on the basis of ancient clay oil lamps for case studies in Greek contexts was applied.[21] A fundamental phase was the creation of virtual prototypes of ancient lamps composed of the 3D model of the lamp in its geometric, dimensional and

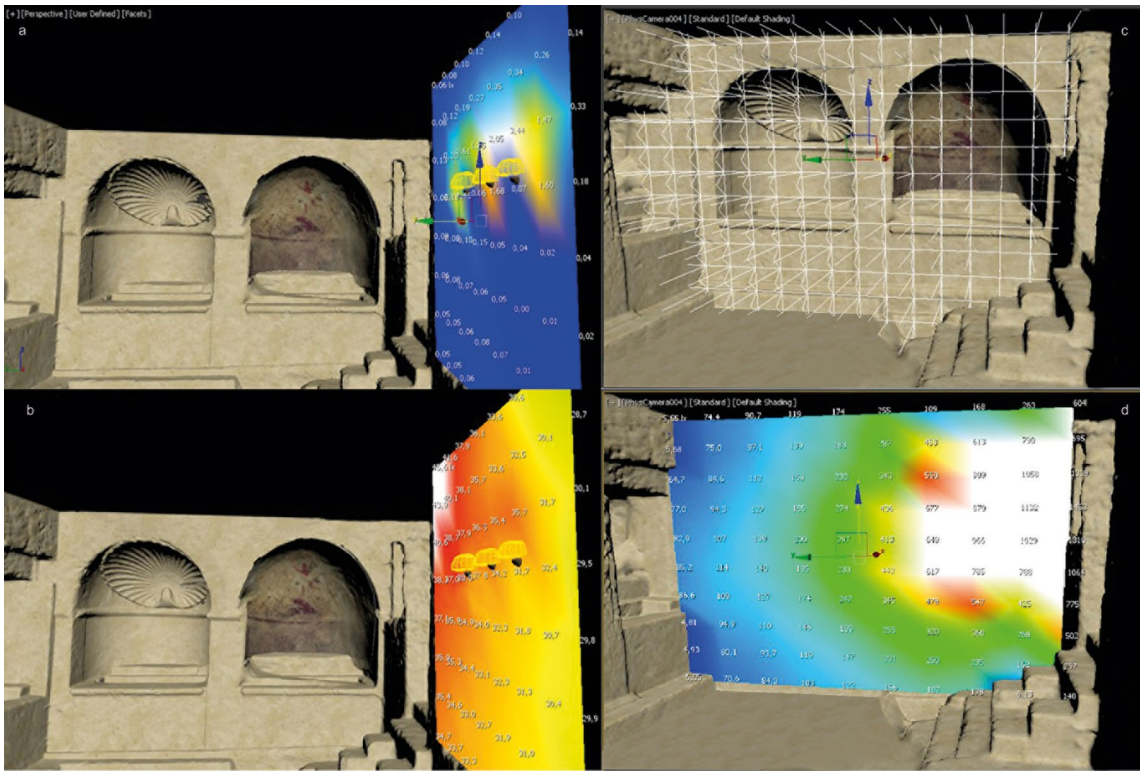

Fig. 7: Lighting distribution: direct light by oil lamps (a), and total light (b) on the north wall, natural light on vertical visual planes near the entrance (c–d).

material characteristics and the photometric file (.ies). This included reproducing the photometric characteristics of an oil lamp with a cotton wick (1 cm). The distribution of light was defined by reference to previous studies[22] and photometric diagrams existing in literature.[23] A goniophotometer verification of one or more combined ancient oil lamps is ongoing.

A generic 3D model of a one-nozzle clay oil lamp, with a reservoir of medium size (in accordance with the dimensions of the niches) was used for the environment of the Tomb N83. As the photometric distribution shows, this object produces the greatest amount of light directed upward, but a portion is directed downward as well, producing reflections off of the surface affected by light. Since it emits a very warm light, the colour temperature introduced for the oil lamplight is very low (1500K°) (fig. 5).

The evident lack of uniformity of light distribution is also shown by the studies of light in the 3D model created with the 3Dmax software. Thus, the light generated by three oil lamps – one in each niche – are analysed in the simulated scenarios with combined lighting (daylight and artificial light by oil lamps), in different seasons and times of the day. The amount of daylight is very changeable since it depends on the seasons and climate conditions. The evident lack of uniformity in light distribution[24] is also highlighted by the studies of light in the 3D model created through the 3Dmax software (fig. 5).

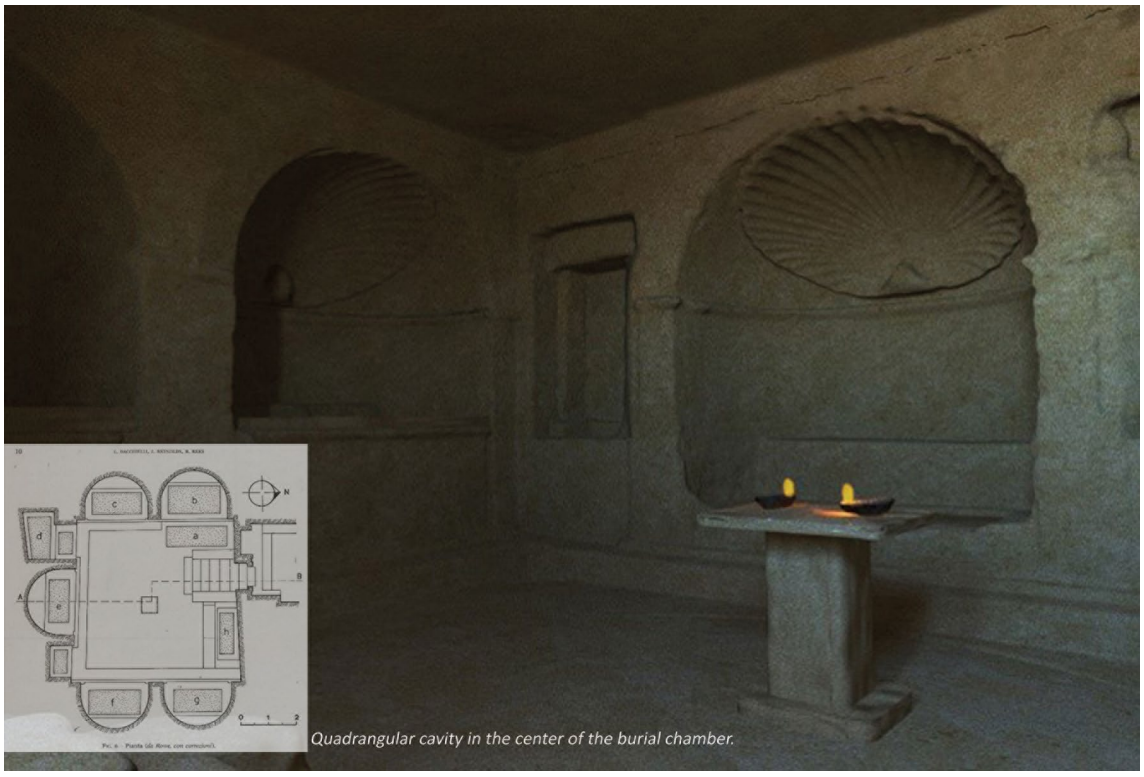

Fig. 8 Scenario with two oil lamps on a support element.

These elements have also been confirmed by the lightmeter function of the 3Dmax program, which makes it possible to calculate and display lighting levels in a perspective viewport. The luminance values are mapped into pseudo-colours that represent the lighting levels on the chosen visual plane, (horizontal or vertical), and range from blue (minimum value) through cyan, green and yellow, red and white (maximum value).

Some of the results are shown. The calculated values indicate considerable differences (up to over 2500 lux in summer) between the area near the entrance and the area on the left (fig. 6).

Moreover, the simulation with the three lamps in the niches shows an increase of the luminance levels on the wall, making it useful to read the Demetria inscription. In this case, the light of the flames should have effects not only on the emotional perception but also on the visual ability needed to perform the visual task of text reading. On the contrary, it had no influence on the fruition of the wall paintings.

Additionally, this study analysed the distribution of daylight on the vertical visual plane of the area near the entrance, where the wall painting is located. This results in the parts most illuminated by natural light (fig. 7). Since the Roman lamps were portable artificial lights, they could be located in different places. Therefore, another scenario is created based on the hypothesis concerning the quadrangular hollow (60 × 60 cm) that exists in the centre of the burial chamber. As assumed previously, this had the

architectural function of supporting a lithic element, maybe the pedestal of a trapeza for funerary offers, among which could be oil lamps. Therefore, a geometric shape simulating a generic element of a trapeza was created to virtually place two lamps and reproduce the atmosphere of ritual practices (fig. 8).

P. L. – M. Z.

Conclusions

A 3D survey of the Demetria Tomb/N83 constitutes an important documentation, considering its ongoing degradation.[25] For this reason the tomb was modelled as a case study, despite some limits of the initial 3D survey and even if some archaeological questions concerning its reconstruction remain unresolved.

The method applied for the creation of a virtual interpretative model was demonstrated to be a concrete tool for valorisation, tourism and for the promotion of the scientific data. Thanks to the use of ICT (Information and Communication Technology), the interactive web pages give the possibility to communicate and spread information about ancient contexts. The virtual reconstruction results are very useful for studies on ancient lighting in connection with the architectural context. Furthermore, the photorealistic scenarios provide an additional and emotional perception of the light inside Roman tombs, and give functional data to the current lighting design of ancient spaces.

Notes

[1] Cf. Schneider – Wulf-Rheidt 2011; Moullou 2015.

[2] For the natural lighting inside the tombs cf. Knosala 2011.

[3] Di Vita-Evrard et al. 1996, 119 and note 19, pl. LVI c.

[4] For this and other examples, Santucci 2019 (with bibliographical references).

[5] For a standard duration of ancient lamps in connection with the fuel used, cf. the contribution by M. Broich-Höhner in this volume.

[6] For the latest edition of the tomb and its wall paintings, Santucci 2017.

[7] Bacchielli et al. 1992, 18–21 fig. 14.

[8] Bacchielli 1990/1991, figs. 4.7.9, tavv. I–III.

[9] Cf. Rowe 1959, 10 'three lamp niches'; Bacchielli et al. 1992, 14.

[10] In the houses at Delos the lamp niches have a lower height of around 1.5–2 m from the floor, cf. Moullou 2015, note 51 with other references.

[11] Bacchielli et al. 1992, 14 fig. 2.

[12] Santucci – Thorn 2003, 192.

[13] Bacchielli et al. 1992, 9 f. fig. 6.
[14] For the general project by the University of Chieti, Menozzi – Tamburrino 2012.
[15] Lercari et al. 2016.
[16] Bacchielli et al. 1992; Santucci 2017.
[17] The 3D visualization of the tomb can be found at the online address: http://www.it.cnr.it/ba/3D/cirene/.
[18] Potenziani et al. 2015.
[19] Thorn 2005, fig. 173.1.
[20] Papadopoulos et. al. 2009.
[21] Moullou et al. 2012a.
[22] Moullou et al. 2012a.
[23] Moullou et al. 2012b.
[24] UNI EN 12464-1, 2011.
[25] For the current risks involving Libyan cultural heritage, Mugnai et al. 2017, with references on the various aspects of the problem; for the contribution of 3D survey in preserving cultural heritage at risk, Núñez Andrés et al. 2012.

Image Credits

Fig. 1: © University of Urbino, Historical Archive of the Italian Archaeological Mission at Cyrene. – Figs. 2–8: © ITC-CNR Bari.

References

Bacchielli 1990/1991
L. Bacchielli, La tomba cirenea del Buon Pastore, RendPontAc 63, 1990/1991, 3–21.

Bacchielli et al. 1992
L. Bacchielli – B. Rees – J.M. Reynolds, La Tomba di Demetria a Cirene, QuadALibia 15, 1992, 5-22.

Di Vita-Evrard et al. 1996
G. Di Vita-Evrard – L. Musso – F. Mallegni – S. Fontana, Le necropoli di Leptis Magna, I. L'ipogeo dei Flavi a Leptis Magna presso Gasr Gelda, LibAnt n.s. 2, 1996, 85–133.

Knosala 2011
T. Knosala, Licht im Reich der Schatten. Beobachtungen zu Metamorphose und Bedeutung des Lichtes im Kontext römischer Grabbauten, in: Schneider – Wulf-Rheidt 2011, 183–204.

Lercari et al. 2016
N. Lercari – J. Shulze – W. Wendrich – B. Porter – M. Burton – T. Levy, 3-D Digital Preservation of At-Risk Global Cultural Heritage, in: C.E. Catalano – L. De Luca (eds.), Proceedings of Eurographics Workshop on Graphics and Cultural Heritage – Genova 5–7 October 2016 (Goslar Germany 2016) 123–126.

Menozzi – Tamburrino 2012

O. Menozzi – C. Tamburrino, Laser Scanning and Infra-Red Thermographic Prospecting for Diagnostic Mapping and Restoration Projects: the Case of the Painted Tombs at Cyrene (Libya), in: M. Ioannides et al. (eds.), Progress in Cultural Heritage Preservation, Proceedings of the 4th International Conference 'EuroMed 2012' – Lemessos, Cyprus 29 October – 3 November 2012 (New York 2012) 343–348.

Moullou 2015

D. Moullou, Lighting Night-Time activities in Antiquity, in: M.E. Micheli – A. Santucci (eds.), Lumina, Atti del convegno internazionale – Urbino 5–6 giugno 2013 (Pisa 2015) 199–212.

Moullou et al. 2012a

D. Moullou – E.N.D. Madias – L.T. Doulos – C.A. Bouroussis – F.V. Topalis, Lighting in Antiquity, in: M. Kostic (ed.), Proceedings of 5th Balkan Light International Conference – Belgrade 3–6 October 2012 (Belgrade 2012) 237–244.

Moullou et al. 2012b

D. Moullou – N. Bisketzis – Ch. Tselonis – D. Egglezos – O. Filippopoulou – F.V. Topalis, Methods and Tools for the Study of Artificial Illumination in Antiquity, in: N. Zacharias (ed.), Proceedings of the 2nd Archaeological Research and New Technologies Conference – Kalamata 21-23 October 2010 (Kalamata 2012) 107–114.

Mugnai et al. 2017

N Mugnai – J. Nikolaus – D. Mattingly – S. Walker, Libyan Antiquities at Risk: Protecting Portable Cultural Heritage, LibStud 48, 2017, 11–21.

Núñez Andrés et al. 2012

A. Núñez Andrés – F. Buill Pozuelo – J. Regot Marimón – A. de Mesa Gisbert, Generation of Virtual Models of Cultural Heritage, Cult. Herit. 13, 2012, 103–106.

Papadopoulos et al. 2009

C. Papadopoulos – G.P. Earl, Structural and Lighting Models for the Minoan Cemetery at Phourni, Crete, in: K. Debattista – C. Perlingieri – D. Pitzalis – S. Spina (eds), Proceedings of the 10th International Symposium on Virtual Reality, Archaeology and Cultural Heritage VAST (2009) St. Julians, Malta 22–25 September 2009 (Aire-la-Ville Switzerland 2009) 57–64.

Potenziani et al. 2015

M. Potenziani – M. Callieri – M. Dellepiane – M. Corsini – F. Ponchio – R. Scopigno, 3DHOP: 3D Heritage Online Presenter, Comput. Graph. 52, 2015, 129–141.

Rowe 1959

A. Rowe, Cyrenaican Expeditions of the University of Manchester 1955–1957, Comprising an Account of the Excavated Areas of the Cemeteries at Cyrene and of Objects Found in 1952 (Manchester 1959).

Santucci 2017

A. Santucci, Le pitture della Tomba di Demetria-N83 a Cirene: nuova restituzione grafica, nuove questioni interpretative, LibAnt n.s. 10, 2017, 105–135.

Santucci 2019

A. Santucci, Narrare l'illuminazione. Considerazioni sul repertorio letterario e iconografico del mondo greco e romano, in: L. Chrzanovski (ed.), Greek, Roman and Byzantine Lamps from the

Mediterranean to the Black Sea, Acts of the 5th International Lychnological Congress (Lumen! Sibiu 15th–19th September 2015), In Memory of Dorin Alicu, Monographies Instrumentum 63 (Drémil Lafage 2019) 256–271.

Santucci – Thorn 2003

A. Santucci – J.Copland Thorn, Tahuna/Windmill/Tomba dei Coniugi/N1: la grande tomba circolare della Necropoli Nord di Cirene, in: N. Bonacasa – A. di Vita (eds.), Scritti in memoria di Lidiano Bacchielli, QuadALibya 18 (Roma 2003) 183–204.

Schneider – Wulf-Rheidt 2011

P.I. Schneider – U. Wulf-Rheidt (Herg.), Licht-Konzepte in der vormodernen Architektur, Internationales Kolloquium Berlin 26. Februar – 1. März 2009, Diskussionen zur Archäologischen Bauforschung 1 (Regensburg 2011).

Thorn 2005

J.C. Thorn, The Necropolis of Cyrene. Two Hundred Years of Exploration, Monografie di archeologia libica XXVI (Roma 2005).

UNI EN 12464-1, 2011

UNI EN 12464-1, Light and Lighting, Lighting of Work Places. Part 1 : Indoor Work Places (July 2011).