Digital Technologies for the survey and the interpretation of objects of archaeological interest:

The case of Iasos in Caria, Turkey

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Abstract: With regards to the Archaeological Heritage survey, the decoding of the elements and images, can bring back a reality which is still alive, written on the walls, told by the very stones the houses, the buildings, the monuments, the streets and the squares a city is made of. To study, catalogue and preserve accurately these traces of the past is the core of the problem for historical remains preservation. This also means making information about different historical periods available, building a solid picture of the historical value not only of the monument but also of the whole social communities of the territory**.**

A ten years experience in the archaeological heritage survey of boundary walls of Iasos in Caria has given many opportunities to test the possibilities regarding the preciseness and the level of detail offered by the plane photogrammetry supported by an accurate topographic survey. An enough dense cloud of points allows the planarization of surfaces characterized by a quite rugged morphology, with restrained errors and with the possibility of carrying out metric and stratigraphic analysis based on high resolution frames. Also, starting from these "leveled" surfaces, it is easy to reconstruct canonical views with their anomalies and foreshortenings. This can be done through the 3D modeling or through the conventional representation in orthographic projections.

Zusammenfassung: Die Beschreibung und die Dokumentation archäologischer Bauwerke sind von höchster Bedeutung sowohl im Erkenntnisprozess als auch im Bereich des Schutzes dieser Bauwerke.

Die archäologischen Erfahrungen, die in den letzten zehn Jahren auf dem Mauerring und auf anderen Bauten in Iasos / Karien durchgeführt wurden, gaben uns die Gelegenheit, die Möglichkeiten der Photogrammetrie, unterstützt von einer sorgfältigen topografischen Vermessung, im Bezug auf die Genauigkeit, die Einzelheiten und die Zweckmässigkeit für eine weitere Einschätzung zu überprüfen. Eine ausreichend dichte Wolke von Punkten erlaubt eine höchst präzise Plandarstellung der von einer gegliederten Morphologie charakterisierten Flächen und gibt dazu die Möglichkeit, metrische und stratigraphische Analyse, aufgrund der hochauflösenden Einzelbilder, durchzuführen. Außerdem ist es leicht, von diesem Verfahren ausgehend, traditionelle Übersichten in orthogonaler Projektion zu erzeugen und dreidimensionale Modelle zu bearbeiten.

Keywords: archaeological survey, fortifications, mosaics, digital model, image conservation

Introduction

The strategies and directions to be taken for the conservation and fruition of archaeological heritage are since many years object of a cultural debate. In the last decade, even within a framework of several different

theoretical premises and practices, a certain degree of consensus seems to emerge. The inevitable deterioration that archaeological site built structures face once exposed by excavation is a hard evidence which we have to make peace with. This occurrence is increased in intense tourism areas or in those contexts where heritage preservation policies are not yet fully effective. In addition to devices that prevent physical damage, we need effective tools for information storage and conservation of archaeological artifacts images, as they are destined to perish with time. Within restoration processes, any intervention, even if philologically correct and with a minimum impact has two opposite consequences. On one side it guarantees the physical survival of an artifact and on the other taints structural and material authenticity. These alterations are often definitive, as the proposed reversibility of all interventions remains a theoretical goal. Emergency conditions and the scarcity of resources complete the picture of the field in which we operate.

Before taking any decision on the future of an archaeological artifact or site, we need to build an adequate informative background that would record precisely its features in a given historical moment and that could be easily accessible for further studies not necessarily to be conducted in the immediate future.

The survey context : Old city of Iasos in Caria (Turkey)

Iasos city is located within Mendelya Gulf on the south-western coast of Turkey, between the old Caria centers of Miletus and Myndos, close to the modern village of Kıyı Kı şlacık stretched on the coast and immediate hinterland in Muğla region. The ancient urban settlement is located on a small peninsula, sheltered by Leros and Kalimnos islands and connected to the mainland by a thin isthmus. The peninsula is almond shaped and roughly north-south oriented. It develops in length reaching an extension of 900 m and a maximum width of 475 m. Its defining characteristic is an emerging limestone area reaching 80 m above sea level..

In ancient times the peninsula was separated from the mainland by a canal fit for ships. This separated the urban settlement from the mainland and also joined the two small harbors that were established at the sides of the peninsula, as it was common use in Greek sea colonies in Asia minor area. Excavation findings show that the area was known to man since 3000 BC , while some building artifacts unearthed on the island show that urban settlement can be traced back to Middle and Late Bronze age. Other findings have been connected to the existence on the island of Cretan and Mycenaean settlements and an early Greek presence [1]. This presence is testified by consecutive relevant urban interventions that, starting from 6th century BC would deeply influence the functional structure of the site, to the point of shaping its development also in following periods [2].

Remains of prominent architectural conglomerates with military, civilian and religious destination can still be observed today. They represent the importance achieved by the city in Hecatomnid and Hellenistic ages and its strategic role in the complicated political-territorial balance of different powers

operating in the Aegean sea[3].The substantial range of the Roman Iasos buildings and their features show that the city maintained a primary role within the regional Carian context, thanks to the local marble extracting activities. The community is active for the whole late-ancient and proto-byzantine age, even if with some instability periods and a steady demographic decrease. The construction of the fortified kastron on the isthmus could be related to the militarization of the territory promoted by the Eastern Roman Empire from the 7th century AD on[4]. Literature and archaeological findings show that urban settlements remain active though shrinking until Lascaris age[5]. During this time building interventions become increasingly defense-oriented.

The Turkish conquest of the Aegean coast will cause the ultimate abandonment of Iasian urban structures, never to be revived again.

At present, the area shows almost no trace of recent building artifacts, even though local landlords farming activities on almost the entire island have accelerated the deterioration process of the archaeological remains.

The city and its territory have been since 1960 object to studies and excavation carried by the Italian Archaeological Mission. Starting from 1997 a team from the Architecture Design Department of Florence university carried a survey campaign for the documentation of aboveground structures and those unveiled with excavations[6]. These activities find their framework in an interdisciplinary approach aimed at the reconstruction of the urban fabric evolution through time[7]. This project also contemplates the study of few architectural instances particularly meaningful for their typology, building technique and stratigraphic occurrence.

The examples presented in the following paragraphs show an extensive range of the analyzed structures and of the different methods applied for their study, information integration and their visualization

Fig. 1 – Plan of peninsula with topographical survay of the walls

Fig. 2 – Promiscuous use of the archaeological remains and lack of surveillance

Island Boundary Walls

Within the repertory of Iasos fortified structures designed for its defense, the strategic role of the urban boundary wall is fundamental. The different update and adaptation interventions that occurred through the years show the vital importance to the locals of maintaining this defensive stronghold efficient, underlining at the same time the intimate relation with the core of Iasos residential district and the two harbors. These were probably the main economic and infrastructural resource of the city.

For this reason the island walls were the first to be inspected in the 1997 survey. The island boundary wall was definitely in good conditions when scholars and travelers first started to attend the site at the end of 18th century, as the first written and graphic evidences show.

Defensive structure, boundary walls and other buildings were severely damaged by the extensive depredation of the Ottoman authorities. Staring from 1886 they took away most part of the squared construction blocks and re-used them for the building of Babek wharfs in Istanbul[8].

The emerging parts of the walls are heterogeneous both in shape and building technique, displaying a complex stratigraphic history[9]. The original perimeter consisted of walls built with emplecton technique: an exterior isodomic layer in big marble blocks, an interior layer with smaller elements and a core layer of clay and pebbles. This kind of structure is usually dated back to Hecatomnid age and is only visible in few sections. The need for effective defense structures brought to the substitution of emplecton with a solid concrete core technique, probably already from the late imperial age. At the same time, the never ending reconstruction interventions brought to the antique architectural elements re-use in the external wall layer.

The range of tower constructions, even if not substantial in number, is quite varied and accounts for an useful case spectrum for the study of Iasos military architecture development.

The documentation activities have engaged the whole perimeter in its emerged sectors. These have been inspected topographically and through the application of planar photogrammetry. In-depth analysis has been carried on few artifacts (in particular towers and doors) that could give, for their structure and building features, useful timing indications. A similar process has been applied to those sectors of the walls connected to characteristic non defensive buildings. A stratigraphic analysis of the aboveground constructions was conducted in all cases, in order to compile a chronology, even if relative, of different occurrences observed.

For what concerns data management and accessibility, the ongoing GPS survey of the topographic landmarks will allow their georeferencing . A GIS based archive system is being elaborated and will allow interaction and updating of the gathered information.

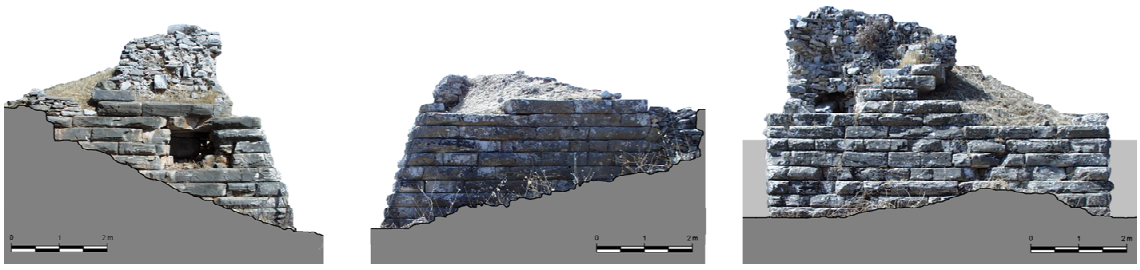

Fig. 3 – Base of late-classic tower near the eastern gate. Photoplans of the fronts (Bertocci 2004)

Fig. 4 – Boundary wall with isodomic masonery near the south cape of the peninsula. Photoplan of the front (Cornieti 2008)

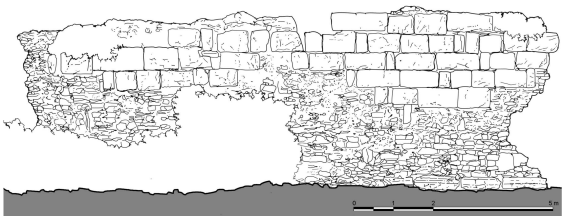

Fig. 5 – Boundary wall with isodomic masonery near the south cape of the peninsula. Vectorial drawing (Cornieti 2008)

Fig. 6 – Boundary wall with reuse architectural blocks. Photoplan of the front (Cornieti 2008)

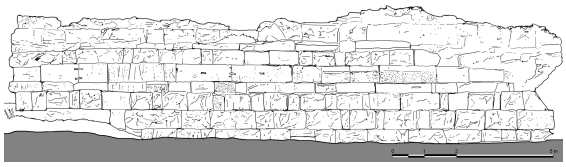

Fig. 7 – Boundary wall with reuse architectural blocks. Vectorial drawing (Cornieti 2008)

Military architecture in Iasos

Together with the analysis of the urban walls, the research team also studied and documented other fortifications located within the island area and surroundings of the city. In particular, the mainland

walls, the Byzantine kastron located on the isthmus and the castle located at the top of the promontory, where the town acropolis was. The mainland walls surround the North-Western heights overlooking the plain and the urban settlement. They are one of the most impressive fortification efforts in the whole micro-Asian context.The perimeter presents and indented trace plan that was adopted in all known traits. Impressive U-shaped well conserved towers punctuate the track. The battlement presents openings and shooting points functional to the use of artillery. Walls have a double layer of limestone blocks, sometimes huge that differ in dimension and manufacture. Though the main questions about the date, function and commission of the walls remain open, recent studies, including those of the writer, tend to consider the powerful facility an intervention designed and executed in the late Hellenistic period[10].Documentation activities in this case was limited to a topographic and photogrammetry survey of the artillery towers, in order to study their different morphological, technical and building features and note the presence of important tactical devices.
For what concerns structures with non flat fronts, we decided, in addition to traditional orthogonal projections views to represent the full extension of the front, in order to check the metric data collected on single building elements and to further elaborate 3D models n the future.
The Byzantine kastron on the isthmus is a fortification connected to the town walls and enclosing a big urban area with a segmented track articulated in projection with towers and bastions.
These structures show a consistent multi-stratification but the implant can be actually connected to the military and territorial reorganization into themi operated by the Eastern Roman Empire starting from 6th century AD. This plan saw the allocation of permanent troopers in the most strategically important centers.
Also, in this case the structure documentation was carried with a topographic survey relying on planar photogrammetry and supported by stratigraphic analysis of the emerged buildings in the most complex areas.
Finally the Acropolis Castle is a fortified circuit that encloses the plain top of the promontory with a total extension of approximately 360 m. The walls structure has a double external layer consisting of small limestone blocks, reuse elements, brick fragments . The internal core layer is in cocrete. The perimeter is punctuated in projection by square plan or U-shaped towers. The type of structure and building technique should belong to the late-byzantine era, probably around the time of Komnenos or Lascaris dynasties, but further investigation is still needed[11]. In this case as well, the detail topographic survey integrated with planar photogrammetry, allows us to render complicated traditional views and the development of fronts, useful for the stratigraphic analysis of buildings and the individuation of dimensional and constructional anomalies.

Fig. 8 – Mainland wall. Section of a U-shaped artillery tower and photoplan of the curtains (Cornieti 2008).

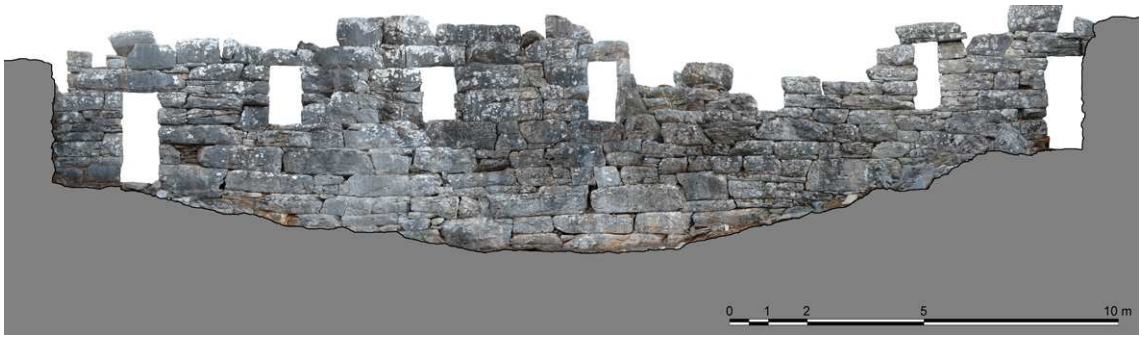

Fig. 9 – Mainland wall. Development of external surface of a U-shaped artillery tower (Cornieti 2008).

Fig. 10 – Mainland wall. Front of a U-shaped artillery tower (Cornieti 2008).

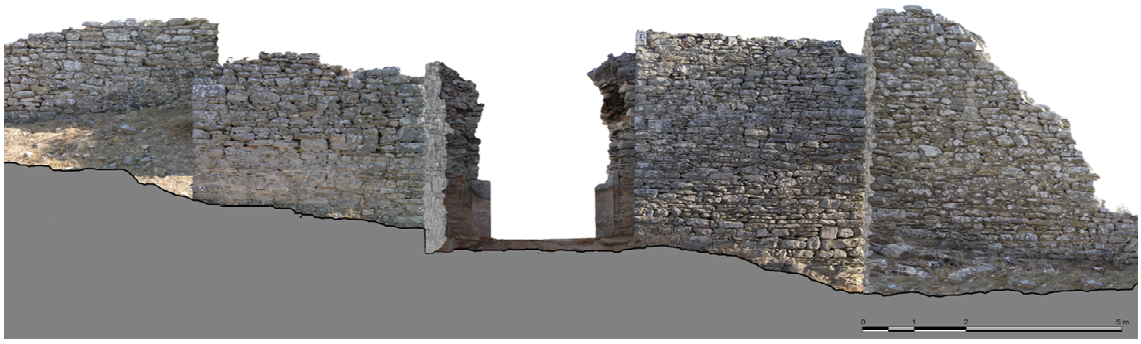

Fig. 11 – Acropolis Castle on the top of the peninsula. Front of the northern gate wit projecting towers (Cornieti 2008).

The Mosaics House

The Mosaics House is a building dating back to late imperial age located at the south foot of the promontory in an area that was probably a rich residential district in Roman age.

The articulated architectural organism reveals a complex stratigraphic history. The house was built on pre-existent structures and shows signs of different modifications and enlargements that took place in a couple of centuries time-span. From a typological point of view, it presents interesting elaborations on the theme of the Greek-Hellenic dwelling and its late Roman Empire declinations[12].

Unearthed during the 70s, the structure was object ,during the late 90s and the following years, of additional excavation, conservation and restoration interventions including the construction of a roof structure to protect the remains.The building has very interesting decorative features. Most of the halls have mosaic floor with valuable geometric, vegetable and animal life decorations. Part of the walls still presents traces of multi-colored paint used for fresco decorations.

Despite prevention and maintenance works, a comparison of the graphic and photographic documentation of the just-excavated building (1970) and its present status enlightens a quick ongoing macro deterioration, especially noticeable in the decorative apparatus that has also been object of depredation .

The aim of survey is documenting in the most comprehensive and reliable manner the actual status of the artifact, both to be able to plan possible conservation interventions and to secure perpetually its image, in the wider sense[13]. As in the previous cases, we started with a topographic survey of the domus to insert it within the existing cartography and at the same time to relate its structures to adjacent buildings. Internal spaces have been surveyed integrating data from the topographic inspection with direct measurements.

This phase included the realization of accurate first hand eidotypes, first selection of building structures aimed at trilateral survey and a following direct detail survey to obtain Cartesian coordinates in order to register also small variations and anomalies in surface laying. In the survey of mosaic floors, wall decorations and texture, orto photo plans were obtained through inverse perspective processes applied on the analytical elaboration of metric data and digital pictures taken with common digital cameras.

The rendering process entailed the production of traditional bi-dimensional drawings and high resolution photo-plans, but also of geometric polygonal models initiated with the conversion of all metric and morphologic survey data into a CAD platform. Since the images produced were very irregular and given the need for a model that can be managed with common computers, we opted for the use of bump mapping in addition to diffusion mapping. A simplified model in VRML format was produced with the intent of guaranteeing its navigability and accessibility for teaching and publication purposes. With regards to the elaboration of orto photo plans, the high number of photographic shots, often taken in different environmental and lighting conditions lead to a heterogeneity of the chromatic data captured. These were corrected relying on a small number of colometric samples considered to be accurate and scaling all images with the confrontation and statistical review of RGB histograms.

Fig. 12 – A room of the Mosaics House at end of excavation’s works, on 1970.

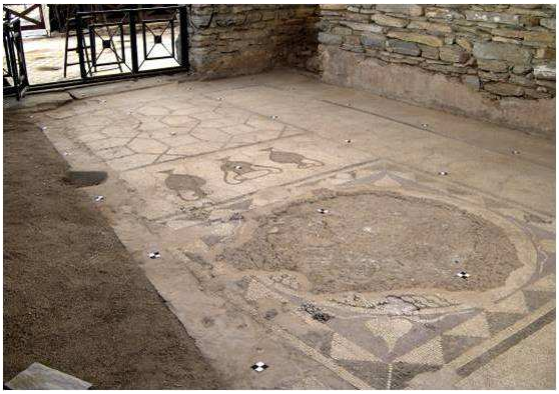

Fig. 13 – The same room, as appeared on 2004.

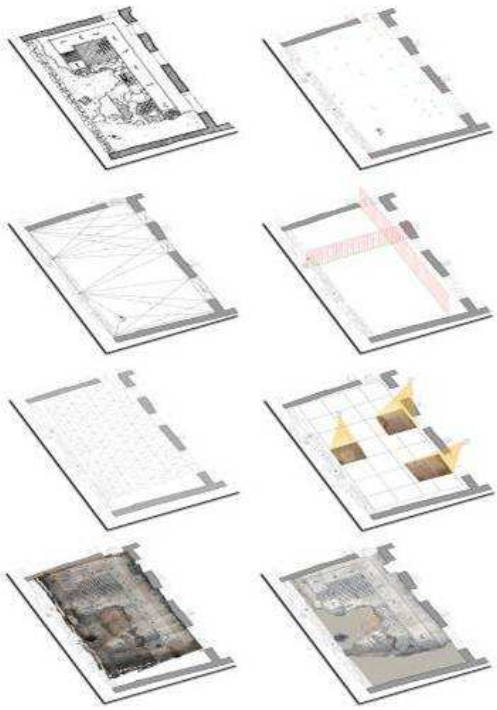

Fig. 14 – Scheme of survey and data processing.

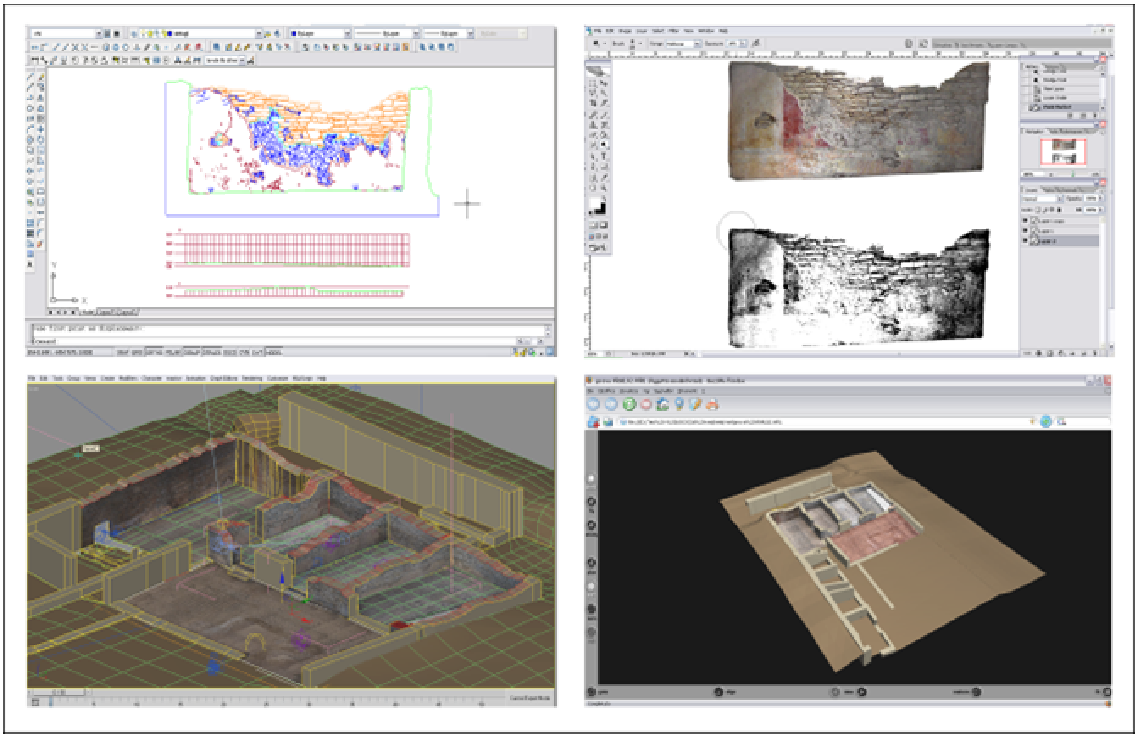

Fig. 15 – Digital processing from vectorial drawing to 3D polygonal model and VRML version.

Fig. 16 – General view of the 3D model.

Fig. 17 – Plan of the Mosaic House

Fig. 18 – Plan and sections of a room with mosaic floor and fresco-painted walls

Fig. 19 – Image in detail of an ancient restoration work by the high resolutior 3D model.

Fig. 20 – Renderized view of a mosaic-floored hall

Conclusions

The use of digital technologies has without doubt brought about a revolution in archaeological research and heritage documentation activities in the last years. Their extensive and deep-rooted diffusion and the easy circulation of information within the academic community (that is in itself a product of late technologies) make it possible today to critically ponder on this topic, free from unjustified enthusiasm or prejudicial refusals.

These technologies are fundamental in managing the complexity of present knowledge models in which knowledge is created through the integration and interaction of a big number of information. Not always has this process been followed by an integration of professional skills and responsibilities. Documentation activities, even when they see a massive accumulation and elaboration of data, bring in some cases to unsatisfying outcomes for what concerns the advancement of knowledge. This can be partially motivated with the shift between professionals that retrieve and elaborate data and those who will interpret them, often already separated by a different cultural background.
Research activity in Iasos, even with its limits, aims to structure the documentation process as a cognitive continuum where we can find contributions both from tools with a high degree of technology and from traditional archaeological and architectural critical readings, in the integration of different skills.

References

Andreussi, M.1998. Rilevamento delle strutture murarie emergenti per la ricostruzione diacronica del tessuto urbano di Iasos «Bollettino dell’Associazione Iasos di Caria» V, 1998, p. 14.

Angiolillo, S., Cicilloni, R., Frau M., Passeroni, P. 1999. Relazione preliminare sulle campagne di scavo 1996-97 a Iasos, in «ACagliari», LIV, 1999.

Belli, P., Benzi, M., Momigliano N., Graziadio, G. 2006. Iasos nell'età del Bronzo, in Pierobon Benoit, R., ed, Iasos e la Caria: nuovi studi e ricerche, «La parola del passato» LX.

Berti, F. 2005. Le vicende di una torre di difesa «Bollettino di Numismatica» XL-XLIII.

Berti, F., Del Gaudio, M., Siboni, M. 2005. Esperienze italiane di restauro musivo all'estero: il caso dei pavimenti della Casa dei mosaici a Iasos (Turchia), in Atti del X Colloquio AISCOM, Tivoli 2005.

Bertocci, S. 2004. Indagine sulle murature di una torre del lato orientale della cinta di Iasos in Caria, in: Iasos tra VI e IV sec. a.C. Miscellanea storico-archeologica, Supplemento al v. 81 «Atti dell'Accademia delle Scienze di Ferrara» CLXXXI.

Cornieti, M. 2008. Le fortificazioni di Iasos di Caria. Strumenti per la conoscenza e la documentazione dell'architettura della difesa. Tesi di Dottorato in Rilievo e Rappresentazione, Firenze, 2008.

Franco, C. 1994. Le mura di Iasos. Riflessioni tra archeologia e storia, «Revue des Études Anciennes», tome 96, n. 1-2.

Johannowsky, W. 2000. Note sullo sviluppo urbanistico di Iasos, «La parola del passato» LIV.

Masturzo, N. 1995. La torre del porto occidentale e le fortificazioni post-classiche di Iasos, in Iasos di Caria. Un contributo ferrarese alla archeologia microasiatica. Progetti e lavori di restauro, Ferrara, 1995.

Laviosa, C., 1995. Voce "Iasos" in Enciclopedia dell'Arte Antica, II, supp. III.

Levi. D. 1970, Iasos. Le campagne di scavo 1969-70 in «Annuario della Scuola Archeologica di Atene e delle Missioni Italiane in Oriente» XLVII-XLVIII, n.s. XXXI-XXXIII.

Mc Nicoll, A. W. 1997. Hellenistic Fortification from the Aegean to the Euphrates, Oxford, 1997.

Pierobon Benoit, R., ed, Iasos e la Caria: nuovi studi e ricerche, «La parola del passato» LX.

Pimouguet Pedarros, I. 2000. Archéologie de la défense. Histoire des fortification antiques de Carie (époques classique et hellenistique), Paris, 2000.

Serin, U. 2004. Early Christian and Byzantine Churches at Iasos in Caria: an Architectural Survey, Città del Vaticano, 2004.

VV. AA., 2004. Iasos tra VI e IV sec. a.C., Miscellanea storico-archeologica Supp. V. 81, «Atti dell'Accademia delle Scienze di Ferrara» CLXXXI.

VV. AA., 2008. Iasos in età romana., Miscellanea storico-archeologica Supp. V. 83-84, «Atti dell'Accademia delle Scienze di Ferrara» CLXXXIII-CLXXXIV.

Viscogliosi, A. 1995. Il territorio di Iasos in Enciclopedia dell'Arte Antica, II, supp. III.

[1] On the Prehistoric age at Iasos, see: Pecorella 1972. On the Bronze Age, see: Belli et alii 2006.; to have a updated bibiliography of the works on Iasos, see besides: Berti 2005, pp. 11-12.

[2] Johannowsky 2000, passim.

[3] See recently, Iasos tra VI e IV sec. a.C. 2004; Iasos in età romana, 2008; Pierobon Benoit 2006.

[4] Masturzo 1995, p. 173, Cornieti 2008, pp. 181-193.

[5] Serin 2004, passim.

[6] The research team is composed by Prof. Stefano Bertocci, Prof. Marco Bini, Dr. Michele Cornieti, Dr. Mauro Giannini, Dr. Michelangelo Tiefenthaler, Dr. Francesco Tioli, from the Department of Architectural Design at the University of Florence, Dr. Maddalena Andreussi from the Department of Science of Antiquity at the University "La Sapienza" of Rome, under the co-ordination of Dr. Fede Berti, Director of the Italian Archaeological Mission in Iasos.

[7] Andreussi 1998, p. 14.

[8] Franco 1994, p. 172, with previous bibliographycal references.

[9] Bertocci 2004 p.127- 139, Berti 2005, p. 299 segg.; Cornieti 2008, V: 93-144.

[10] Mc Nicoll 1997, Pimouguet Pedarros 2000, Cornieti 2008

[11] Masturzo 1995, Serin 2000, Cornieti 2008

[12] On the excavation and restoration works, see Levi 1970; Angiolillo et alii 1999; Iasos di Caria 1995; Berti et alii 2005.

[13] The research on the Mosaics House has been carried out by Stefano Bertocci, Michele Cannoni, Michele Cornieti, Christian Soverini and Michelangelo Tiefenthaler, University of Florence, in collaboration with Prof. Simonetta Angiolillo, University of Cagliari. The issues of the project have been presented at 5th International Conference Science and Technology in Archaeology and Conservation, 7-10 july 2007 Baeza and Granada, Spain, through the oral paper: The Preservation Project for the Image of Building' Structures in Archaeological Sites: the Case of the Mosaics House in Iasos of Caria.