

KNOWLEDGE, ANALYSIS
AND INNOVATIVE METHODS
FOR THE STUDY AND THE DISSEMINATION
OF ANCIENT URBAN AREAS



Proceedings of the KAINUA 2017
International Conference in Honour
of Professor Giuseppe Sassatelli's 70th Birthday
(Bologna, 18-21 April 2017)

edited by
Simone Garagnani, Andrea Gucci

ARCHEOLOGIA E CALCOLATORI

28.2

2017

All'Insegna del Giglio

KNOWLEDGE, ANALYSIS
AND INNOVATIVE METHODS
FOR THE STUDY AND THE DISSEMINATION
OF ANCIENT URBAN AREAS



Proceedings of the KAINUA 2017
International Conference in Honour
of Professor Giuseppe Sassatelli's 70th Birthday
(Bologna, 18-21 April 2017)

edited by
Simone Garagnani, Andrea Gausci

ARCHEOLOGIA E CALCOLATORI

28.2

2017

All'Insegna del Giglio

Realizzazione grafica della sovracoperta di Marcello Bellisario
Rivista «Archeologia e Calcolatori» (ISSN 1120-6861, e-ISSN 2385-1953)
ISBN 978-88-7814-785-0, e-ISBN 978-88-7814-786-7
© 2017 – All’Insegna del Giglio s.a.s. – www.insegnadelgiglio.it
Firenze, dicembre 2017
Stampa, Andersen S.p.a.
Abbonamento: € 40,00. Spedizione: Italia, gratuita; estero, a carico del destinatario.

I dati forniti dai sottoscrittori degli abbonamenti vengono utilizzati esclusivamente per l’invio della pubblicazione e non vengono ceduti a terzi per alcun motivo.

TABLE OF CONTENTS

SIMONE GARAGNANI, ANDREA GAUCCI, ELISABETTA GOVI, <i>Ancient reality and contemporary research. An introduction to the Conference KAINUA 2017 and its Proceedings</i>	11
ANCIENT CITIES: PAST AND CURRENT PERSPECTIVES	
MARIO TORELLI, <i>From ruins to reconstruction: past and present</i>	27
PAOLA MOSCATI, <i>Archaeological computing and ancient cities: insights from the repository of «Archeologia e Calcolatori»</i>	47
KAINUA PROJECT	
GIOVANNANGELO CAMPOREALE†, <i>Sulla genesi della città nell'Italia preromana. Economia, sociologia, urbanistica: il caso dell'insediamento dell'Accesa</i>	69
ELISABETTA GOVI, <i>Kainua-Marzabotto: the archaeological framework</i>	87
ANDREA GAUCCI, <i>Kainua Project: principles, theoretical framework and archaeological analysis</i>	99
GIULIA MORPURGO, CHIARA PIZZIRANI, CHIARA MATTIOLI, <i>The craft settings in Kainua-Marzabotto: places and archaeological issues</i>	113
STEFANO SANTOCCHINI GERG, ENRICO ZAMPIERI, BOJANA GRUŠKA, GIACOMO MANCUSO, <i>Topographical survey and digital models</i>	129
SIMONE GARAGNANI, <i>Archaeological Building Information Modeling: beyond scalable representation of architecture and archaeology</i>	141
AURELIO MUZZARELLI, MALIK FRANZOIA, <i>The ancient Digital Terrain Model and the infrastructure of the Etruscan city of Kainua</i>	151
BOJANA GRUŠKA, GIACOMO MANCUSO, ENRICO ZAMPIERI, <i>Building materials and virtual models of the Etruscan city of Kainua</i>	165
GIUSEPPE SASSATELLI, <i>Kainua Project Special Session: conclusioni</i>	177
ETRUSCAN CITIES AND THEIR LANDSCAPES: NEW PERSPECTIVES, INNOVATIVE METHODS AND DISSEMINATION	
CARMINE PELLEGRINO, AMEDEO ROSSI, <i>Contemporary landscape and the archaeological record. An integrated approach to the study of the Etruscan-Samnite site of Pontecagnano (SA)</i>	189
MARIA PAOLA BAGLIONE, BARBARA BELELLI MARCHESINI, CLAUDIA CARLUCCI, LAURA MARIA MICHETTI, <i>Pyrgi, harbour and sanctuary of Caere: landscape, urbanistic planning and architectural features</i>	201

GIOVANNA BAGNASCO GIANNI, MATILDE MARZULLO, ANDREA GARZULINO, <i>The last ten years of research at Tarquinia</i>	211
GIUSEPPINA ENRICA CINQUE, HENRI BROISE, VINCENT JOLIVET, <i>Civita Musarna (VT), il suo territorio e la chora di Tarquinia in età ellenistica: uno spazio ritualmente suddiviso?</i>	223
PATRICIA S. LULOF, MAARTEN H. SEPERS, <i>The Acquarossa Memory Project. Reconstructing an Etruscan town</i>	233
EMANUELE TACCOLA, LISA ROSSELLI, <i>Understanding Etruscan art and architecture through 3D modeling: the case of Volterra</i>	243
TOMMASO QUIRINO, <i>Open architecture RDBMS and GIS as tools for analysing the Etruscan presence in the Po Plain: towards a model of the urban/non urban landscape</i>	253
FROM THE ANCIENT CITIES TO THE LANDSCAPES: PROJECTS AND RESEARCHES	
FRANK VERMEULEN, <i>Scanning and visualization of Roman Adriatic townscapes</i>	269
ALESSANDRO CAMPEDELLI, MARCO DUBBINI, MARTINA MONICA, <i>Geo-archaeological study of the territory of Burnum's Roman site (Croatia) through LANDSAT multi-temporal satellite images and high resolution GeoEye</i>	277
ILARIA ROSSETTI, <i>Reshaping the urban space: Bakchias in Ptolemaic and Roman times</i>	291
FEDERICA BOSCHI, ENRICO GIORGI, MICHELE SILANI, <i>Reconstructing the ancient urban landscape in a long-lived city: the Asculum Project – combining research, territorial planning and preventative archaeology</i>	301
FERRAN CODINA, GABRIEL DE PRADO, ISIS RUIZ, ALBERT SIERRA, <i>The Iberian town of Ullastret (Catalonia). An Iron Age urban agglomeration reconstructed virtually</i>	311
ANNA CHIARA FARISELLI, FEDERICA BOSCHI, MICHELE SILANI, MELANIA MARANO, <i>Tharros – Capo San Marco in the Phoenician and Punic Age. Geophysical investigations and virtual rebuilding</i>	321
SIMONE MANTELLINI, <i>A city and its landscape across time: Samarkand in the ancient Sogdiana (Uzbekistan)</i>	333
STARTING AND ONGOING PROJECTS	
STEFANO FINOCCHI, VINCENZO BALDONI, <i>Numana and its ancient territory: new data and research perspectives</i>	345

GIUSEPPE LEPORE, ENRICO GIORGI, VINCENZO BALDONI, FEDERICA BOSCHI, MARIA CONCETTA PARELLO, MARIA SERENA RIZZO, <i>New methodologies to analyze and study the Hellenistic-Roman quarter in Agrigento</i>	353
MICHELE SILANI, ENRICO GIORGI, FEDERICA BOSCHI, GABRIELE BITELLI, ALBERTA MARTELLONE, <i>Seeing into the past: integrating 3D documentation and non-invasive prospecting methods for the analysis, understanding and reconstruction of the ancient Pompeii. The case of the House of Obellio Firmo (IX, 14)</i>	361
ISABEL ESCRIVÀ, JOSÉ J. MARÍN, ALBERT RIBERA, MIQUEL ROSSELLÓ, ALFREDO SANTONJA, <i>Reconstructing the Late Antiquity Episcopal Complex of Valentia</i>	369
GERVASIO ILLIANO, <i>Misenum: the harbour and the city. Landscapes in context</i>	379
VALERIA POSCETTI, SAVERIO GIULIO MALATESTA, VIRGINIA CIRILLI, FRANCESCO LELLA, VITO RONDINELLI, SALVATORE ESPOSITO, MARCO BALSÌ, <i>Preliminary results of the Castelmonardo Project</i>	391
METHODOLOGIES, APPLICATIONS AND INTEGRATED SOLUTIONS	
MARIA ROUSSOU, FRANCESCO RIPANTI, KATERINA SERVI, <i>Engaging visitors of archaeological sites through “emotive” storytelling experiences: a pilot at the Ancient Agora of Athens</i>	405
MARCO GAIANI, <i>Management and communication of archaeological artefacts and architectural heritage using digital IS. What today? What next?</i>	421
ANDREA D’ANDREA, ANGELA BOSCO, MARCO BARBARINO, <i>A 3D environment to rebuild virtually the so-called Augusteum in Herculaneum</i>	437
GIOVANNA LIBEROTTI, CORRADO ALVARO, <i>Using laser scanner technology to analyse mud-brick architecture in the ancient Near East. The Palatial Complex of Arslantepe (Malatya, Turkey)</i>	447
MOISÉS HERNÁNDEZ CORDERO, <i>Geomatics approach to surveys for Late Antiquity buildings. The Episcopal Palace in Side, Turkey</i>	457
FILIBERTO CHIABRANDO, GIULIA SAMMARTANO, ANTONIA SPANÒ, GRAZIA SEMERARO, <i>Multi-temporal images and 3D dense models for archaeological site monitoring in Hierapolis of Phrygia (TR)</i>	469
ELISABETTA DONADIO, RICCARDO MAZZA, FEDERICO BARELLO, <i>Multimedia digital solutions from image and range based models for ancient landscapes communication</i>	485
VALERIA CERA, <i>Knowledge and valorization of historical sites through low-cost, gaming sensors and H-BIM models. The case study of Litternum</i>	497

ALFONSO IPPOLITO, MARTINA ATTENNI, CRISTIANA BARTOLOMEI, <i>Digital acquisition: reflections on data quality</i>	507
AARON PATTEE, ARMIN VOLKMANN, MATTHIAS UNTERMANN, <i>Integrative GIS-based investigation of the medieval fortress architecture of Pfalz, incorporating photogrammetry, geoinformatics and landscape analysis</i>	521
JACOPO BONETTO, ARTURO ZARA, <i>The Nora Virtual Tour: an immersive visit in the ancient city</i>	531
SILVIA BERNARDONI, MARCO MONTANARI, RAFFAELE TROJANIS, <i>Open History Map</i>	539
GIOVANNI AZZENA, ROBERTO BUSONERA, CHIARA PERINI, <i>The future (?) of effective protection</i>	549
SHORT PAPERS	
SARA LORETO, <i>Gropello Cairoli (PV): computer applications for historical-topographic synthesis</i>	563
ANNACHIARA PENZO, FEDERICA PRONI, ANTONIO GOTTARELLI, <i>The archaeological settlement of Monte Bibebe (Bologna)</i>	571
ILENIA GRADANTE, DAVIDE TANASI, <i>3D digital technologies for architectural analysis. The case of the “Pagan Shrine” in the Catacombs of Santa Lucia (Siracusa, Sicily)</i>	581
FRANCESCO GABELLONE, IVAN FERRARI, <i>Reconstruction of Villino Florio’s wooden ceiling using 3D technologies</i>	587
FRANCESCO GABELLONE, IVAN FERRARI, FRANCESCO GIURI, MARIA CHIFFI, <i>3D technologies for a critical reading and philological presentation of ancient contexts</i>	591
ANTONIO PECCI, FABIO DONNICI, <i>When there was no GIS system: rediscovering archaeological researches of the 19th century through the use of the drone. The case study of Mount Siri (Anzi, Basilicata)</i>	597
MARTIJN VAN DER KAAIJ, <i>Heron Visualisation Engine. Visualisation and dissemination of semantic cultural heritage data</i>	603
TATIANA VOTROUBEKOVÁ, <i>Etruscan rock-cut tombs with decorated façades. A 3D approach</i>	609

SEEING INTO THE PAST: INTEGRATING 3D DOCUMENTATION
AND NON-INVASIVE PROSPECTING METHODS
FOR THE ANALYSIS, UNDERSTANDING
AND RECONSTRUCTION OF THE ANCIENT POMPEII.
THE CASE OF THE HOUSE OF OBELLIO FIRMO (IX, 14)

1. THE FRAMEWORK OF THE *GRANDE PROGETTO POMPEI – PIANO DELLA CONOSCENZA*

In 2015 the Department of History and Cultures of the University of Bologna took part in the *Grande Progetto Pompei – Piano della Conoscenza*, with the task to accomplish a modern and complete documentation of the northern segment of the city (the so-called “Lotto 3”).

The *Grande Progetto Pompei*, financed by the European Union and Italy, is an ongoing very ambitious programme, which involves all the crucial aspects that a complex site like Pompeii has to offer, included the needs of knowledge, safety, conservation, capacity building, communication and fruition (<http://www.pompeisites.org/Sezione.jsp?idSezione=357>).

As part of this, the *Piano della Conoscenza* was a programme involving analytic documentation of the state of conservation of the ancient city, which promoted a detailed topographic survey and degradation mapping of all the surviving structures. To reach this goal the city was divided in 6 areas, which were assigned to 6 different project teams. The so-called “Lotto 3”, assigned to the University of Bologna, corresponds to the northern area of Pompeii (*Regiones* III, IV, V, IX), included between Via Vesuvio, Via Stabiana and Via dell’Abbondanza, for a total surface of 7.2 ha.

More in general, the new programme has become the fundamental instrument in systematically and continuously monitoring the site, finally, and for the first time ever, providing an accurate and comprehensive picture of the conservation state of every building in the ancient city. The huge computerized archive produced by the programme gave rise to an invaluable data bank, that is essential both for research and for scheduled maintenance as well as for planning the upcoming restorations out.

Before today, the monuments of Pompeii had a comprehensive mapping at a 1:500 scale. With the *Piano della Conoscenza*, a 1:50 scale survey was carried out, achieving a mapping that is 10 times more accurate than the previous one. This represents a very important and detailed record of all the survived archaeological evidence, articulated in walls, pavements, finishes and fixtures (such as balconies, *impluvia*, tubs, stairs, etc.). The new documentation is even more significant considering the mapping of all the elements

of disrepair, such as gaps and lesions, and of all the traces of plaster on the walls, as well as of the bricklaying techniques. All of these elements have been recorded and recreated also in shapefile format in order to connect and manage every information into a GIS platform.

The field work was organized in teams with archaeologists, topographers and photographers. The project also included inspections by teams made up of archaeologists, architects, restorers, engineers, and structural experts. Thanks to this collaboration, an interdisciplinary and complete documentation of the conservative state of the whole ancient city was accomplished, on which every building element is also quantifiable in terms of geographic referencing and metric extension.

The “Lotto 3” is characterized by the presence of buildings of particular relevance and high monumental impact, as the House of the Nozze d’Argento, the House of Marco Lucrezio Frontone, the House of Marco Lucrezio Stabia and the House of Obellio Firmo.

Besides an aerial photogrammetric survey by means of drones, the plano-altimetric and photogrammetric survey of the whole sector was accomplished using total stations, laser scanner and high-resolution cameras. This advanced topographic survey allowed the production of detailed plans, vertical sections and perspective drawings, with the characterization of the employed building techniques, as well as of a photogrammetric documentation that has constituted the basis for the analysis and mapping of materials and structural degradation in the whole “Lotto 3”.

2. NEW RESEARCH IN THE HOUSE OF OBELLIO FIRMO

After this experience, in 2016 a new project has been started in agreement with the former Soprintendenza Pompei, focused at the study, preservation and enhancement of the House of Obellio Firmo, always included in the northern sector of the ancient city.

This is one of the oldest *domus* in Pompeii, that was built during the pre-Roman Age for a local important family. It remains to be seen whether or not this family had been that of the *Obellii* ever since the origins of the house, a family who inhabited the structure prior to the eruption and played a leading role in the city’s politics.

The building is a big residential complex, which with the facade occupies the entire short side of the urban block, and is articulated on two *atria* and a peristyle. The first *atrium*, with Corinthian columns in tuff, was monumental and enriched by a fine marble decor aimed at underlined the aristocratic status of the owner. The second *atrium*, smaller and with Doric columns, was surrounded by residential and service rooms.

The new research contemplates an in-depth analysis of the house,



Fig. 1 – The House of Obellio Firmo, panoramic view and laser scanning survey 2016 of the tetrastyle atrium. Photo and data processing: M. Silani.

employing systematically laser scanning and photogrammetry methods in the direction to generate a geometrically and photometrically accurate 3D model of the whole building. To reach this goal we decided to repeat the laser scanning survey carried out during the *Piano della Conoscenza*, employing a laser scanner of new generation, which fosters the acquisition of highest quality 3D data and HDR imaging, warranting range and angular accuracy paired with low range noise and survey-grade dual-axis compensation. The new employed instrument led to a highly detailed 3D colour point clouds mapped in realistic clarity (Fig. 1).

The new laser scanner mapping will foster a detailed documentation in 1:50 scale, not only regarding the planimetry but also derivate products such as sections and prospects. Furthermore, it will also be possible to document recent restoring interventions carried out thanks to the *Grande Progetto*

Pompei and to compare the present structure's conditions to those recorded in 2015. Finally, the obtained millimetric detail will be essential to the surface modelling of the entire building.

In parallel, we proceeded with a further photogrammetric documentation by means of panoramic and full-frame Digital Single-Lens Reflex (DSLR) cameras, both for the colouring of point-clouds and for the extraction of high-res orthophotos to be applied to the 3D model in progress.

The new generated model is going to constitute the starting point for the further analysis of the walls' stratigraphy, with the aim to recognize and interpret the stratigraphic relationships between walls structures and stratigraphic units.

Thanks to these new experiences it has also been possible to document in high-resolution all the ornaments, paintings and finishes in terms both of rigorous geometry and of photo-realistic restitution.

In particular contexts such as the wall paintings of certain *cubicula*, it became necessary to document every detail with great care, both geometrically, by augmenting the single-scan resolution, and in the radiometric resolution. To that purpose, many images were acquired using different techniques and digital cameras. Taking advantage of these methods the following elements were acquired:

- a spherical image starting from the internal camera of the laser scanner itself, made by 274 photograms of 4 megapixel each to obtain a colossal spherical image with the 1 Gb scan;
- a spherical image, also with a camera inside the laser scanner, also made by 274 photograms, although acquired with the HDR technique, and a 3 step exposition for every single photogram, thus obtaining a spherical image of ca. 50 megapixel;
- a spherical image with the panoramic camera NcTech Istar 360, at a 9 step exposition to obtain a spherical image of 50 megapixel;
- and finally the acquisition of 15 photograms with a full frame camera Sony Alpha 7R II of 42,4 megapixel for the creation of a spherical image to apply by means of point cloud.

Experimenting different techniques of acquisition and comparing results let us define the best solution for the documentation of the main decorative features and their relative details.

In the same manner, it was decided to augment the detail level in the documentation of certain small objects inside the House of Obellio Firmo.

Keeping going down this road, the main elements of the furniture, such as the *lararium*, the *tabula vasaria*, the *trapezofori* and the wooden strongbox, have been measured having recourse to structured-light 3D scanner, able to reach an accuracy under the millimeter and an exact geometric reconstruction of the surface shape.

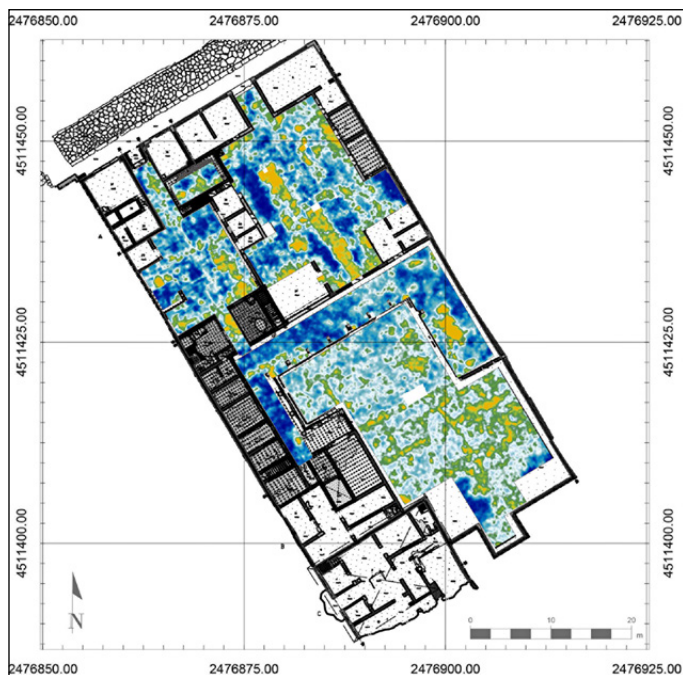


Fig. 2 – House of Obellio Firmo, GPR survey of the main open spaces. Slice maps' depth 0.50-0.70 m. Data processing: F. Boschi.

The full-scale deepened documentation of the house also includes a detailed geophysical mapping of all the accessible domestic spaces, systematically employing the ground penetrating radar technique. The survey, carrying out using a system equipped with a 600 MHz antenna, was characterized by an extremely high resolution data recording. This has fostered the production of a detailed 3D documentation of also the evidence that lies beneath the surface, represented by the numerous slice-maps which describe the subsoil under pavements and ground at different depths.

At the present state of works the high-resolution Ground Penetrating Radar (GPR) mapping covered all the largest open spaces of the building, included both the *atria*, the *peristilium*, the garden of the *peristilium*, as well as many others smaller service and domestic rooms (Fig. 2).

Besides the detection of all the buried infrastructures, such as pipelines and tanks, particularly impressive are the data collected in the garden. Indeed, here the geophysical survey clearly shows the presence of remains of foundation walls, which for characteristics of shape, layout and dimensions are referable, with every probability, to earlier divisions of the housing unit.

3. NEXT STEPS AND EXPECTED RESULTS

The preliminary results achieved by the non-invasive prospecting survey are being integrated with the analysis of the standing walls, in terms of structural stratigraphy, building techniques and materials. This combined work has been supporting in a worthwhile way the archaeological reconstruction and interpretation of the house's history, with regard to its first genesis as well as to its main development phases during the centuries.

To reach this goal, the management and sharing of the amount of the gathered information, related to both the out-of-ground elevated structures and the subsoil, will be organized within a comprehensive 3D model and within a Building Information Model (BIM). The 3D model, that is a work in progress, is a mesh model and represents the basis for the production of a parametric model, which will be managed in a BIM project.

The “total” approach we are adopting to study the House of Obellio Firmo, which we could define as four dimensional, aims to encourage the pursue of all the main goals of the projects, which includes:

- the reconstruction of the historical phases of the House, trying to go back in time before the moment fossilized by the eruption in 79 AD and with particular attention to the oldest Samnitic phases;
- the outline of a well-founded strategy of intervention for the next restoration activities of the whole building;
- the enhancement and public fruition of the House, only recently re-opened and integrated to tours¹.

MICHELE SILANI, ENRICO GIORGI, FEDERICA BOSCHI

Alma Mater Studiorum – Università di Bologna
Dipartimento di Storia Culture Civiltà

michele.silani2@unibo.it; enrico.giorgi@unibo.it; federica.boschi5@unibo.it

GABRIELE BITELLI

Alma Mater Studiorum – Università di Bologna
Dipartimento di Ingegneria Civile, Chimica, Ambientale e dei Materiali
gabriele.bitelli@unibo.it

ALBERTA MARTELLONE

Parco Archeologico di Pompei
alberta.martellone@beniculturali.it

¹ This manuscript derives from the fruitful teamwork carried out on the field (and not just) by all the authors, who wrote together the first. The central part of the paper, entitled *New research in the House of Obellio Firmo*, is due to Michele Silani. The final paragraph is due to Federica Boschi. The included images were elaborated by Michele Silani and Federica Boschi on the basis of data owned by Soprintendenza Pompei.

ABSTRACT

In 2015 the Department of History and Cultures of the Bologna University took part in the *Grande Progetto Pompei – Piano della Conoscenza*, with the task of providing a modern and complete documentation of the so-called Lotto 3 in Pompeii. The new survey was carried out by means of integrated innovative diagnostic survey techniques in order to provide a total documentary research of the whole sector. In 2016 a new project was started in agreement with the competent Superintendency, and focused on the study and preservation of the House of Obellio Firmo, included in the Lotto 3 of the Roman city. The new research contemplates an in-depth analysis of the building, employing systematic laser scanning and photogrammetry methods to generate an accurate 3D model of the house. This model is going to constitute the starting point for the further analysis of the wall stratigraphies and for the mapping and monitoring of the structures' state of decay. The full-scale analytical documentation of the building also includes a detailed geophysical mapping of all the accessible domestic spaces, by using the ground penetrating radar technique. The preliminary results achieved by the non-invasive prospecting survey, integrated with the analysis of the surviving walls and building techniques, supply valid information for the archaeological interpretation of the house's history. In order to allow the management and sharing of the information collected, the data are going to be organised within a building information model (BIM) with a triple objective: the reconstruction of a fragment of the ancient urban landscape in Pompeii during the oldest phase, with particular attention directed to the Samnitic period; the outlining of a precise strategy of intervention for the restoration and preservation of the House of Obellio Firmo; the re-opening of the building to sightseeing tours and its restitution to public use.

28.2

2017

Knowledge, Analysis and Innovative Methods
for the Study and the Dissemination of Ancient Urban Areas
Proceedings of the KAINUA 2017 International Conference

€ 72,00

ISSN 1120-6861

e-ISSN 2385-1953

ISBN 978-88-7814-785-0

e-ISBN 978-88-7814-786-7



9 788878 114785 0

ARCHEOLOGIA
E CALCOLATORI