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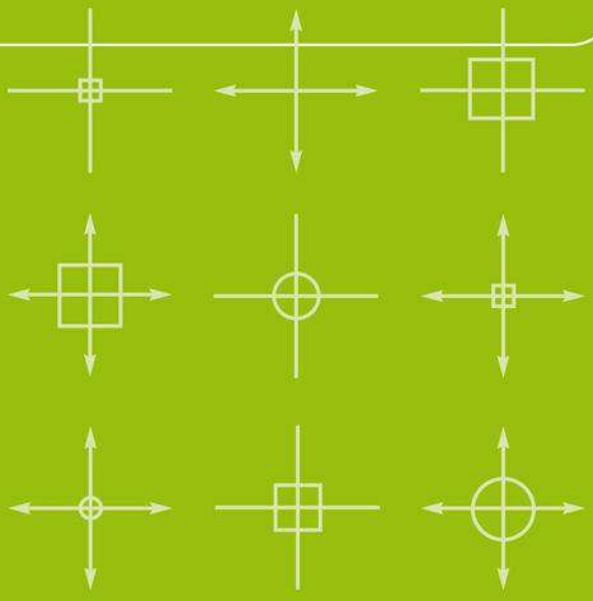
Proceedings



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Subject to modifications,
Vienna, 2012

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Preface

Karin FISCHER AUSSERER

Director of the City of Vienna Department of Urban Archaeology

Dear Colleagues,

on behalf of Urban Archaeology Vienna I would like to wish you all a warm welcome to the 16th International Conference on Cultural Heritage and New Technologies (CHNT) here in The Coat of Arms Halls of Vienna City Hall.

Over the years this event has evolved from a modest gathering of a small number of archaeologists to an internationally recognised event attended by experts from around the globe.

As decided by the scientific committee at last year's post-conference meeting, this year's event marks the start of a five-year conference cycle. This year's theme of "Prospection, Survey and Data Integration" will be followed in 2012 by "Excavation"; 2013 "Correct Documentation"; 2014 "Processing" and concluded in 2015 by "Public Relations". This series of five consecutive conferences will consider these aspects of archaeology and cultural heritage with a particular focus on urban archaeology.

At this point I would like to thank the members of the scientific and local committees and the chairs for their great dedication and without whom this conference would not be possible.

Taking place for the first time this year is the section "Urban Archaeology" with the theme "Streets, Roads and Squares". In this section, the technological issues will step back and let the archaeology itself be the main focus. The planning and realisation of this section will be lead by staff from Urban Archaeology Vienna, whom I would also like to greatly thank.

The "Vienna CHNT Poster Award" is taking place for the third time this year and enjoying growing popularity. It presents a good opportunity for many newcomers to get their first taste of a conference and perhaps lead on to a full presentation in next year's "Newbies" session.

I must not forget to thank the rest of the staff at Urban Archaeology Vienna, as well as the various departments of Vienna City Council, whose assistance in the planning and execution of the conference has again been essential.

Finally, I would like to wish the conference a smooth run and hope that all participants have three days full of new information, ideas and discussions, but also a little time to enjoy the Viennese hospitality and the wonder of this magnificent city.

The Roman town of *Ammaia* (Portugal):

From total survey to 3D reconstruction

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Abstract: Simultaneous with on-going archaeological excavations of the Roman town site of *Ammaia* in South-Central Portugal, a group of researchers acting within the EC funded project "Radiography of the Past (Radio-Past)", have during the past two years, achieved a full coverage geophysical survey of the intra-mural part and large tracts of the extra-mural areas of this abandoned ancient city in *Lusitania*. Using a wide array of instruments, for prospections with GPR, earth resistance and magnetometers, this approach allowed an in depth analysis of an abandoned Roman centre, linking the excellent survey data with stratigraphic information, obtained via earlier excavations and via focused ground truthing operations, including small trenching and augering. Together with data from remote sensing and fine DGPS surveys this now allows to study the urbanism of a very systematically and *ex novo* built Romano-Lusitanian town. Part of the field project also leads to a tentative reconstruction of many aspects of the urban pattern and structures, providing a unique high resolution survey-based approach to visualising ancient cities. This paper presents aspects of integrated methodology of survey, high resolution mapping results and discusses the process of visualisation of the site in Roman times.

Keywords: non-destructive survey, Roman towns, Lusitania, 3D Visualisation, Reconstruction.

The project *Ammaia*: the framework

As recent research is more and more proving (CAMPANA and PIRO 2009; CORSI and VERMEULEN 2010; VERMEULEN et al. 2012; MILLETT and JOHNSON forthcoming), the integrated approach, merging traditional instruments of research like surface artefacts collection, aerial photography interpretation, topographical survey and excavations, with up-to-date techniques of geophysical and geomorphological survey, is disclosing new perspectives in our knowledge of complex (still buried) archaeological sites. In most cases, this synergy allows the production of a 2D map of the site, where excavated evidence can be paralleled with buried structures detected via the interpretation of the geophysical survey and/or aerial photography coverage. Three-dimensional perspective can be achieved with the integration of Ground Penetrating Radar (GPR) data, corings, test pits, ground-truthing excavations and production of Digital Terrain Models (DTMs), while the overlap with the processing of the finds collected on the surface can enlighten some aspects of chronological occupation and evolution of the site. These peculiar aspects of studying and visualizing deserted archaeological sites are the core objectives of an EU funded project, the

People/Marie Curie IAPP project short-named Radio-Past[1]. The researchers of the project, composed by staff of four academic institutions (the University of Évora in Portugal, Ghent University in Belgium, the University of Ljubljana in Slovenia and the British School at Rome, a UK institution) and three SMEs (the companies 7Reasons Media Agency from Austria, Past2Present from The Netherlands and Eastern Atlas from Germany), integrated with post-doc recruited researchers, join their resources and very different skills to tackle each possible aspect connected with archaeological survey, mainly on (abandoned) urban sites.
The project Radio-Past seeks mainly pathways to integration of different methodologies in the wide and by now spectacularly developed field of non-destructive survey systems and technologies applied to archaeology, but also pursues the valorisation of the results by innovative ways of visualisation and the development of strategies for efficient management of the sites. Furthermore, the project also concurrently targets the development of effective scientific systems for the dissemination of survey results. In particular, the combination of high-resolution fieldwork with computer-based means of mapping and data visualisation, should allow virtual reconstructions of a buried town or large settlement within a relatively short space of time, as opposed to the more traditional excavation-centred approach that could take generations before a broader view of the site becomes available.
The operational strategies and the integration of different approaches is tested in several “open laboratories”, selected archaeological sites spread over the Mediterranean and continental Europe, where different teams of researchers gather during survey campaigns. The most important “open-lab” of the project Radio-Past is the archaeological park of the Roman town of *Ammaia*, in Portugal.
Here many research and fieldwork activities are carried out since the mid Nineties, under the scientific direction of the Universities of Évora and Coimbra first, and under the sole direction of the University of Évora since 2007. The latter is also piloting other projects in partnership with the Portuguese National Research Fund (FCT) and several universities (Cassino, Ghent and Lisbon: see CORSI 2012: 159–163), where *Ammaia* is the main target of scientific research.
The site, being a deserted Roman town, now almost completely free from modern constructions but with the unfortunate exception of a state road cutting through the archaeological site, very limitedly agriculturally exploited (mainly olive trees), has been declared “Monument of National Interest” in 1949. Now, the management of the site and of the in-site small museum is attributed to the Fundação Cidade the *Ammaia*, which also owns the lands on which most of the estimated intramural surface of the Roman town extended.
Ammaia was a mid-size town located in central Lusitania (Fig. 1), possibly founded in Augustan age (end of the first century b.C.–beginning of the first century AD), which in the time of the emperor Claudius (first half of the first century AD) was elevated to the status of civitas, and only later became a municipum (terminus ante quem: emperor Lucius Verus, 161–169 AD). Its ruins (Fig. 2) are located in the Freguesia of São Salvador de Aramenha, in the municipality of Marvão, in the heart of the Natural Park of the Serra de São Mamede, a mountainous area of east-central Portugal, extending into Spanish territory.

[1] ‘Radiography of the past, integrated non-destructive approaches to understand and valorise complex archaeological sites’, starting date 1 April 2009, duration 48 months: see: www.radiopast.eu, VAN ROODE et al. 2012. The research leading to these results has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 230679, under the action Marie Curie – People IAPP.

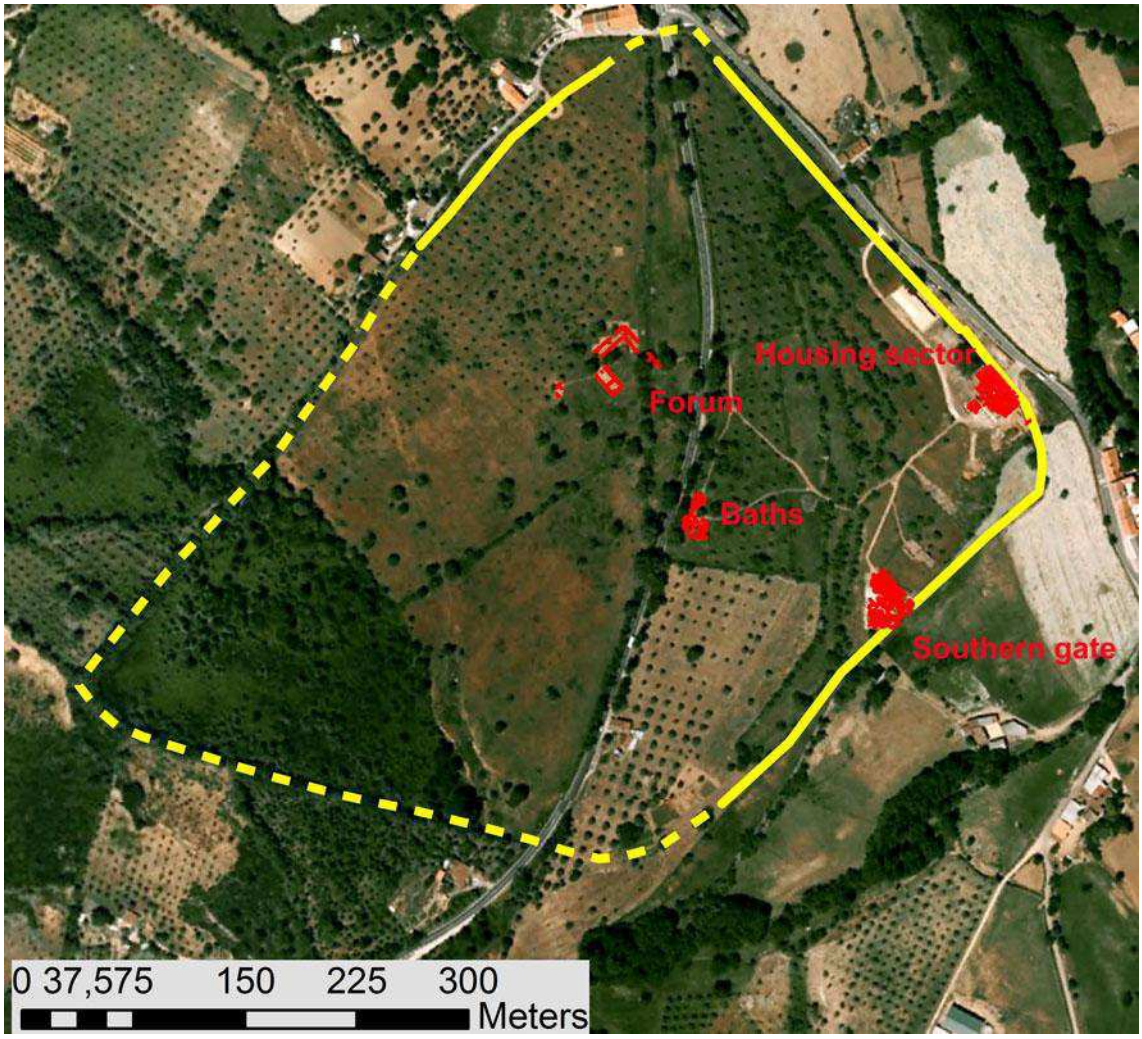

Fig. 1 – *Ammaia* (S. Salvador de Aramenha, Marvão - Portugal): view from the air of the site with the indication of the main excavation areas (Copyright: Radio-Past).

The datasets

Until the beginning of the twenty-first century, archaeological research in *Ammaia* has been limited to traditional excavations, concentrated on areas where ruins were still visible above ground (see Fig. 1), as is the case in the area of the Southern gate (Porta Sul: Fig. 3, n. 3); the Forum area (Fig. 3, n. 5), where the concrete nucleus of the main temple's podium is still visible and where excavation trenches brought to light segments of a *cryptoporticus;* the main bath complex of the town (Fig. 3, n. 4). Excavations have also been carried out in zones where some restoration work has been conducted, such as in the area around the building that houses the archaeological museum, the 17th-century farm called Quinta do Deão (Fig. 3, n. 1), or where facilities for the archaeological park were planned, such as the visitors car park in front of the museum (Fig. 3, 6). Stratigraphical excavations have been resumed for certain areas in recent years: in the thermal complex (campaigns 2008, 2009, 2011: CORSI and VERMEULEN forthcoming) and in the Forum area with focused excavations in the porticos area (campaign 2010), and the opening of a big trench in front of the temple mainly meant as "ground-truthing" operation for the high-resolution geophysical survey

performed in the Forum area (see further; campaigns 2010–2011: VERMEULEN, CORSI and DE DAPPER 2012).

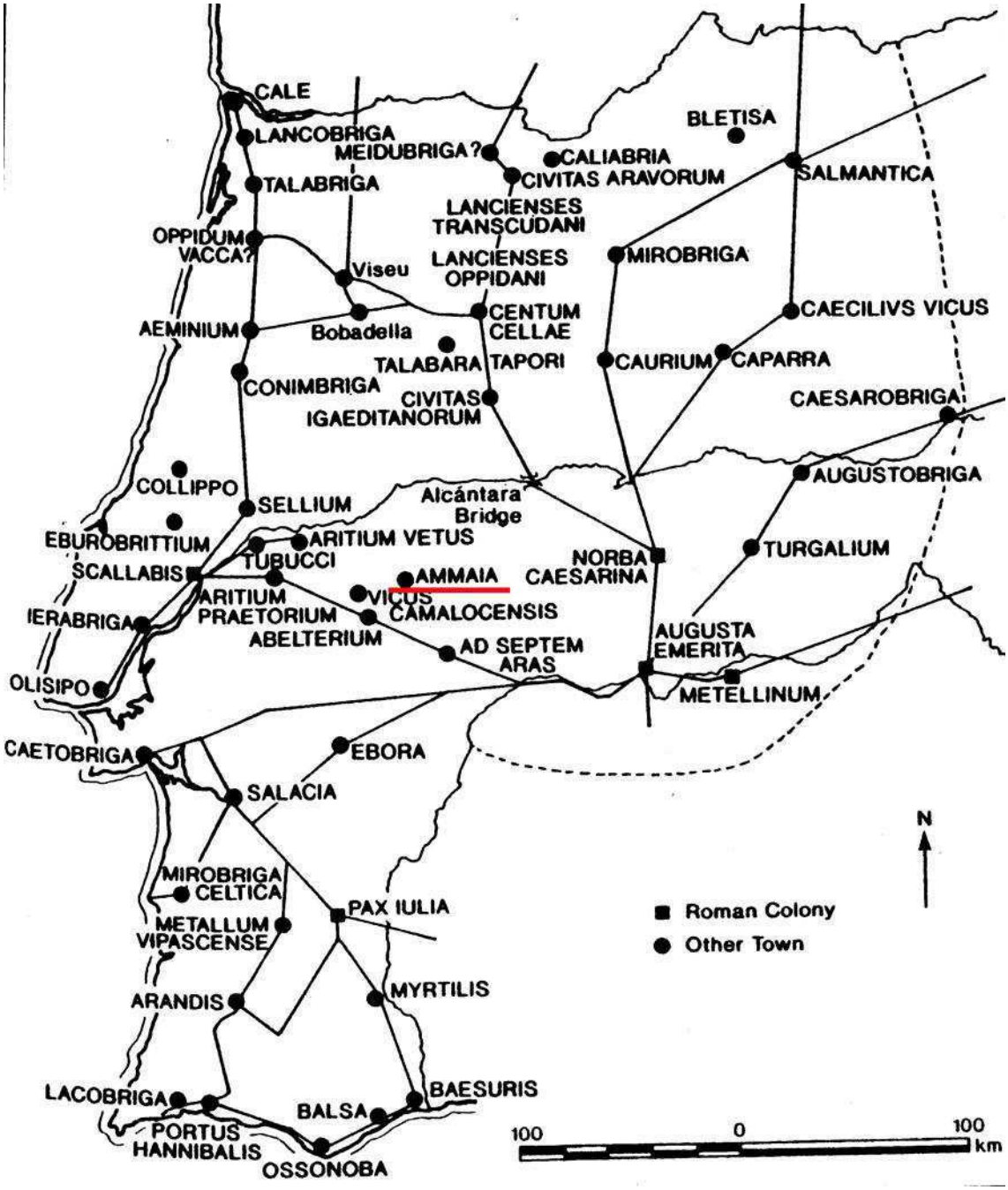

Fig. 2 – Map of the Iberian peninsula with the indication of the delimitation of the *provinciae* and location of the most important Roman towns (After: Edmonson 1990).

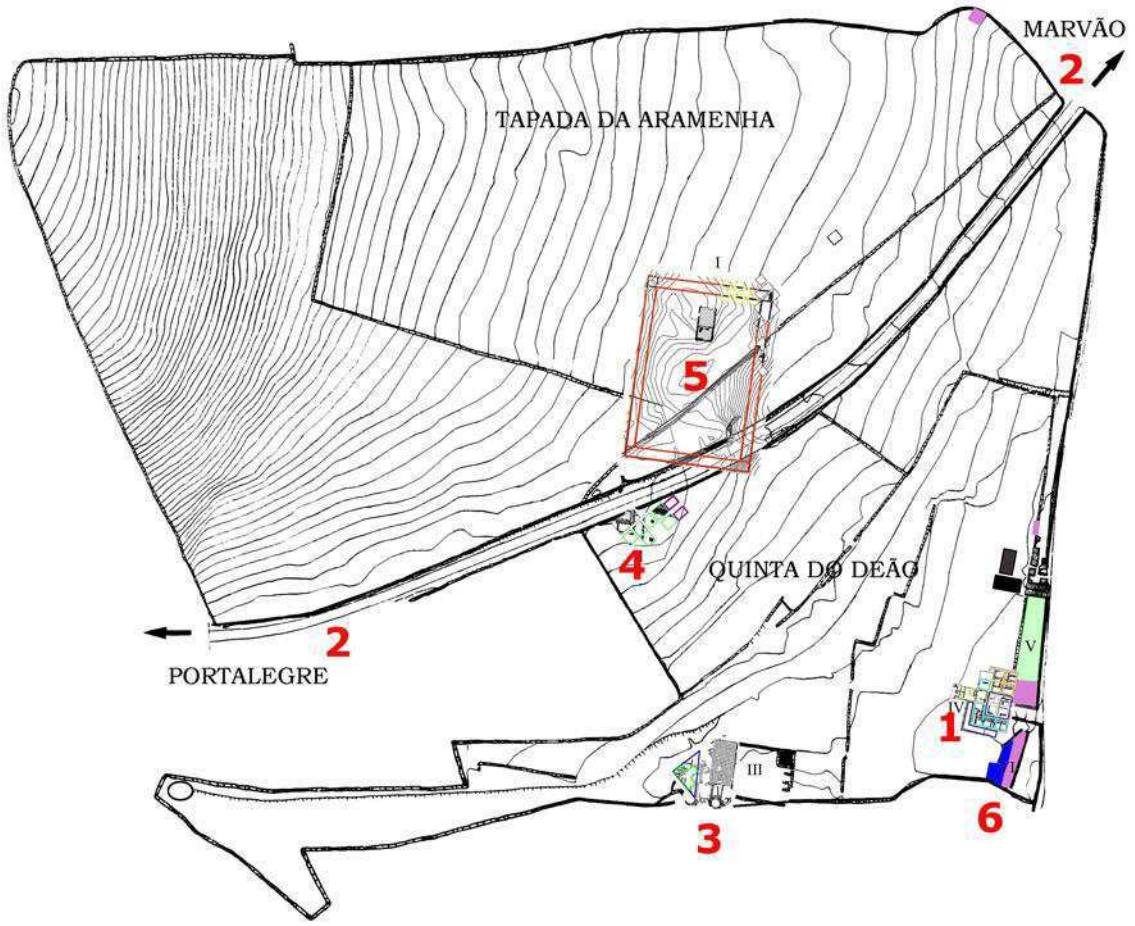

Fig. 3 – São Salvador the Arameñha (Marvão). Delimitation of the area owned by the *Fundação Cidade de Ammaia*, including most of the intramural surface of the Roman town of *Ammaia*. Numbers indicate the location of: 1) the on-site museum hosted into the building Quinta do Deão, 2) the modern road connecting Marvão to Portalegre, 3) the excavated area of Porta Sul, 4) the excavated area of the Thermal bath, 5) the partially excavated area of the Forum, 6) the excavated part of the town wall. Elaboration: C. Corsi, on the base of the cadastral map (copyright: *Fundação Cidade de Ammaia*).

Starting in 2001 a geoarchaeological survey was undertaken by a joined team of archaeologists and geomorphologists from the universities of Ghent and Cassino, with the most important results of the discovery of a long segment of one of the aqueducts of the town and a first proposal for the location of the town walls of Ammaia (Fig. 2) based on surface remains, excavated evidence, and morphological observations (VERMEULEN et al. 2005; CORSI and VERMEULEN 2009). The proposed enclosed urban area, of c. 20 hectares, is situated on lightly sloping terrain near water resources and lies between two narrow palaeo-valleys connected perpendicularly with the River Sever. In this proposal, the walled zone extended to include the small hilltop of Malhadais, probably incorporated for strategic purposes, even if it is our belief that this uphill area was nonetheless never occupied.

As anticipated, the site of Ammaia was chosen by the Radio-Past project as test site for the integration of a wide set of approaches and multidisciplinary survey techniques. We will focus here on the geophysical survey, carried out with different methods and by different teams from 2008 until the autumn of 2011. At the present state of research we can present the results of a full intra-mural magnetometry survey (with the exclusion of the steep slope) for a total extent of 18 hectares (AAPS Southampton and Paul Johnson for the

Radio-Past project); a GPR high-resolution survey for the central area of the town and along the national road N359 (Lieven Verdonck, Ugent, Radio-Past), a high-resolution magnetometry and RES survey of the Forum area (Jeroen Verhaegge, Ugent), a RES survey of a selected area (Paul Johnson, Uevora, Radio-Past), an extensive magnetometry survey of the extramural area (Eastern Atlas, Radio-Past).

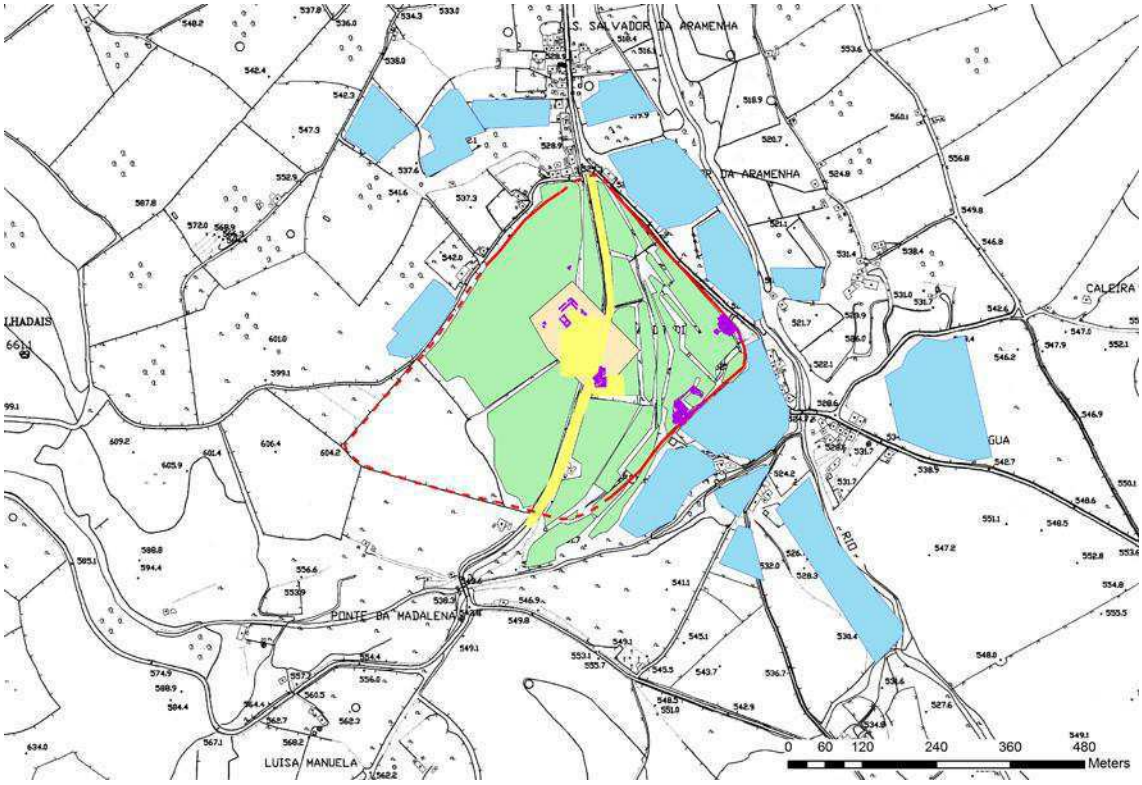

Fig. 4 – *Ammaia*: Area investigated with georadar (yellow, 2008–2010: L. Verdonck), with magnetometry survey (grey, 2009: University of Southampton and J. Verhaegge) and with magnetometry (green, 2010–2011: P. Johnson; blue: Eastern Atlas) on the base of the estimated intramural surface. The presence of the modern road connecting Portalegre to Marvão and archaeological evidence (in red) are also indicated (Elaboration: C. Corsi).

The data interpretation

These datasets have offered invaluable information for many different aspects of the Roman town. The collection and integration of digital data at *Ammaia* aims mainly to assemble and interrelate fragmented data into a more informative whole, so as to increase their interpretive value. For the implementation of these aims a number of digital tools are being employed. Since most of the datasets consist of spatially referenced information the use of Geographical Information Systems (GIS) has been an integral part of data management. Data integration in a GIS significantly facilitates the interpretation of geospatial information, either by simply enabling the combined visualization and interrelation of different datasets, or via the use of spatial analysis and statistics. Several specialists are engaged at the moment in making the best profit of the data integration and in trying to visualize the townscape in its natural environment.

(C. C.)

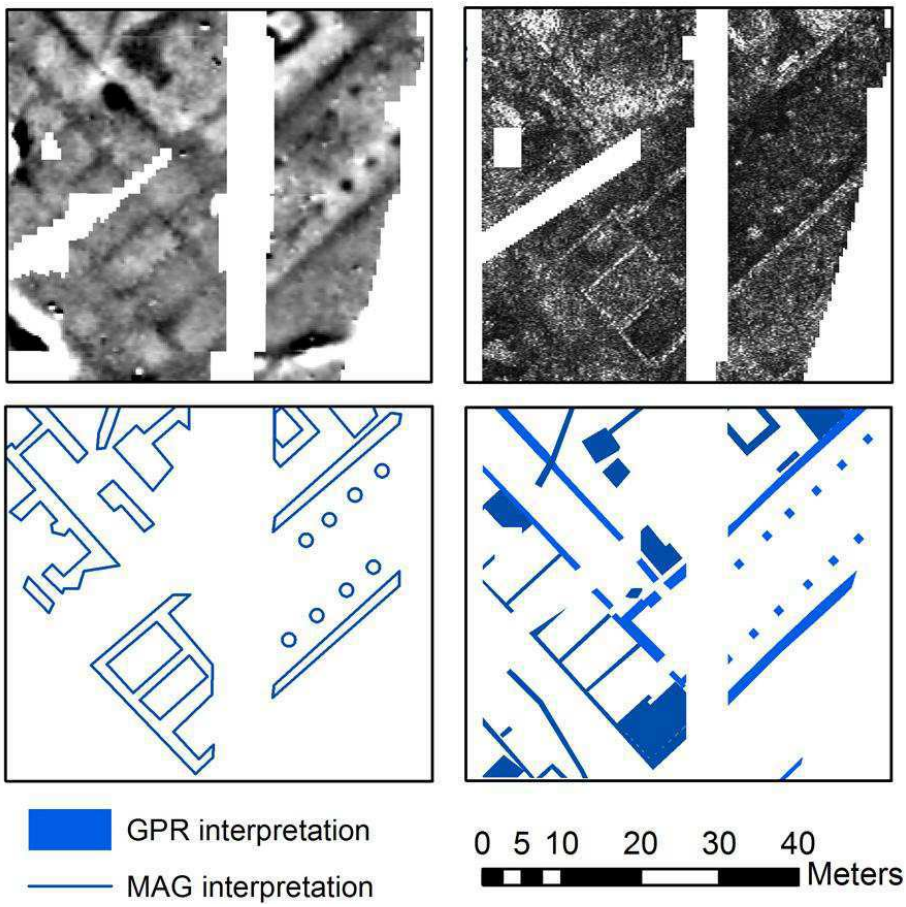

Fig. 5 – Upper left: greyscale image of the gradiometer survey results from the area of the "block XV" SE of the Forum (survey P. S. Johnson) compared with the greyscale image of the GPR survey of the same area (upper right, survey L. Verdonck).
Lower left: vectorised interpretation of the gradiometer survey from the area of the "block XV" SE of the Forum (survey P. S. Johnson) compared with the vectorized interpretation of the GPR survey of the same area (lower right, survey l. Verdonck) (Elaboration: E. Paliou).

The digital reconstruction

The visualisation of the geophysical results is approached by referencing the existing data with better preserved sites of the region and comparing similar structures and dimensions, aiming to preserve architectural local features and details of decoration.

Fig. 6 – Left: View of roman *Ammaia*, Right: The Forum Temple (© 7reasons).

Reconstruction of the visible Remains

Visualisation of "Porta Sul", the South Gate of Ammaia

Fig. 7 – Panorama of the visible remains of the southern city gate "Porta Sul" (© 7reasons).

In a first step the visible monuments of the "Porta Sul" (south city gate) were taken to sketch out some ideas of reconstruction in order to gather experience with existing data and their interpretation. Within this work, different information sources were assembled to create the possible reconstruction.
At first it seemed to be an easy task but then it showed problematic to interpret a valuable height for walls and roofing. The former arch of the Southern Gate was removed in the nineteenth century to be integrated in the city walls of the nearby town of Castello de Vide, but was later dismantled, thus a photo of that time was the only indication of the gates height, while the remaining basement gave exact measurements of its width, suggesting a rather decorative purpose of the "Porta" and the city walls (rather than a fortification purpose). A certain height was added to support architraves and decorative elements above and around the gate, whereas the dimension of the surrounding building could be defined by the visible remains.

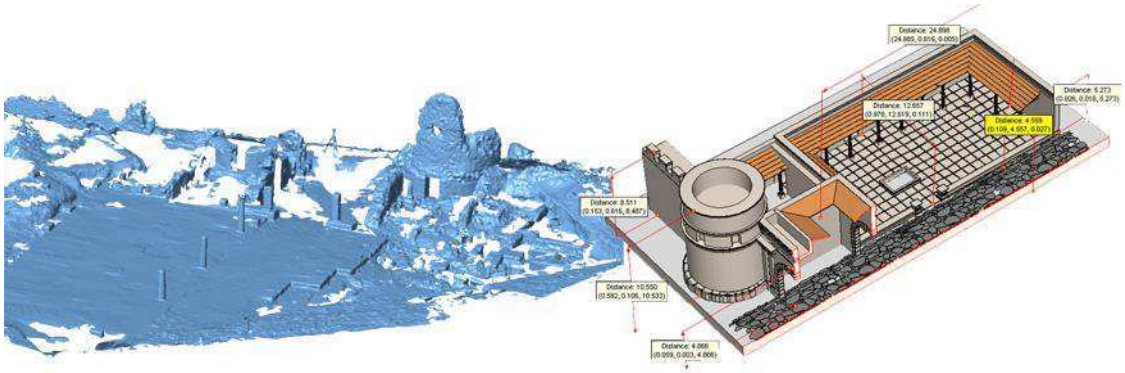

Fig. 8 – 3d Laserscan of the southern gate and a suggestion for its reconstruction (© 7reasons).

From the measures of these proportions we adapted other heights like the city wall and the towers, whereas the reconstruction of the latter is still undergoing intense discussions concerning the proportional fitting of the whole ensemble. The open spaces, to both sides behind the west side of the gates, are laid out with massive (approx. 1x1m) squared granite blocks forming a rectangular shaped square of approx. 23x12 m on each side, leaving us with a total open space of nearly 50x23 m (divided by a street of approx. 4 m width). It is

certain that a place of this size must have had a practical function. The exact usage is still unclear, but it is assumed that a possible market (macellum) connected to the north of the square might have existed here. Together with clearly visible, round marks (holes of approx. 7 cm, in regular interval, 3 m from the surrounding walls) a porticus could be proposed. Although there is no indication if these holes where used for posts, pillars or columns, their placements show that some shelter structure like tends or roofing could be expected. Some regular granite blocks are displayed along the border between the square and the street; they could be interpreted as plinths and they could have been laid down to divide the street from the square in order to keep dirt and water off the square. Together with the visible remains of a threshold on the north-eastern side of the square, and the trace of a basement of approx. 2x3 m (a statue?) various 3D layouts of the “Porta Sul” were made and discussed.

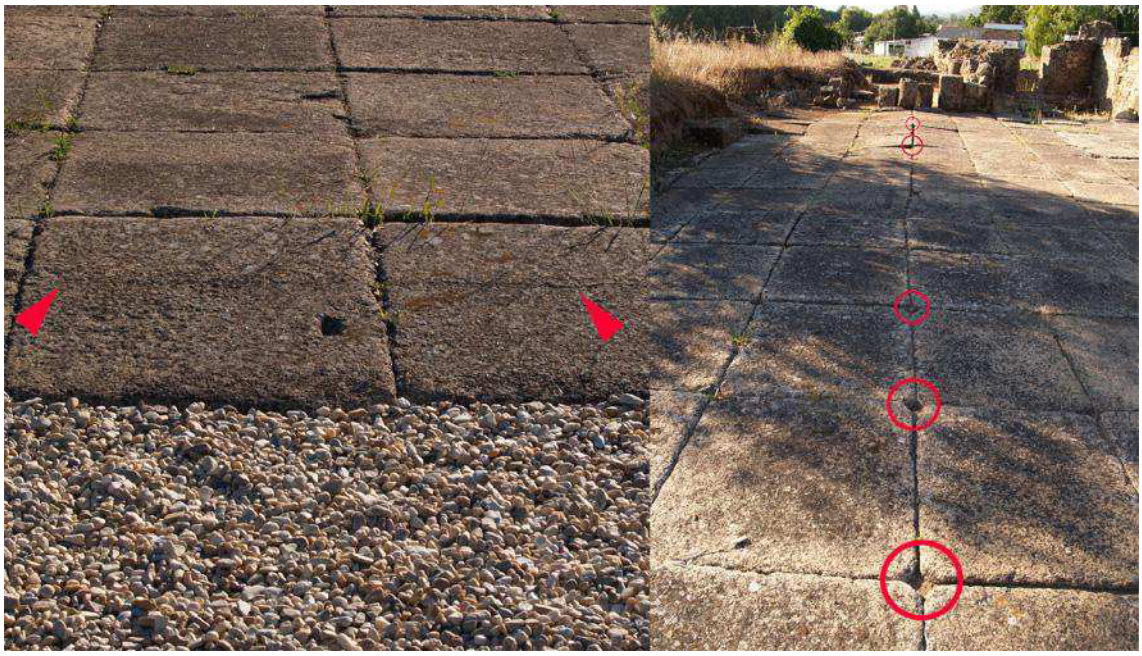

Fig. 9 – Left: Marks of heavy structures. Right: Holes in regular distance (© 7reasons).

The results showed that a first supposed colonnade along the street would have failed to support the architectural conception of the square, since the street width is too narrow to obtain the wanted optical effect, thus disturbing the appearance of the gatehouse, and it was therefore redrawn. In order to visualise the usage of a shelter surrounding the outer walls of the square, we placed a *porticus* according to the measures of the visible (post) holes, but we have to admit that also a much lighter structure, like a tent, held by wooden or iron posts could have been used.

The city wall and its towers are still standing up to 2,5 m and the remains give a good indication of dimension and thickness of these structures. The city walls, in the region of the gate, where approx. 2 m thick and were made in *opus caementicium,* faced with *opus incertu.* However, they, showed no signs of a stone socket, whereas the two towers did. The walls of the towers are approx. 1 m thick and it can be presumed that their height did not reach more that 10 m. Careful and, regular laid out openings in the tower and gate walls, of

aprox. 0,20x0,20 m, could indicate the usage of wooden posts, for construction purposes, but they could also have been used later to support different floor levels with wooden traverses.
While the present state of the 3d Model is quite acceptable, we hope to get more ideas for areas of the towers and the city wall through more comparable material and ongoing discussions. Since the complete reconstruction of *Ammaia* is the main aim of the project we will focus on the more prominent buildings and structures like the Forum, the Baths and the street-layout that surrounded them and we will certainly also refine the proposal on the base of the on-coming information and experiences, which then again can be integrated into an updated version of the "Porta Sul".

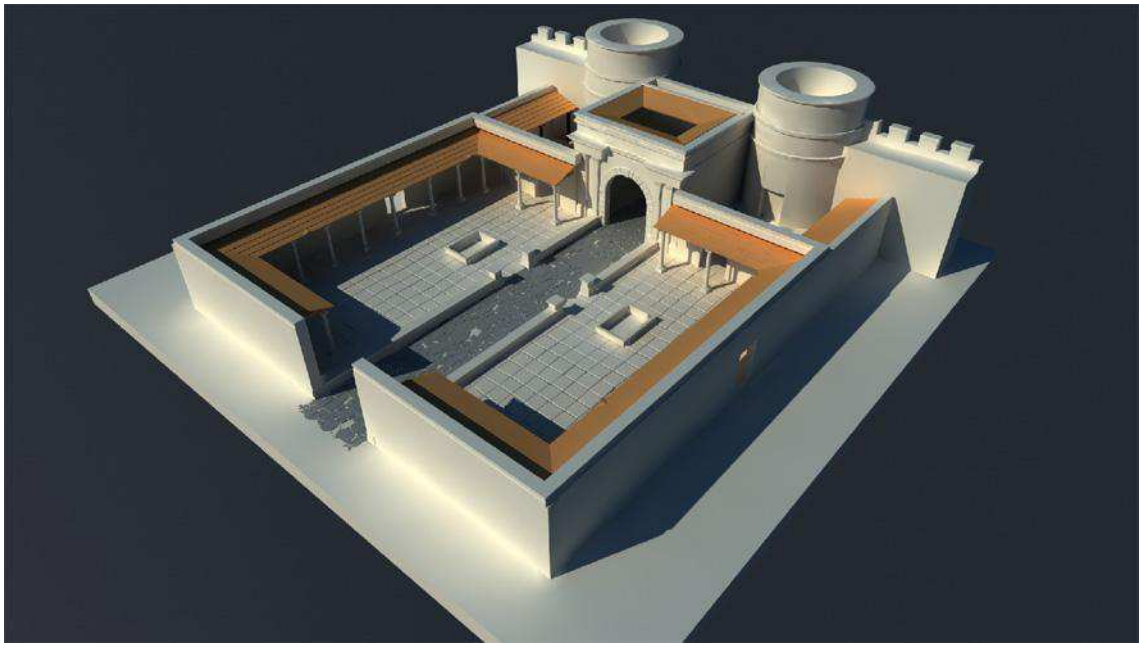

Fig. 10 – Reconstruction of the southern gate (© 7reasons).

Visualisation of the Forum

The Forum of *Ammaia* was partly excavated in the 1994–1998 campaigns, when "Wheeler's excavation squares" of 10x10 m were opened in the NE corner of the porticoes surrounding the Forum square. As these investigations did not apply archaeological stratigraphy and did not provide enough data for the chronological and typological definition of the complex, new stratigraphical excavations were undertaken during the summers 2010 (*porticus* area and the "esplanade" in front of the Temple) and 2011 (only the Temple area). To get a "wider picture" of the whole complex also various geophysical techniques have been applied (2008–2011) to help to understand the complete structure and plan of the building. The proposed dimensions of the complex measured approx. 65x88 m.
Data retrieved with excavations and comparative research with other better know examples from *Lusitania* were used to reconstruct the buildings heights. The excellent results of the geophysical prospections could reveal the remaining structures laying beneath, giving us enough information to reconstruct the complete complex.

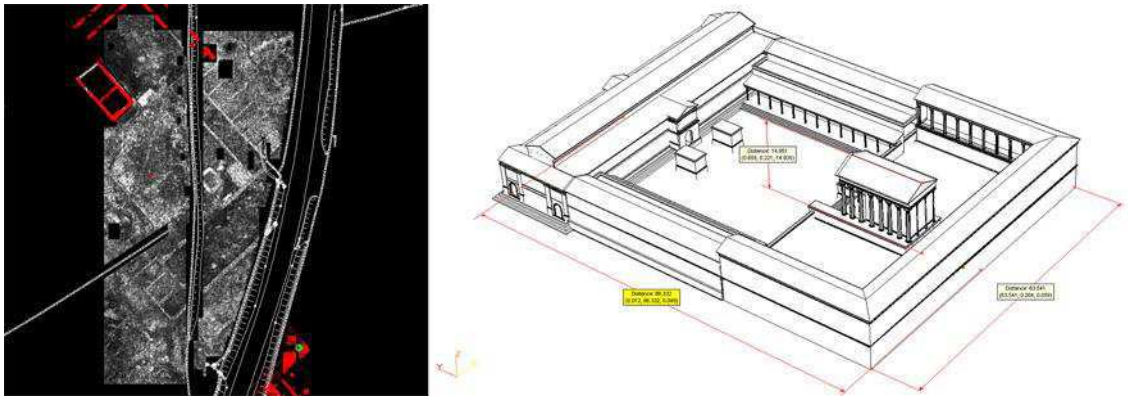

Fig. 11 – Left: Image and interpretation of the geophysical results of the Forum (© Radio-Past). Right: Suggestion for a Reconstruction of the Forum (© 7reasons).

The reconstruction started with the standing and excavated part of the Forum Temple, by searching for suitable comparisons in nearby sites. The Flavian Forum of *Conimbriga* could be used as an overlay, with almost identical dimensions, representing a height of approx. 18 meters (60 Roman feet, from base to the rooftop) whereas the used columns height was set to an idealistic 30 Roman feet (9 meters) leaving us with a perfect height for a “tetrastyle” with four columns on its front side resulting in a 1:2 proportion for its outline. The reconstruction of the temple of *Conimbriga* seemed to be very idealistic and a comparison with the temple of Évora indicated that these ideal proportions where not always used. It seemed that the heights might have been a bit lower than estimated and we, therefore, also redesigned the height of *Ammaia*’s Temple to approx. 15 meters.

The surrounding building of the sacral area is thought to be a *cryptoporticus* on the eastern side of the Forum, due to some indications like the size of the wall and some carefully comnstructed holes found in parts of the excavated walls, pointing to a possible substructure of posts and beams (wood or stone), carrying a floor above. It is not likely to assume a one storey building for the sacral porticoes, since the height of the temple would protrude the overall proportions of the ensemble, giving us opportunity to sketch out a total height of approx. 40 Roman feet (approx. 12 m) supported by columns of 20 Roman feet. The complex of taverns (*tabernae*) connecting southeast to the *cryptoporticus* suggests rather large dimensions of the shops (approx. 6x9 m each) with a portico facing the square of the Forum. It was therefore presumed that two floors existed here, reaching a total height of approx. 9 m (base to roof). A gallery (balcony) in the second floor (5–6 meters above ground) was added to allow light to pass to the rooms of the second storey. In terms of the building functions, this arrangement would allow for a trading and storage area in the basement (shops), extending the shops range by using partly the affiliated porticoes, as shop fronts (show case), while using the rooms of the second floor for administrative purposes.

The most prominent building of the whole complex, the Basilica, used for judicial, negotiation and trade purposes, was positioned opposite to the Temple. It had assumed main entrances in its axis and measured approx. 45x17 m. Since the “radiography” of this area showed, that the interval of the shop-walls continued through the structure on the short faces of the Basilica, we sketched out a protruded entrance, allowing us to line up its roof with the one of the chain of *tabernae*. It can be assumed, that the building had three “floors”, with the Basilicas lighthouse counting as a third floor supported by the columns of the middle ship. The

recommended height was, therefore, assumed to be approx. 12 m. In order to align three axes in the longitude of the Forum complex, the roof of the tavern buildings where thought in continuation of the *cryptoporticus* roof ridge, whereas the centre of the Basilica, with the preferred main entrance, was lined up with the crest of the temple roof. The radiography of the Forum's inner open spaces (market place, sacred place) showed clear indications of several build structures. It can be supposed, that various small shrines and monuments (like votive and decorative elements) were scattered over the square.

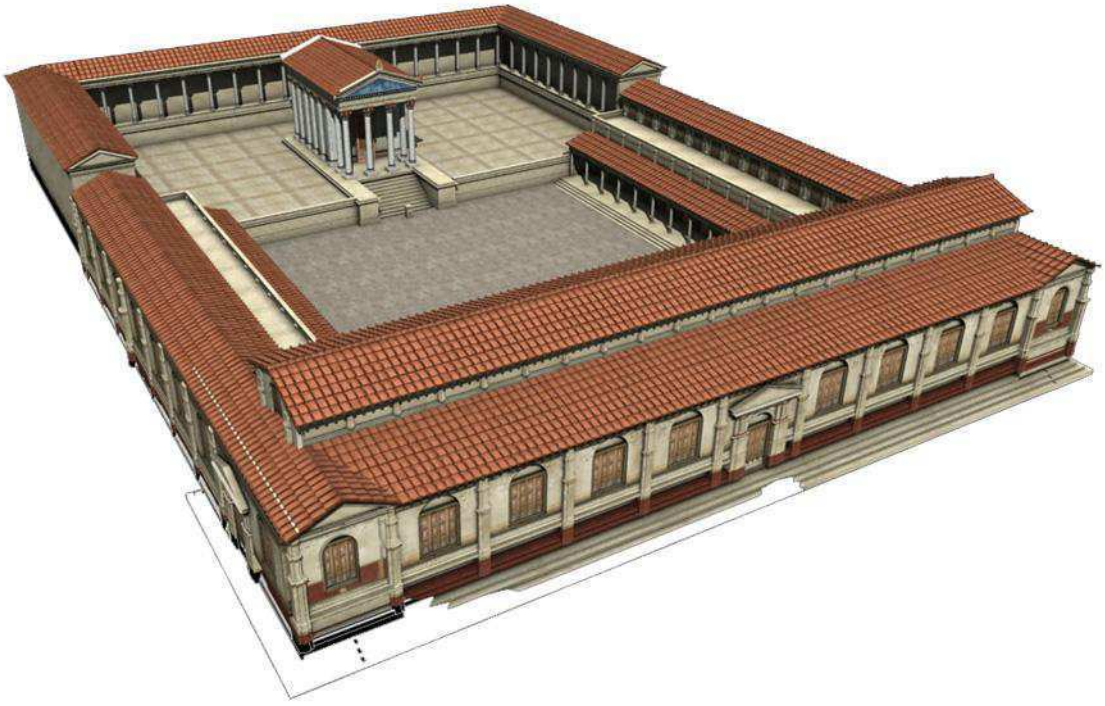

Fig. 12 – Reconstruction of the Forum of Ammaia (© 7reasons).

Reconstruction of the subterraneous remains

The reconstruction of the many still buried ruins of *Ammaia* is approached by using the interpretation of the geophysics results and comparisons of better preserved sites. In order to accelerate the modelling process, a 3D realtime editor (application for videogame production) was adapted to our special needs. The main features of this implementation provide the operator with a library of pre-made house-modules, which can be placed on the digitally imported 3D terrain, where each "block" of the town grid resembles a separate work environment.

The images of the GPR (Ground Penetrating Radar), as well as the results of the Earth Resistance and Magnetometer surveys, where then mapped to the according section of the virtual terrain model.

The preparation of the Building Block library "borrowed" some of the typological features from the nearby site of *Conimbriga,* but also characteristics of the well preserved Italian sites of *Herculaneum* and *Pompeii,* and were adapted to a locally reasonable proportion. This led to an average height of 3,5 m for the first floor and approx 2,5 m for the second floor, resulting in an average overall height of approx 8–11 m from bottom-floor to cornice height. The module structures are arranged to corner-parts (in two directions), middle parts and additive parts like porticos, balconies, gates and minor decorations. With this method we are capable to

sketch out ideas for the final reconstruction, discuss the results within the 3D environment with all team members and make eventual changes quickly. The resulting geometry can be exported to a 3D animation program as soon as a section has reached a satisfying state of reconstruction.

(M. K., G. W.)

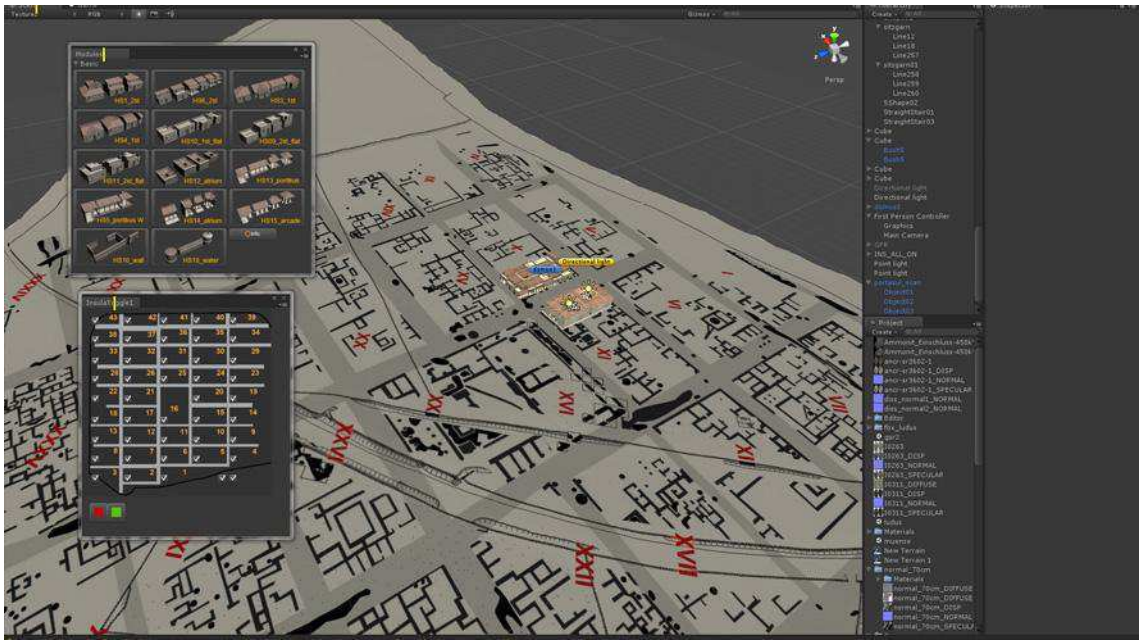

Fig. 13 – Screenshot of the 3d realtime editor with library items and the virtual terrain (© 7reasons).

Fig. 14 – Test result of a layout made from building blocks of the 3d Editors Library (© 7reasons).

Conclusions

As stated above, the reconstructions and visualisations are the result of interactive work and discussion among specialists of different fields (archaeologists, geophysicists, computer specialists, geomorphologists, …) and are based mainly on existing evidence and comparative research. In fact, as in the Past most architecture, especially houses, were built complying to a comparatively uniform code of design, presenting a common tradition of a social class or local tradition, it is easy to integrate excavation results with images of still existing built examples or historical descriptions and drawings. Mostly when working with Roman towns, as it is the case at *Ammaia*, we can rely upon a huge patrimony of available models for public and private buildings, and on the detailed knowledge we have of local traditions and building techniques, and by means of the study of available building materials we can infer many aspects of the existing architectures at a good degree of likelihood (KLEIN et al. forthcoming).

We are well aware that the reconstructions that we present are tentative and experimental, and that new data and ground-truthing or the availability of new tools for data processing could in the future cast doubts or even dismantle our proposals. But this process of confrontation is very helpful in understanding if "things work": the vision of reconstructed spaces and architectures, the simulation of movements of people and carts along urban streets, the evaluation of relationship between built and open spaces, the estimation of altimetry and slopes can help in putting to the test our interpretations.

Ethically, it is essential that in these reconstructions we clearly state which parts are integrated and which are existing, and this aspect is especially delicate when we deal with a non-specialist public. The matter is much more complex considering that our datasets are already "invisible" as they are predominantly 2D interpretations of geophysical surveys (3D in the case of GPR), and therefore already subject to a high interpretative factor. The distinction for the viewer between "existing" layers of data and reconstruction is, therefore, achieved via the animation, where the spatial referencing of data and the DTM of the site and its surroundings is followed by the progressive building up of volumes and landscape (see, for instance, http://www2.radiopast.eu/?page_id=1831).

One aspect that has been neglected by scholars since the times when reconstructions of archaeological sites and monuments were entrusted to the production of *maquettes,* is the chronological evolution of the settlement. As the transformations and changes were impossible to show, the most common strategy was to choose for the reconstruction of the site in its (assumed) greatest splendour. The best example of this approach is the *maquette* of imperial Rome designed by Italo Gismondi in the late 1930's and still displayed at the Museum of "Civiltà Romana" in Rome.

This limit of scale models has been surely overcome by the possibility to introduce animations in digital reconstruction, simulating the evolution and transformation of the site, often following the developments until the abandonment and the disruption of the settlement, but this process can be reconstructed only in sites where archaeological research has been collecting a huge amount of stratigraphic data, and this is not often the case.

Of course all these aspects would need a theoretical elaboration and this is why, in the framework of the project Radio-Past, some guidelines for all these matters are under development.

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