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A Landscape Matrix: the EM tool and the via Appia

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***Abstract*– This paper approaches the application of the Extended Matrix Tool to a broader landscape context. The idea underpinning this research is that this tool has a great potential in de-structuring landscape complexities and bridging together specialists from different fields thanks to semantic modelling. The selected case study, the II mile of the via Appia, frames a multi-stratified scenario made of a combination of Roman funerary monuments, private villas, squatters, homeless and XVIII-XIX century casals. This case study offers the opportunity to test a workflow in which archaeological data and 3D visualisations could effectively enhance archaeological research as much as foster multidisciplinarity**

I. INTRODUCTION

Fixed point in a neverending transforming landscape, *necropoleis* act like a live narration, in which space and its content cooperate in creating a dialogue between the living and the dead through a spoken language - or space semantic - composed by a combination of three elements: use of landscape, tomb architecture and material culture. Nowadays, most of the funerary contexts are heavily fragmented: due to architectural reuses, spoliations of the monuments, and the removal of artifacts; what is still visible and interpretable of these contexts are just fragments.

The current state of tombs on the via Appia in Rome clearly illustrates such processes. Even though the funerary vocation of its landscape (especially from the I d.C. onwards) is a well-known paradigm in ancient Roman studies, the level of knowledge of the funerary monuments on the very first stretch of the Via Appia is still largely incomplete. Heavy reuses, squatters and private owners are the main factors which have led to landscape transformations and the obliteration of monuments. Now urbanized and inhabited, this area still shows (hidden) traces of its past developments.

The increased application of 3D recorded data and virtual reconstructions greatly changed the scenario in terms of research possibilities: it is possible to record artifacts, digitally recreate relationships with objects and their broader funerary environment, digitally reconstruct monuments and simulate their relationships. A scientific-oriented and transparent application of 3D visualisations could play a key role in the challenge of reconstructing these fragmented contexts. Moreover, the power of data accessibility through digital visualisations could foster landscape analysis capabilities towards a proper "landscape Matrix". This paper approaches such delicate issues and starting from the selected stretch of the Via Appia proposes a digital and visual approach. Based on the application of new digital tools, such as the Extended Matrix Tool, this workflow will focus on how accessing 3D data into a shared environment could foster multidisciplinary research possibilities on multi-layered case studies such as heavily reused funerary landscapes in problematic urban contexts.

II. THE II MILE OF VIA APPIA ANTICA

The Via Appia, also known as Regina Viarum from an urbanistic point of view played a central role not only in connecting Rome and its suburbium but also in strengthening the Roman expansion and presence in the south of Italy. Moreover, from a social and cultural point of view, the importance of the Via made it the perfect stage for wealthy families, freedmen, *collegia* (groups of citizens united by rules and shared interests) and even private citizens to affirm their status through funerary monuments [1–3]. Each of these monuments was built and positioned in accordance with styles, architectural features, materials, etc., that reflected a specific societal structure among the multitude of transformations that affected Roman society during the centuries [4,5]. Even though Roman funerary architecture' semantics deeply changed across the centuries, the role of the via Appia as a privileged space of commemoration remains mostly unaltered (Fig. 1).

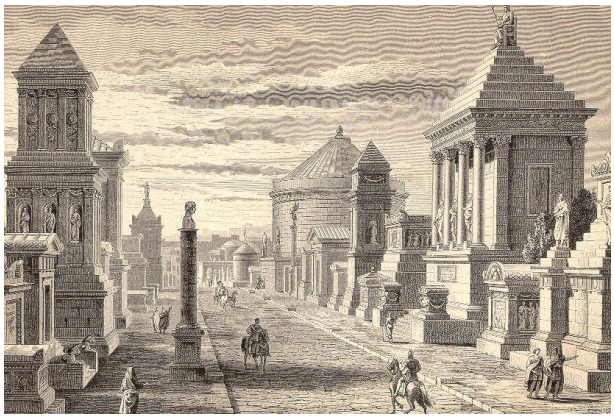

Fig.1. Reconstructive *v*iew of via Appia made by L. Canina

In brief, for centuries the via Appia acted like a bridge in connecting the city and its surroundings, but also in creating a social link between alive and dead. This uninterrupted centrality generated a superimposition of a multitude of funerary landscapes which spatially coexisted in the same area but structurally and semantically differed: each "landscape" represented a sort of physical expression of specific social instances. Therefore, each landscape had its own semantics, even when apparently there were strong physical similarities. This process happened mainly because of structures' reuses but it was made possible mostly thanks to a generalised religious and funerary ritual continuity. The peri-urban position of this specific stretch of the Via Appia, placed as a gate to the city, made it an especially valuable and challenging case study for analysing how space semantics transformed the landscape in social and cultural superstructures or "mindscapes"[6].

In addition to that, the discovery of the pieces of evidence for the existence of a Republican-era monumental architectural complex situated behind the barn of Vigna Cartoni (the yellow building in fig. 3) added another layer of complexity to the scenario [7–9].

Nowadays, this very first stretch of via Appia outside the Aurelian Walls represents the "gate" of the Parco Archeologico dell'Appia Antica. However, from a social and urbanistic point of view, this specific stretch constitutes a major challenge for national and local institutions (fig. 2). In fact, the diachronic juxtaposition of monuments is physically and visually absorbed by the presence of villas, XVIII-XIX century casals and private walls and buildings. In this scenario, the widespread presence of squatters, homeless and illegal owners further complicates monuments and park accessibility. This was one of the main impulses that led to a 40 years-long ongoing local community activism which has among its objectives the recovery and restitution of those areas to public fruition.

Fig.2 View of the via Appia, on the left the Sepulchre of Priscilla, on the right the Fienile Cartoni

One of the main results of this activism was that the City Council started a series of expropriations that are now going to drastically change the area (fig. 3).

Is it possible to de-structure these physical super-impositions into a 3D environment? Could 3D visualisations help in decoding archaeological landscapes and to address such future transformations?

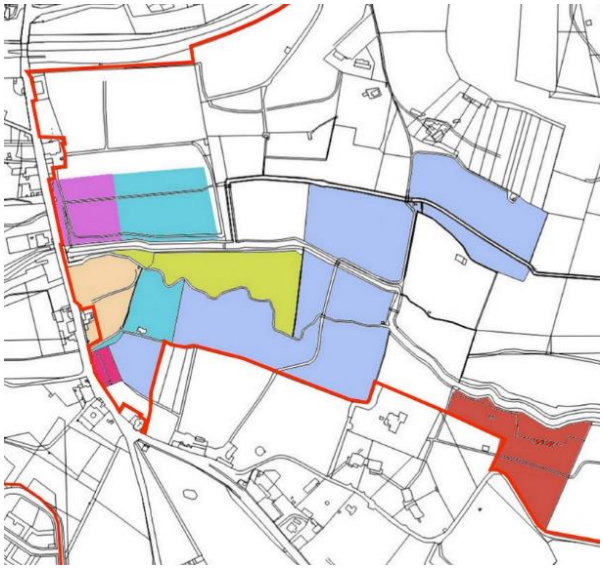

Fig. 3 Cadastral units under expropriation

III. METHODOLOGY

The development of the Extended Matrix tool (EM tool) by E. Demetrescu from the CNR-ITABC is giving a booster to a deep methodological transformation towards information modelling applied to digital archaeology[1]. The EM tool is an open-source plugin for an open-source 3D modelling software (Blender) increasingly used in the Digital Humanities. The plugin itself is just a connector between the 3D modelling software and the Extended Matrix, a formal node-based language which reflects the stratigraphic approach distinctive of archaeology as a discipline: the Matrix of Harris[10,12,13]. This language is expressed via semantic graphs through the open-source software, yEd.

In brief, the system allows for a documented process of reconstruction, which is sharable among users and fully inspectable directly inside Blender. Thanks to this system each geometry acquires its set of data and characteristics and a chronological relationship with the other geometries as expressed in the graph. The EM is an incredible tool for archaeological research, its potential is still not fully expressed and goes far beyond the discipline. In fact, this tool was meant to make transparent and intelligible the archaeological hypotheses

[1] [10–13]

that led to virtual reconstructions [11,14]. However, the possibility to connect data to digital geometries represent a huge step towards semantic modelling. This paper wants to address and exploit some of the possibilities offered by this tool.

In this research, the EM tool was applied to the whole stretch of the via Appia and not just on a single building. The idea behind the process is de-structuring the fossilised landscape to grasp its diachrony. Starting from a combination of drone, archival and published data and cadastral information a digital replica of the area was modelled using the open-source software Blender. Each building-proxy was connected with a construction phase and, where possible, more proxies were created to represent buildings that had more than one major phase (i.e. green and red proxies in fig. 3). The Matrix generated in yEd frames the macro-transformations that affected this specific stretch of via Appia and involved different level of complexity. The Matrix graph was created connecting data, sources and information to specific nodes. Afterwards, the nodes were connected to proxy geometries in Blender using the EM tool.

Physical structures, hypotheses of reconstruction and monuments reuses find their specific visual transposition from the data collected and ordered in the yEd graph. The final 3D model frames a multidimensional scenario in which landscapes from the past, the present and the future coexist and can be interrogated.

Fig. 4 The 3D model of the stretch of the via Appia Antica with proxies geometries

IV. CASE STUDY

In particular, the workflow was applied/tested to two monuments. The first case study, the so-called Sepolcro di Geta, clearly summarises the evolutionary complexity of this area. The monument since Roman times has been reused continuously over the centuries and is currently part of private property. Its history clearly affected the conservatory state of the structure and also prevented researchers from investigating the monument and nowadays very little is known about the monument. Even though the sepulchre clearly relates to the macro category of the tower-shaped tombs, the monument itself has never been studied before and even its chronological attribution appears to be problematic. Thanks to the authorisation of the private owner, a 3D recording campaign was carried out combining terrestrial laser scanning (TLS) with terrestrial and aerial photogrammetry. Afterwards, the two point clouds were merged and the textured model was imported into Blender (fig. 5). Here, the model has been optimized for further elaboration thanks to the 3D Survey Collection addon. The addon allows for a process of geometric and textured simplification that generates different Levels of Detail (LOD) based on the user's need. After this step, the historical and iconographic sources that were collected and organised into the yEd graph were linked to the proxy geometries created in Blender. The proxies were designed with the aim of recognising structural intervention on the monuments and, where possible, their chronological phase (fig. 6). Furthermore, thanks to the new BlenderBIM addon, BIM geometries were used to model some of the modern architectural superstructures and connected with the EM proxies.

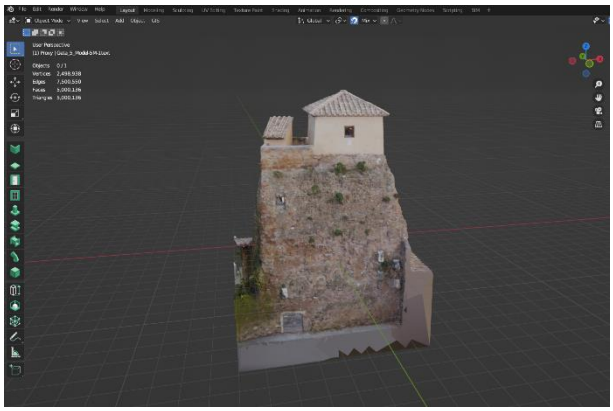

Fig. 5 The 3D model of the so-called Sepolcro di Geta

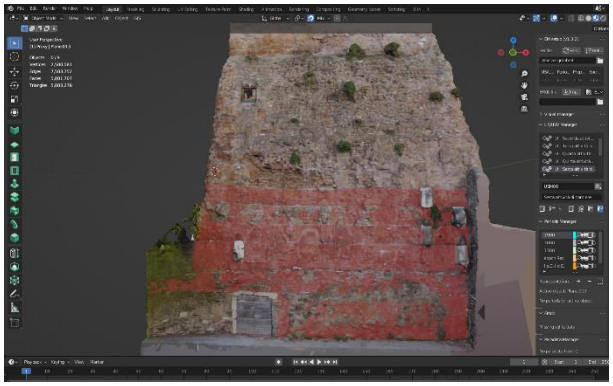

Fig. 6 Detail of proxy geometries modelling

The second case study, is the reconstructive hypotheses of the Temple of Mars. The 3D reconstruction model was realised by Viktor Malakuczi and Gabriele Monastero in 2016 and based on Prof. R. Dubbini's research hypotheses (fig. 7). The structure was modelled basing on a combination of archive data and comparisons with similar known structures. However, the site itself was

casually discovered during ACEA interventions on water pipes, so the structure was never stratigraphically excavated. The reconstruction hypothesis was designed for the first time in Maya. The .fbx exported file was imported into Blender and there proxy geometries were created to connect each element to the corresponding source in the yEd graph.

Fig. 7 The 3D model of the temple made by Viktor Malakuczi and Gabriele Monastero

V. DISCUSSION

The level of knowledge on this stretch of the via Appia Antica is still inadequate. However, even though the monuments used as case studies are explanatory of this widespread lack of archaeological data, they offer a great opportunity to exploit the potential of 3D semantic data and the impact of the Extended Matrix tool. The process applied to the so-called Sepolcro di Geta allowed for the understanding of different ancient and modern interventions. Unfortunately, the state of the art on tower-shaped tombs does not allow for immediate comparisons finalised to reconstructions. However, in this first step of deconstruction and analysis the usage of 3D semantic data, thanks to the EM tool, gave an incredible contribution to the whole heuristic process. Furthermore, the combination of BIM geometries and freehand semantic geometries opens to future scenario of multidisciplinary collaborations among different professionals based on 3D data exchange. Even though the two modelling approaches are still not directly connected, the whole workflow is easily approachable and valuable at the moment and the usage of open-source solutions makes the future of its development bright and very promising.

Furthermore, the combination of the two Matrix and the 3D semantic data collection inside a unique environment allowed for further reflections and results. In fact, the visualisations of existing landscape elements, combined with hypotheses of physical and cultural elements from historical landscape manifestations, offer a unique possibility to address future transformation/development of the area. In this case, the model of the temple could play a central role. In fact, the area where the structure of the supposed temple was found is currently occupied by an abandoned warehouse, which the City Council is about to expropriate. As a consequence, in the mid-term future the area is going to face a deep transformation which will need to take into consideration visible and hidden historical landmarks. Therefore, the capability offered by 3D data in this context, in terms of knowledge sharing and landscape intelligibility, will be fundamental for enriching and leading future processes of development.

Furthermore, the workflow showed how 3D semantic data exchange could have a great impact on researches and project planning. A shared 3D environment could be used and enriched by different professionals as much as serve as a visual language fostering dialogue among researches on hypotheses validation

VI. CONCLUSIONS

The potential offered by the EM tool and semantic modelling is an increasingly recognized field of research. More specifically, this paper underlines the capabilities offered by the 3D environments in bridging together data, and therefore professionals, from different fields. In the case of the via Appia dataset the 3D environment, the proxy model and the associated reconstructions offer the unique possibility to exploit landscapes in their multidimensionality and to enhance archaeological research. In this case the 3D environment helps to visualise landscapes of the past together with present and, possibly, future landscapes.

The produced semantic 3D model, part of the author on-going PhD research, was further shared with two MA students of architecture, Anna Todesco and Mariaeugenia Vena, and used to support their project. Part of the on-going experiment consists in exploiting the potential of semantic modelling and digital visualisations in re-shaping pluristratified urban contexts combining contemporary instances with archaeological features.

Another key aspect is the system's flexibility. The 3D model reconstructive hypothesis of the Republican-era monumental architectural complex was produced by Viktor Malakuczi and Gabriele Monastero. Thanks to published data and archival information it was possible to produce a series of nodes in YeD, included in the broader landscape Matrix, focused on making transparent the process behind this hypothetical reconstruction. This specific set-up could be of great help in planning urbanistic or architectural interventions, making visually intelligible data from ongoing archaeological researches to professionals from other fields.

In conclusion, the Extend Matrix Tool and Blender are powerful tools for the open-source community. Even

though the EM tool was structured to improve research in Digital Archaeology, or in Archaeology in general, it has a not yet fully discovered potential of development that encompasses even more disciplines. Specifically, this type of semantic modelling could open the gates to new types of Information Modelling that could more precisely represent the morphological and constructional complexities of historical buildings and archaeological sites.

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