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XIV | 2020

Open software, hardware, processes, data and formats
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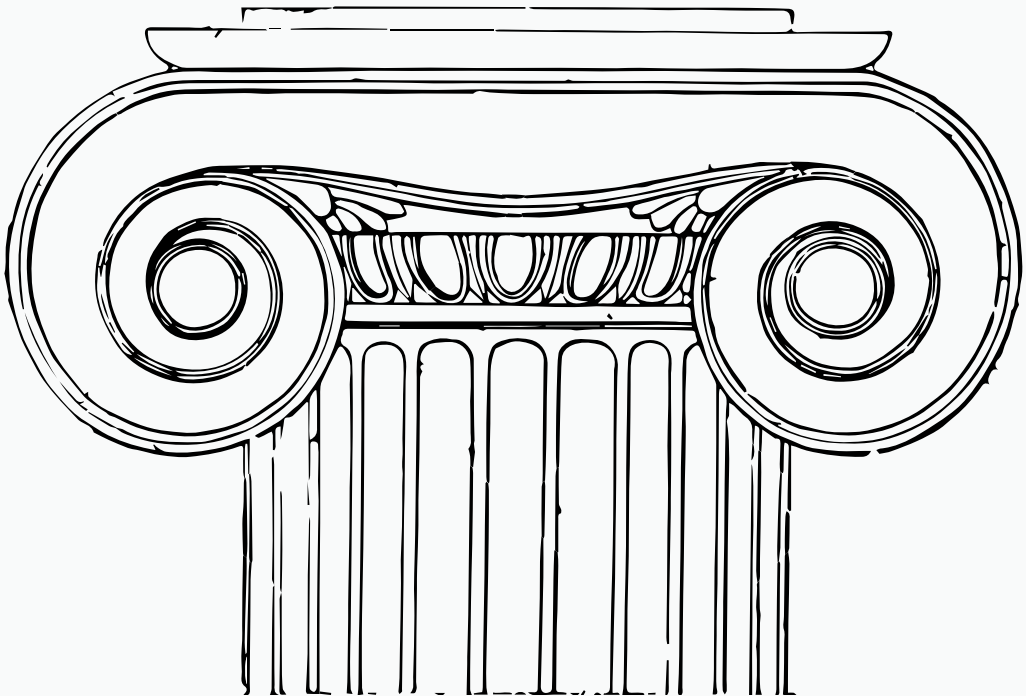
BOOK OF ABSTRACTS



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1

USE AND APPLICATION OF FREE/LIBRE AND OPEN SOURCE (FLOS) TOOLS IN ARCHAEOLOGY

VALUTAZIONE INTEGRATA DELLE DINAMICHE DI RISCHIO DI EROSIONE DEL SUOLO IN PRESENZA DI DEPOSITI ARCHEOLOGICI. IL METODO PROPOSTO DAL PROGETTO RESEARCH (REMOTE SENSING TECHNIQUES FOR ARCHAEOLOGY)

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Dottoressa di ricerca in archeologia classica, è attualmente titolare di un assegno di ricerca presso l'Università degli Studi della Tuscia. Le sue ricerche si concentrano prevalentemente sull'urbanistica e l'architettura di età classica, soprattutto romana, con particolare attenzione agli aspetti metodologici e interpretativi. Ha partecipato e partecipa ai progetti CLIMA (2015-18) e RESEARCH (in corso) ed è altresì coinvolta nel progetto STABLE (in corso), per conto dell'Università della Tuscia e in particolare per lo studio dei siti antichi, le procedure di valutazione del rischio e per la pianificazione e gestione delle attività di ricerca.

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Stefano De Angeli (Urbino, 28/09/1959). Ha studiato a Urbino, Roma e Heidelberg. Dal 1995 al 2005 è stato ricercatore di Archeologia classica presso l'Università degli studi della Tuscia. Dal 2006 è professore associato di Archeologia classica presso il medesimo Ateneo. Ha partecipato e partecipa come responsabile scientifico di UO a diversi PRIN (2000-2002-2004) e a diversi progetti europei sia come partner (EMAP/2013-18; STABLE/in corso) che come coordinatore scientifico (CLIMA/2015-18; RESEARCH/in corso). È stato co-responsabile scientifico della missione archeologica presso l'Oasi di Farafra (2009-2015) e dirige la missione archeologica presso il sito di Falerii Novi.

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Giancarlo Pastura (Narni, 1983). Ricercatore presso l'Università degli Studi della Tuscia, dove insegna Archeologia cristiana e medievale. Laureato nel 2009 presso il medesimo Ateneo, ha conseguito un master di II livello e il Dottorato di ricerca presso "Sapienza" Università di Roma. Dal 2015 al 2019 è stato titolare di un assegno di ricerca "Sviluppo di tecnologie di remote sensing applicato ai Beni Culturali". Direttore del Museo Archeologico dell'Agro Cimino, delle catacombe di Sant'Eutizio e del complesso Orte Sotterranea, partecipa a diversi progetti europei quale responsabile delle indagini geofisiche e del rilievo tridimensionale. Ha al suo attivo oltre quaranta contributi scientifici.

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Matteo Serpetti (Terni, 27.05.1981). Laureato nel 2007 in Conservazione dei Beni Culturali (Università degli Studi della Tuscia), dal 2007 al 2009 ha frequentato un Master di II livello in SIT (Università di Roma "Sapienza"), nel 2011 un corso per l'uso dei software Grass/Qgis. Nel 2014 ha conseguito il diploma di scuola di specializzazione in Beni Archeologici (Università di Roma "Sapienza"). Dal 2007 partecipa a ricerche promosse dall'Università degli Studi della Tuscia e dall'Ufficio SIT Per i Beni Culturali del CNR di Roma. Dal 2016 fa parte della missione archeologica di Poggio Gramignano (Arizona University). Dal 2017 partecipa a progetti europei: CLIMA, RESEARCH e STABLE.

L'erosione del suolo può essere definita come la progressiva rimozione dalla superficie di strati di terreno, attraverso il distacco e trasporto di singole particelle a opera di vari agenti, sia naturali che antropici. Questo fenomeno di asportazione del suolo può causare danni significativi al patrimonio archeologico esposto o ancora sepolto. Al fine di proporre buone pratiche di valutazione del rischio dei siti archeologici, il progetto RESEARCH (REmote Sensing techniques for ARCHaeology), sulla base di un metodo innovativo, ha definito un articolato flusso di lavoro in grado di elaborare in maniera integrata dati archeologici e geologico/ambientali per produrre, attraverso un software di tipo Open source (QGIS), una più dettaglia mappatura del rischio di erosione del suolo sul patrimonio archeologico.

Il presente metodo è stato verificato su un'area campione, all'interno del

sito archeologico di Falerii Novi (Viterbo, IT), la cui area urbana, delimitata da un circuito murario in blocchi di tufo, conserva una complessa stratigrafia archeologica. Il sito, nonostante sia stato sottoposto a vincolo, è attualmente utilizzato a scopo agricolo, con conseguente incremento di gravi fenomeni erosivi, che comportano un aumento del rischio per la conservazione del deposito archeologico.

La presenza di strutture sepolte nell'area è stata confermata e localizzata attraverso un'indagine magnetometrica effettuata alla fine degli anni '90 e recentemente riconfermata da una completa mappatura effettuata con strumentazione georadar, i cui risultati hanno altresì consentito di stabilire lo spessore della coltre di suolo che separa il piano di campagna dalle singole strutture sepolte e dalle relative stratigrafie archeologiche più superficiali.

Per la valutazione dell'erosione del suolo e dei conseguenti accumuli sono state eseguite una serie di simulazioni (tramite dei modelli open source, quali RUSLE 3D, SIMWE e USPED) che, interpolando dati ambientali e del suolo, hanno generato delle mappe di erosione del suolo per la valutazione del quantitativo di materiale asportato e deposto nell'area di studio.

I dati prodotti da questi due differenti flussi di lavoro sono stati poi elaborati in forma automatizzata all'interno della Piattaforma RESEARCH, sviluppata in ambiente QGIS. Ciò ha consentito di generare mappe di minaccia dell'erosione del suolo e mappe di vulnerabilità archeologica, che successivamente combinate fra loro hanno prodotto delle specifiche mappe del rischio.

Tali cartografie costituiscono un utile strumento per il monitoraggio di aree di grande estensione e possono essere utilizzate da enti e istituzioni preposti alla tutela e alla conservazione del patrimonio archeologico, per la pianificazione di interventi sul lungo periodo.

HUMAN RESPONSE TO LATE HOLOCENE CLIMATE CHANGE IN NORTHERN ITALY: INTEGRATION OF GEOMORPHOLOGICAL AND ARCHAEOLOGICAL DATA THROUGH A FLOS-BASED WORKFLOW

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Filippo Brandolini has a PhD in Environmental Sciences and he is a Marie Curie Fellow H2020-MSCA-IF-2019. Brandolini does research in landscape archaeology, geospatial analysis and fluvial geomorphology. Dr. Brandolini's PhD was focused on interdisciplinary approaches in landscape studies, combining geosciences and archaeological sources with FOSS GIS software products.

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Francesco Carrer's main research interests are in landscape archaeology and ethnoarchaeology, mountain archaeology, spatial analysis and computer modelling. Dr. Carrer is specifically interested in seasonal pastoralism, from an ethnographic and an archaeological perspective, and in the development of GIS applications for analysing long-term socio-ecological dynamics.

The transition from Roman into Medieval Period represented a crucial moment for the reorganisation of human settlement strategies in the Po Valley, mainly due to climatic changes and socio-political factors. Following a FLOS-based interdisciplinary approach, this research combines geopedological data and archaeological sources to assess the role of alluvial geomorphology for Late-Holocene settlement strategies (fig. 1).

In this research three different FOSS applications have been employed: QGIS, GRASS GIS and R through Rstudio. Point Pattern Analysis (PPA) (Bevan et al. 2013) was employed to provide a solid statistical assessment of human interaction with alluvial environments. Variability in Roman and Medieval settlement patterns is analysed against two related proxies for alluvial geomorphology and agricultural suitability: flood hazard and soil

texture. Continuity between Roman and Medieval sites, which might have influenced the average relationship of the latter with the two environmental variables, has also been quantitatively assessed through Inhomogeneous cross-K function.

This study investigates how alluvial geomorphology and agricultural suitability influenced settlement patterns in the Roman and Medieval period, and whether pre-existing Roman occupation attracted Medieval sites. The easiest way to address the former was by assessing whether a selected inhomogeneous model described the spatial variability of a point process more accurately than a stationary model. Two "environmental" spatial covariates were produced for this purpose, MTI and SOIL. The third covariate, the distance from via Aemilia (VAE), served as a"socio-cultural" covariate (Fig. 2).

Point Pattern Analysis (PPA) for Roman and Medieval sites were performed in R using the package 'spatstat' (Baddeley, Rubak, and Turner 2015) and GRASS maps were managed through 'rgrass7'(Fig. 3). PPA suggests that Roman site distribution in the area has no correlation with flood hazard (MTI), but shows a weak inverse correlation with soil texture (SOIL). An inverse correlation with MTI and a direct correlation with Soil have been identified for Medieval sites. This suggests that different land-use techniques enabled the Romans to exploit large areas of flood-prone areas successfully. On the other hand, alluvial geomorphology highly influenced settlement strategies during the Early Medieval period (Brandolini and Carrer 2020).

To assess the independence of the two-point processes (Medieval and Roman settlement patterns), second-order properties were investigated using the inhomogeneous cross-K function that was calculated from the sites, as well as for 999 Monte-Carlo simulated bivariate point patterns. The Cross-K function highlighted significant proximity of Medieval sites to Roman sites for short distances, up to 1.2 Km (Fig. 4). This implies that even considering the different responses to alluvial geomorphological conditions in Roman and Medieval times, within a 1.2 Km radius, the Medieval sites are closer to Roman sites than expected.

To conclude, this project represents a useful example of how the integration of FLOS tools is extremely effective and enables a wide range of applications to investigate past landscape dynamics on different scales.

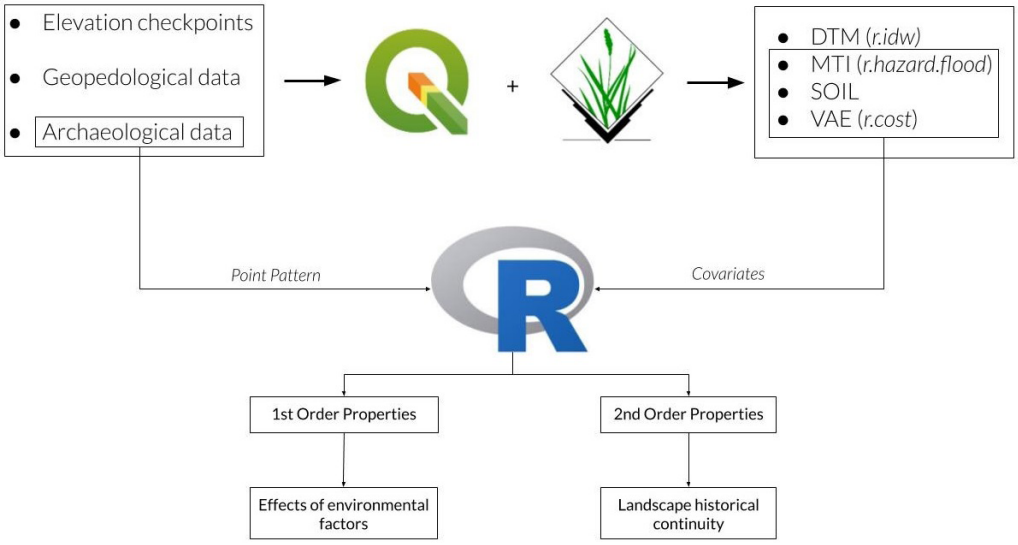

Fig. 1. Project FLOS-based workflow

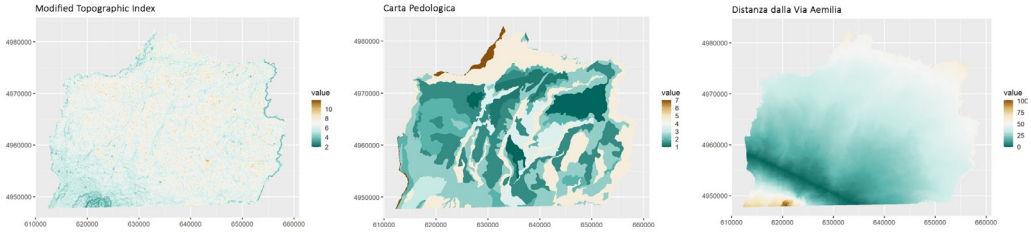

Fig. 2. The three covariates employed in the PPA. From the left: MTI, SOIL, VAE.

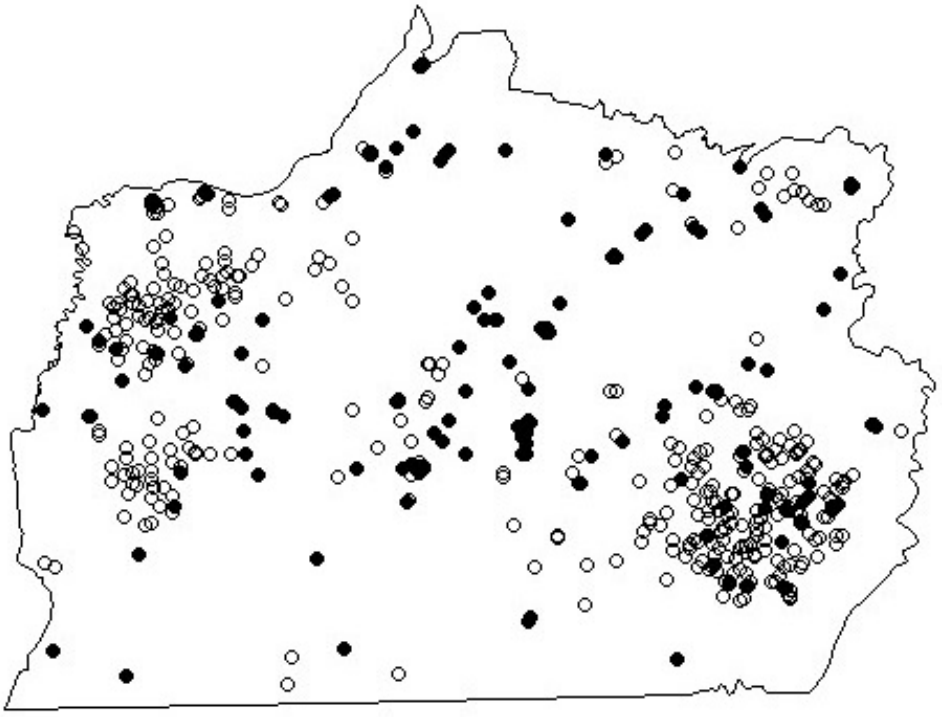

Fig. 3. Spatial distribution of the Roman Point Pattern (white dots) and the Medieval Point Pattern (black dots) within the study area (bounded region).

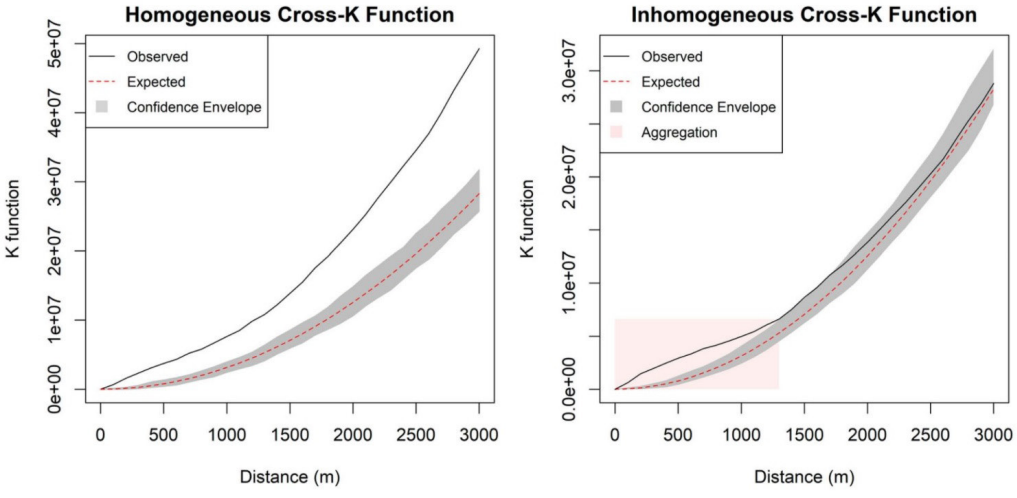

Fig. 4. Homogeneous and inhomogeneous cross-K function measurements.

UN WORKFLOW OPEN SOURCE PER L'ELABORAZIONE DELLE IMMAGINI TERMICHE ACQUISITE DA DRONE

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Dottorando del corso di Storia e Scienze filosofico-sociali dell'Università di Roma Tor Vergata e laureato in Archeologia medievale, Gabriele Ciccone si è specializzato in tecnologie applicate conseguendo il Master in Tecnologie Open Source per i Beni Culturali presso il Centro di Geotecnologie dell'università di Siena. Ha partecipato a numerose campagne di scavo e di prospezione geofisica in Toscana, Sicilia e in Messico Ha svolto stage presso il VHLAB-CNR e ha lavorato presso la Noho Ltd. di Dublino, dove si è perfezionato come modellatore 3D per la fruizione e valorizzazione dei beni culturali. Socio dell'associazione Una Quantum Inc, è docente per i corsi di Modellazione 3D per i BB.CC. con Blender.

Nell'ambito del progetto di dottorato "Flying off-site: nuove metodologie di indagine per l'analisi dei paesaggi storici" (XXXV ciclo, Dottorato in Storia e Scienze filosofiche-sociali, Università Tor Vergata), parte della ricerca è stata dedicata all'individuazione di un workflow efficiente per l'elaborazione di rilievi 3D e ortofoto ricavati dai sensori termici.

Nella prima fase sono state programmate riprese termiche della stessa area con voli effettuati in diversi momenti della giornata, al fine di valutare le variazioni termiche dovute ai differenti orari di ripresa. In questa fase, a causa della bassa risoluzione delle immagini termiche, sono stati effettuati voli aventi strisciate sovrapposte con un overlap di 90% tra gli scatti, lateralmente e longitudinalmente. La seconda fase, dedicata all'elaborazione delle immagini, è stata svolta con differenti software sia proprietari che open source, al fine di valutarne le potenzialità in termini di precisione del dato e di velocità dell'elaborazione: è apparso subito evidente come l'orario di ripresa determinasse la buona riuscita o meno della fase di allineamento delle immagini, in tutti i software fotogrammetrici proprietari e open source testati.

Le elaborazioni hanno evidenziato una situazione differente tra i set di immagini scattate in condizioni di buona luminosità, rispetto ai set ricavati dal-

le riprese effettuate dopo il tramonto e prima dell'alba. Se nel primo caso, infatti, tutti i software hanno correttamente individuato i punti in comune tra le immagini in fase di allineamento, riuscendo ad elaborare sia le ricostruzioni 3D che le successive ortofoto, nel secondo la scarsa luminosità delle immagini non ne ha permesso un corretto allineamento, impedendo l'avanzamento delle elaborazioni con tutti i software proprietari e open source testati.

In linea con la letteratura scientifica in materia di fotografia termica al di fuori del mondo archeologico, è stato elaborato un workflow che permettesse di unire le immagini RGB e IR (termiche), in formato JPG, in singole immagini in quattro bande (R, G, B, IR) in formato TIFF, al fine di riuscire ad elaborare le immagini TIFF con i software di fotogrammetria per la ricostruzione del rilievo 3D e la successiva elaborazione dell'ortofoto, da cui infine estrarre la banda relativa all'immagine termica. Inizialmente, con gli esempi ricavati da altri ambiti di applicazione delle immagini termiche, il workflow è stato elaborato facendo ricorso a software proprietari: è stato utilizzato Matlab (software chiuso ma distribuito gratuitamente per la ricerca universitaria) per le fasi di conversione in grayscale e ridimensionamento delle immagini IR (da 640x480 a 3840x2880), per il taglio delle immagini RGB (da 4056x3040 a 3840x2880), e infine per l'unione nelle singole immagini TIFF a 4 bande; in seguito le immagini sono state processate con Metashape, dalla ricostruzione 3D fino all'estrazione della singola ortofoto termica. Raggiunto l'obiettivo, il passaggio successivo è consistito nell'elaborare un medesimo processo di lavoro adoperando soltanto software open source, sia per valutare un'effettiva possibilità di workflow esclusivamente open, che per verificare pregi e difetti rispetto ai software proprietari. Sono stati testati differenti software sostitutivi di Matlab (GNU Octave, Scilab, SageMath, R) arrivando infine a preferire Octave in quanto il più simile a livello di sintassi; ciò ha permesso di non dover rielaborare né stravolgere le funzioni già utilizzate per Matlab. Successivamente è stato sperimentato il software OpenDroneMap (attraverso l'interfaccia WebODM), sia tramite i nodi di calcolo interni che con quelli di MicMac, per arrivare all'elaborazione dell'ortofoto. Tuttavia, per l'estrazione dell'ortofoto IR, non essendoci tale funzione in ODM, sono state testate differenti possibilità, tra le quali le migliori sono risultate essere QGis o il freeware Multispec.

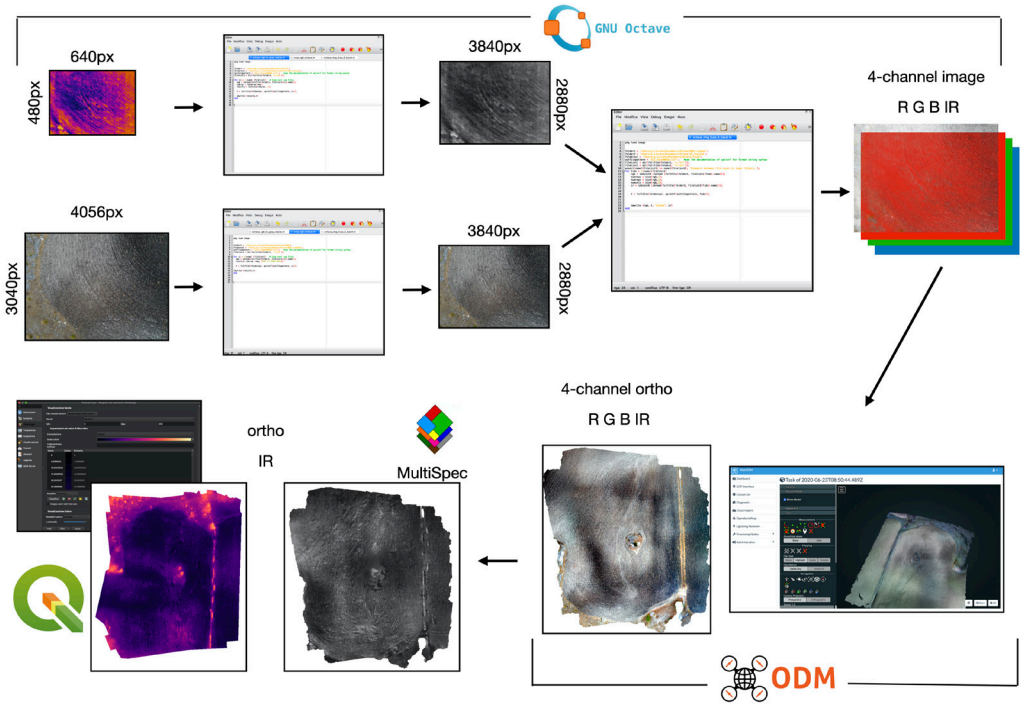

Fig. 1. Schema del workflow open source per l'elaborazione di immagini termiche.

Fig. 2. Esempio di immagine RGB utilizzata.

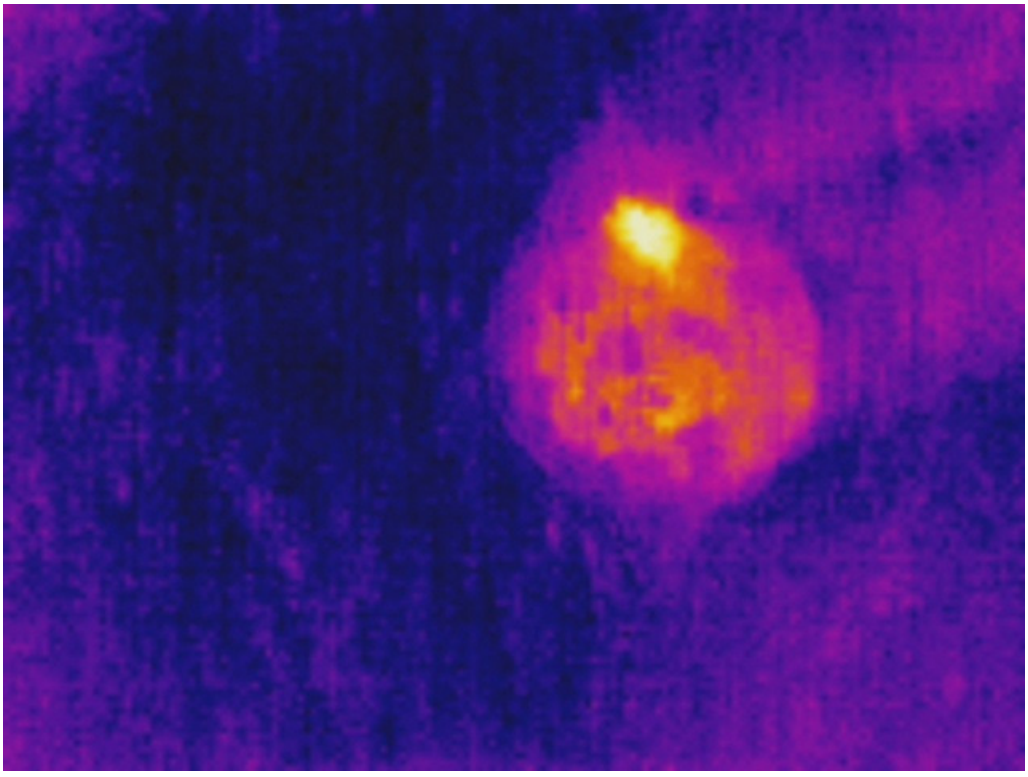

Fig. 3. Esempio di immagine IR utilizzata.

Fig. 4. Ortofoto in 4 bande (R, G, B, IR).

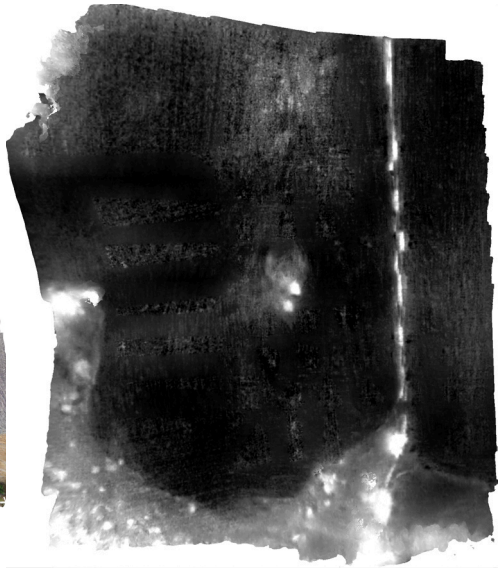

Fig. 5. Ortofoto nella singola banda IR

ANALYSIS OF URBAN MOBILITY IN 18th CENTURY ROME: A RESEARCH APPROACH THROUGH GIS PLATFORM

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Graduated in 2017 at Sapienza University of Rome in Archaeological Sciences, Domizia D'Erasmo combines an Egyptological background with skills in Digital Humanities, acquired during her university career. In January 2020 she won a Sapienza Junior Research Grant aimed at the development of a GIS platform to investigate the urban mobility of eighteenth-century Rome. Her recent scientific interests combine the study of the ancient Egyptian landscape with Digital Humanities. She is also a tutor for the QGIS workshops directed by Julian Bogdani in the framework of the ERC PAThs project (P.I. Paola Buzi).

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https://iris.uniroma1.it/browse?type=author&authority=rp43582

Renata Ago former Full Professor, now Honorary Professor at Sapienza University of Rome where she taught Early modern history. She has been fellow or visiting professor in several institutions and member of the editorial board of different academic journals. In 2009-2014 she was the general scientific coordinator of the European project "European Network for Baroque Cultural Heritage". Her scientific interests concern social history in early modern times. She has worked on rural communities and feudality from the 16th to the 18th centuries, on family and gender history and on the relationship between social exchanges, economic practices and institutions. Her recent interests regard issues on consumption and material culture.

The aim of this paper is to describe the methodology employed for the development of a GIS platform capable of analysing urban mobility in early-modern age. In order to increase the dissemination of data, QGIS is the software used in this research. The use of this tool has allowed not only the intercommunication between different operating systems (OS), but also the production of open source data. The research focuses on the case study of the pathways which took place inside and in the surroundings of the city

walls of Rome in the 18th century. The town in this period appeared with an urban layout that was the result of a series of important initiatives by the authorities, especially the popes. As a result of these transformations, the increase of regular roads and "straight streets" is evident, as well as the adjustment of town squares and buildings. During the planning of the GIS project, this urban layout, which for the most part is no longer visible from modern satellite images, was recreated by using a georeferenced version of the Nuova Topografia di Roma by Giovanbattista Nolli: a city map that was published by the geometer in 1748, and which faithfully represents the urban landscape of eighteenth-century Rome.

Initially, several official itineraries such as papal parades, solemn entrances of ambassadors or foreign princes were mapped out. These paths were traced having access to accurate topographical information obtained from the analysis of booklets published on the occasion of particular events. In a second time we have mapped the common and ordinary daily movements of men and women, workers and shop masters (fig. 1). The itineraries of these "normal" people show a completely different picture from that obtained from the examination of the high-codified pathways. In fact, the reasons for these journeys mostly concern work or social occasions (fig. 2), such as visits to taverns. In order to collect the topographical information related to this kind of events, we have used a wide sample of judicial sources (trials and claims of the Tribunale criminale del Governatore) as well as of requests forwarded to the Presidenza delle Strade. In this phase the topographic data are less detailed than the previous ones and are mostly limited to a departure point and an arrival point, and in some cases to intermediate stops.

The vector data collected during the entire project were then queried in QGIS by spatial analysis aimed at detecting the main routes of urban movement in early-modern period. It emerged that the "new" roads built in the 18th century were rarely used, even in the context of codified pathways such as processions. In fact, the choice of roads appears to be attributable to factors in which the comfort of the streets is not the conditio sine qua non. In conclusion, the project in its entirety highlights the potentialities to analyse the topographical data obtained from the study of the textual sources by comparing them with those present in historical cartography through the GIS platform. Through this approach, it was possible to obtain a complete overview of the urban movements in 18th century Rome in relation to the new city building developments that have taken place in the town (fig. 3). Furthermore, this approach made it possible to query the data

in order to extract information leading to an improved understanding of the uses of an ancient urban layout of this city.

Fig. 1: The image is the result of mapping the paths of ordinary people during different years of the 18th century. The base maps visible in the background are the Nuova Topografia di Roma and Google Satellite.

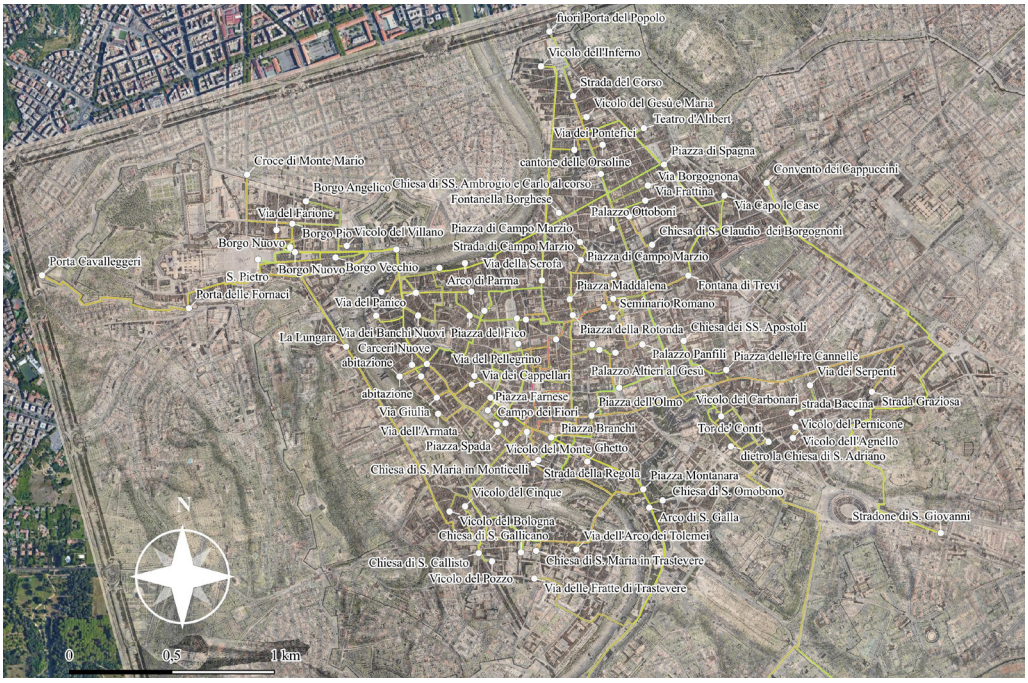

Fig. 2: The image shows the result obtained from the mapping of the "home-work" paths of 1739. The base maps visible in the background are the Nuova Topografia di Roma and Google Satellite.

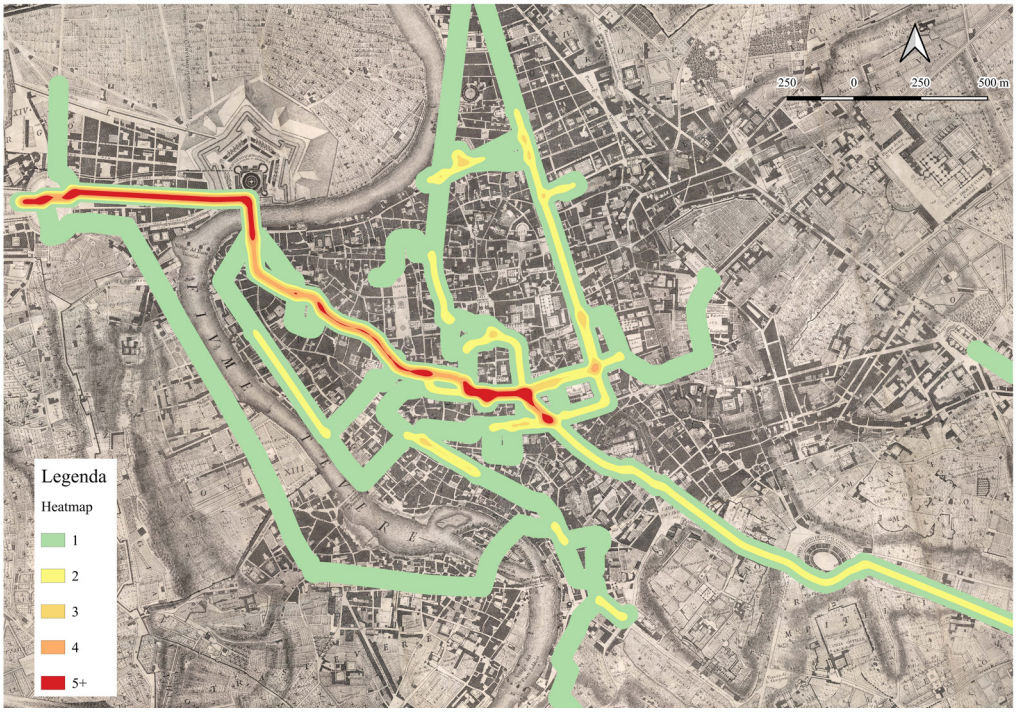

Fig. 3: A heatmap that shows the main roads crossed during the 18th century's processions. The colour scale shows the frequency the road has been used. The base maps in the background are the Nuova Topografia di Roma and Google Satellite.

TOWARDS FREECAD EXPERIMENTATIONS AND VALIDATION AS A FOSS HBIM PLATFORM FOR BUILDING ARCHAEOLOGY PURPOSES

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How far the willingness to achieve specific research goals can drive us into non-conventional strategies? Every day we have to make important methodological choices about scientific and sensitive data, also making compromises. In this sense, the point is always minding the goal of the research, avoiding the use of specific innovative technologies / methodologies / software just for fashion and thinking responsibly depending on resources we spend and data we produce.

In this sense, BIM (Building Information Modelling) methodology – which has become a standard and a mandatory solution for AEC industry (Architecture Engineering Construction) – is recently spreading more and more inside the Cultural Heritage panorama due to its possibilities through three-dimensional databases, related information, queries as well as integration between different kinds of data and professional figures involved. However, the adoption of BIM methodology for Cultural Heritage assets – becoming HBIM (Historic Building Information Modelling) as well as modifying the main workflow (BIM, referring to new constructions is placed at the beginning of the life-cycle of the building; HBIM should be intended as the knowledge of the historical building and then it takes place in a specific life-cycle moment) – is affected by different compromises and issues, especially referred to the software used, mostly designed for AEC industry that rarely fit with Cultural Heritage domain (e.g Autodesk Revit).

This reasoning brings researchers to run into the accuracy and reliable issue of the commercial BIM solutions towards free / libre and open source (FOSS / FLOSS) BIM software, especially for Heritage assets, and the utilization of FOSS BIM solutions for Cultural Heritage domain apart from being a milestone could be also considered a real challenge as well as a watershed. In fact, an unconventional but fitting and good solution to guarantee Heritage data usability, accessibility, transparency and customizable opportunity could be provided by FOSS BIM software thanks to source code accessibility and modifications possibilities, adapting software to Cultural Heritage needs and not the opposite.

So, HBIM methodology is changing the way to produce and investigate Cultural Heritage documentation, at the same time FOSS / FLOSS solutions are changing the general view as well as possibilities of BIM and HBIM methodology, but how does this happen?

FOSS solutions are becoming more and more fundamental and reliable as far as archaeology and in general Cultural Heritage documentation are concerned: in fact, archaeological domain can rely on open source full operative system as ArcheOS based on GNU/Linux; regarding 3D modelling, Blender FOSS software has demonstrated over the years to be as precise as reliable; at the same time QGIS (Quantum GIS) has proved to be an essential solution for geospatial analyses especially concerning Cultural Heritage assets as well as the most widely used GIS platform; moreover, the utilization of the FOSS photogrammetric suite MicMac has grown outrageously, proving itself equal to others commercial software. Then, FreeCAD FOSS / FLOSS software, through its possibilities, could be equally important as CAD and BIM / HBIM

solutions , taking part of this FOSS ecosystem.

Despite HBIM methodology has the potential to become a good answer for building archaeology documentation and analysis, by using ad-hoc and customized FOSS tools as FreeCAD it could become the proper and fitting solution overcoming AEC industry limitations of standard BIM software: in this sense, this project is focus on experimentations, custom modifications and adaptations of FreeCAD to building archaeology assets as HBIM custom platform for documentation and analyses (adapting custom HBIM workflows to specific needs), trying to avoid methodological compromises related to commercial BIM software as well as trying to preserve the original goals of specific research.

ROME - NORTHEASTERN PALATINE SLOPES: OPEN-SOURCE METHODOLOGIES AND TOOLS FOR THE ANALYSIS OF ANCIENT ARCHITECTURES

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Lorenzo Fornaciari graduated in Methods of Archaeological Research at the Sapienza University of Rome and now PhD student in Methods and Methodologies of archaeological and historical-artistic research at the University of Salerno with a research project about analysis and reconstruction of ancient landscape and buildings of the NE Palatine slopes in Rome. From 2016 he is responsible for graphic documentation, survey and GIS at the NE Palatine Slopes excavation and he has also worked as survey expert within the Major project Pompeii.

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Emanuele Brienza graduated in Methods of Archaeological Research and made his PhD in Classical Archaeology at the Sapienza University of Rome. From 1990 to 2014 he was responsible for survey and GIS at the Meta Sudans and NE Palatine Slopes excavations in Rome. From 2000 to 2010 he was Survey and GIS Senior Expert for Pisa University in Egypt. He has also worked as GIS and survey expert in Turkey and has been Senior Consultant in archaeology for the Ministry of Culture of the North Macedonia Republic. Since 2012, he has been a researcher and Assistant Professor of Methods of Archaeological Research at the Kore University of Enna.

Giovanni Caratelli

Giovanni Caratelli archaeologist and researcher at the National Research Council of Italy - Institute of Heritage Science (CNR-ISPC), mainly deals with archaeological survey and technical, stratigraphic and typological analysis of ancient monuments; he was scientific director of the Museo della Città e del Territorio di Cori.

Cecilia Giorgi

Cecilia Giorgi, archaeologist and researcher at the National Research Council of Italy - Institute of Heritage Science (CNR-ISPC), specialized in archaeological survey, direct and instrumental, 3D modelling, analysis of ancient monuments.

The area of the north-east Palatine hill slopes in front of the Colosseum valley has been the place of a more than 30 years long archaeological research, that brought to light to many archaeological evidences and material remains of ancient buildings and monumental interventions of great impact inside an environmental, topographic and stratigraphic continuum.

The huge amount of documentation produced has required the development of a data storage and management system dedicated to give a logic and integrated framework to information but also able to propose new elements for research development. Since 2001 the whole archaeological record has been managed by an intra-site GIS for data-retrieving, spatial analysis and archaeological reconstruction.

During the research this system has been implemented in contents but also in technology, following the advent of new IT products. In particular we dedicated our attention to the spread and availability of open-source software and ArcheoFoss: this in the last years, together with the support of a community of professionals and developers, undoubtedly has represented a fundamental pivot of technological development in archaeological practice with increasing interest and participation.

Our research follows this approach paying great attention to open-data issues and experimenting with entire datasets migration reconstructing the entire system in Qgis open-source platform. This process has addressed not only technical problems? , related to the nature of some proprietary formats, but also, and above all, has generated new reflections on the possibility of renewing methods and techniques for collecting, managing and analyzing data.

Focusing on the study of the ancient building, the use of image-based-modeling photogrammetry techniques revealed a certain inadequacy of the exclusively chrono-typological study of the ancient walls. In fact, these approaches, being anchored to two-dimensional projections of the artefact, inevitably neglect factors related to the three-dimensional environment of structures.

From these reflections, while we were making a new 3D documentation of the ancient walls, in this last 2 years we have performed also a new and integrated recording of the structures, having planned a new form format by criteria aimed at the collection of information related to construction methods, structural expedients, yards dynamics, specific materials selection, quantification of the work in terms of time and number of the workers.

This new file-card format for ancient masonry contexts, for data display, en-

try and editing, was created directly by Qgis. For the contents homogeneity and to facilitate data entry procedures, we have encoded standardized terminologies; in addition, the detailed metrics information and statistics, derived from the analysis of the samples of wall facades, are managed by accessory modules.

All these data are linked to 3D documentation of masonry stratigraphy: in detailed level for the evaluation of single walls and samples; in a general framework level for diachronic and typological evaluation of the architectural complexes of the area.

An external connection with the open-source software CloudCompare is a first attempt to show the graphic quality of the photogrammetric acquisition and to partially overcome the 2.5 dimensional perspective of GIS. Finally, particular attention was paid to the question of the "philological transparency" of data considered like the "basement" of archaeological interpretation. In order to deal with this problem, we have reproduced a new system for collected data analysis and retrieving: photos, 3D models acquired from scratch, sections and elevations, hand-made drawings and all raw data produced during the excavation; through several queries it is now possible to analyze all the recording and elaborations steps made for stratigraphic interpretation.

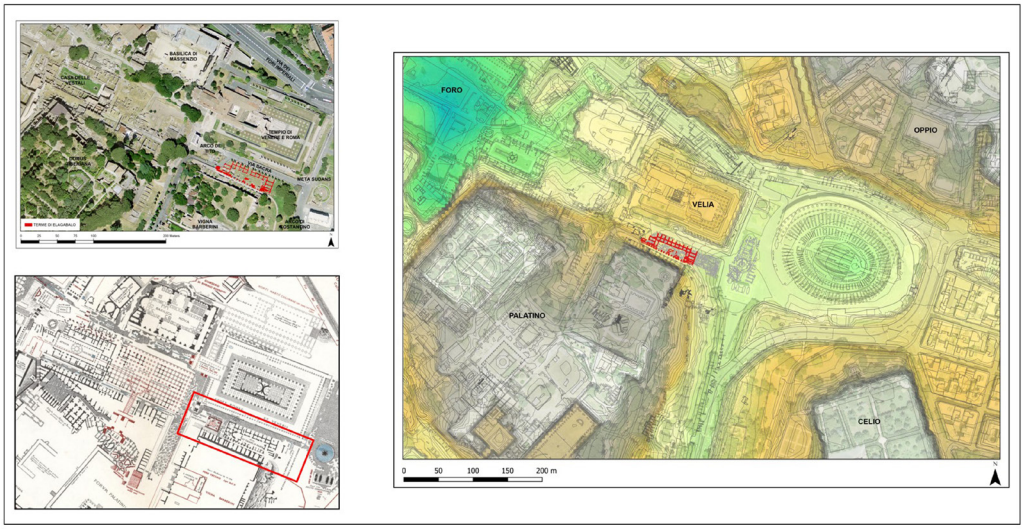

Fig. 1. The territorial context of the NE Palatine slopes.

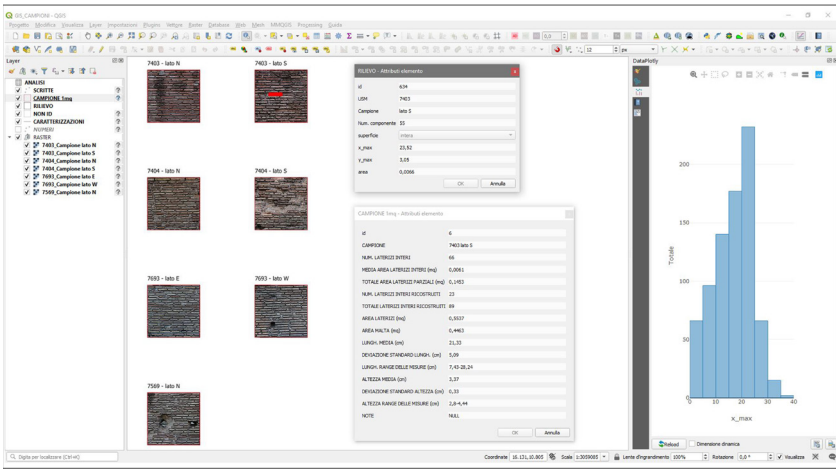

Fig. 2. The new file-card format for ancient masonry contexts.

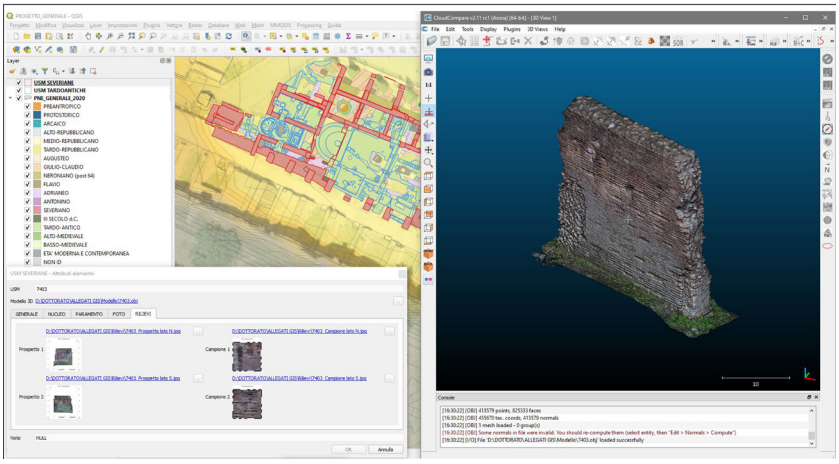

Fig. 3. The link with the collected data.

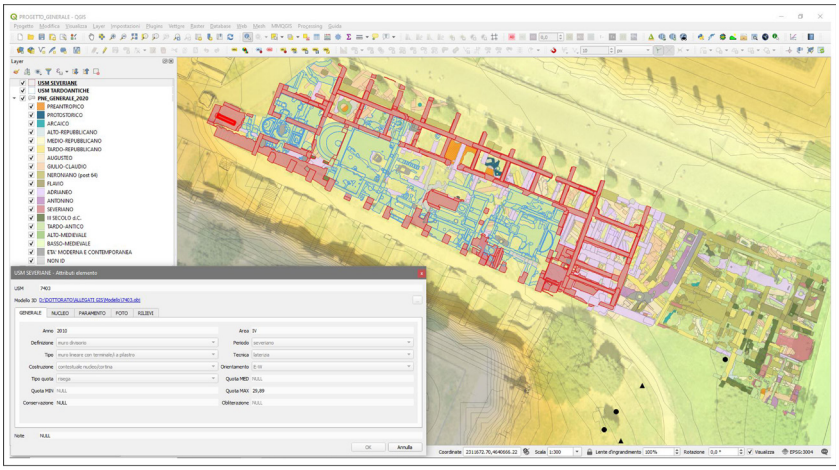

Fig. 4. The treatment of masonry samples.

CULTURA LIBERA PER LA VALORIZZAZIONE TERRITORIALE: METODOLOGIE E STRUMENTI APERTI

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La rivoluzione digitale in atto da un decennio ha completamente stravolto i paradigmi del modo di concepire e fruire la cultura, comportando un profondo ripensamento delle interazioni reale-virtuale e fornendo possibilità e potenzialità ancora pienamente da esplorare. La capillarità di diffusione di dispositivi sempre più costantemente connessi ha cambiato la concezione che gli individui hanno del contesto in cui sono calati, delle proprie capacità e delle proprie possibilità relazionali: è interessante notare come, per agire nel territorio reale, si sia sempre più spesso passati dal territorio digitale. Si analizzerà pertanto l'approccio verso i beni culturali: in Italia si avverte un saldo legame con una storia millenaria di cui ci si sente in qualche modo eredi – riflettendo in questo appieno il termine anglosassone di heritage – calati in un paesaggio a tal punto permeato di cultura da non riuscire a trovare una linea di demarcazione tra singoli elementi di interesse e loro contesto. Troppo diffuso da non essere valorizzato adeguatamente dallo Stato, per mancanza di necessari fondi, per mancanza di personale, per riassestamenti burocratici: ci si sente così in dovere di supplire alle mancanze strutturali organizzandosi, portando la community nella realtà e ridiventando comunità: in tal senso, una delle filosofie e uno degli strumenti più utilizzato è costituito da Wikipedia. Si assiste così a diversi momenti caratterizzati per un approccio squisitamente bottom-up, dal basso della comunità di intenti verso l'alto del livello istituzionale, con forte impatto, creazione di contenuti fruibili liberamente e in grado di attivare azioni di innesco. Nascono così OpenPompei - Scriptorium, all'interno del Grande

Progetto Pompei ministeriale, con scopo principale la trasparenza amministrativa della gestione dell'area archeologica, ma che ha visto un evento di hackathon per la creazione di percorsi interni all'area archeologica, prima ignorati dalle piattaforme geografiche come Google Maps; OpenPatti, attualmente il sito archeologico siciliano più dettagliato e documentato presente su una piattaforma geografica universale; l'esperienza di ArcheoWiki, che ha relazionato diverse realtà museali lombarde di piccola entità; Connected Open Heritage, progetto promosso da Wikimedia Svezia e UNESCO incentrato sulla raccolta di contenuti fotografici di monumenti in aree di rischio o soggette a guerra, e che ha trovato in Italia una declinazione nel patrimonio - materiale e immateriale - in pericolo a causa di calamità naturali; mAppiaM!, per coinvolgere la cittadinanza nella valorizzazione della via Appia e del Parco della Caffarella; Public Archaeology Verona, per far scoprire e conoscere gli aspetti meno della città. Si prenderanno in esame i diversi progetti e le svariate iniziative incentrate sulla cultura collaborativa, illustrando le metodologie via via adottate e gli strumenti adoperati, al fine di individuare un modello incentrato sulla cultura libera per la valorizzazione territoriale in grado di generare anche un impatto economico.

STRUMENTI DIGITALI OPEN SOURCE PER LA DOCUMENTAZIONE DELLA CULTURA VISUALE PALEO-MESOLITICA: DATI PRELIMINARI DA UN FLUSSO DI LAVORO SULLE DECORAZIONI INCISE SU SUPPORTO CALCAREO DALLA GROTTA DI SANTA MARIA DI AGNANO (OSTUNI, BR)

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Donato Coppola

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Donato Coppola, già docente di Paletnologia presso l'Università di Roma Tor Vergata e Università del Salento, è attualmente docente presso il Dipartimento di Studi Umanistici dell'Università degli Studi di Bari; Direttore scientifico del Museo di Civiltà Preclassiche della Murgia meridionale di Ostuni (Brindisi) e delle indagini archeologiche presso il sito di Santa Maria di Agnano (Ostuni).

La complessità genericamente riscontrata nella visualizzazione e analisi dei segni grafici pertinenti al repertorio delle manifestazioni artistiche incise e graffite di età preistorica rappresenta un ostacolo ricorrente alla comprensione dei caratteri del sistema grafemico-simbolico condiviso dai gruppi di cacciatori-raccoglitori di cultura paleo-mesolitica.

Le tecniche consolidate di rilievo grafico e fotografico della ricerca archeologia, ad ogni modo risorse preziose per una documentazione indispensabile, sono oramai integrate da pratiche metodologiche e strumenti di indagine di acquisizione digitale dei dati mediante procedimenti di lavoro ed elaborazioni informatiche.

Con il sostegno delle attuali metodologie e applicazioni digitali, l'analisi della "grammatica dei segni" di età preistorica è virata verso l'indagine interattiva

degli oggetti al variare delle condizioni di illuminazione, che ne tenga conto della visione globale dei valori plastici che assumono i singoli segni in relazione al proprio supporto.

La sperimentazione metodologica è stata avviata sul corpus di incisioni su supporto calcareo recuperate nel corso delle indagini stratigrafiche presso la Grotta di Santa Maria di Agnano (Ostuni, BR) e attribuite ad un contesto rituale del primo Olocene: alla visione monoculare del microscopio digitale è stata integrata una documentazione fotografica ad alta risoluzione, calibrata sulla tecnica di acquisizione e di elaborazione di immagini, denominata Reflectance Transformation Imagining (RTI).

Basato sull'algoritmo opensource polynomial texture mapping (PTM), aggiornato e sviluppato dall'University of California Santa Cruz e la Cultural Heritage Imaging ©, il software libero RTIBuilder esegue un processo di mappatura polinomiale delle superfici, elaborando una serie di immagini del soggetto da una singola posizione e in condizioni di illuminazione variabili: stabilito sia un oggetto statico che una vista fissa della camera, l'applicativo codifica il valore di ogni pixel del frame fotografico e calcola le funzioni di riflettanza dai dati acquisiti, rendendo possibile una fruizione analitica del soggetto in modo interattivo.

Il vantaggio di questo metodo, già ampiamente verificato e validato, è la possibilità di creare, all'interno del software visualizzatore RTIViewer, un ambiente di illuminazione virtuale con molte luci, ognuna delle quali consente di aumentare il contrasto locale di una piccola porzione del manufatto, che di solito occupa alcune centinaia di pixel; il rendering non foto-realistico prodotto da questo ambiente virtuale di illuminazione non è riproducibile nel "mondo reale": il fine scientifico della tecnica è ottimizzare una misura di perfezionamento che massimizzi la nitidezza dell'immagine e allo stesso tempo preservi la luminosità diffusa, garantendo un miglioramento generale della percezione della forma e dei dettagli più particolari, incrementando lo scenario di dati sensibili da esaminare.

VIRTUAL ARCHAEOLOGY FOR THE LITTLE GUY? A CASE-STUDY BASED ASSESSMENT OF THE FEASIBILITY AND SUSTAINABILITY OF MINIMAL RESOURCE VR MODELLING AND ITS APPLICABILITY TO SMALL-SCALE ARCHAEOLOGICAL RESEARCH

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Ben Price is currently finishing his PhD project on Virtual Landscape tools using games engine development suites and how they can be used as a low-cost avenue for tool creation. He has the dubious distinction of having worked in both professional computer games development and archaeology and has a passion for exploring new ways of using computer technology to investigate the past. Previous projects have included his masters which resulted in the 3D printing of an Atlantic Iron Age bronze pin from the shattered remains of its clay moulds.

The prevalence and sheer accessibility of computer games engines has been a revolution in the indie games development scene for a number of years now, and use of games engines in archaeology is certainly no new thing, but can this free resource be used for non-games related tools for archaeological investigation and if so can it be done without the backing of a multidisciplinary team?

In my recent PhD thesis, I attempted to answer just this question and explore the realms of free to use and open source tools to create a Virtual Reality tool that can investigate virtual landscapes produced with LIDAR and a smattering of reconstructed models. The goals of the investigation were to see what the pitfalls were along the development track and whether these could be overcome by a single developer, whether such a tool was even feasible with a games engine (in this case the Unreal Engine 4) and what impressions such a tool would have on archaeologists familiar with the real landscape. This paper is a summarisation of that thesis, discussing how this accessible method of application creation can not only provide an academically beneficial method of investigation but also show that it is affordable and within the means of dedicated people to produce.

The free development tools used were the Unreal Engine 4 by Epic Games which is royalty free for free projects, the Cloudcompare open source project, and the GDAL open source toolset for geographic data. Other software that was used was free for students but not generally free, such as Autodesks Maya, Allgorithmic (now Adobe) Substance. Other free resources were used such as a plethora of free plugins for the Unreal Engine, all with the aim of keeping costs as low as possible.

In essence the project proved that yes, it is possible to produce such a tool but the process (currently) is not for the fainthearted. However recent additions to the Unreal Engine have the potential to significantly improve the workflow resulting in faster conversion of LIDAR data to 3D landscapes. The paper discusses all these options and includes a look at the future of games engine use within archaeology as a cheap development tool.

Fig. 1. A screenshot within the Unreal Engine showing the reconstructed broch structure sitting within the unusually shaped ditch. Broch-ditch

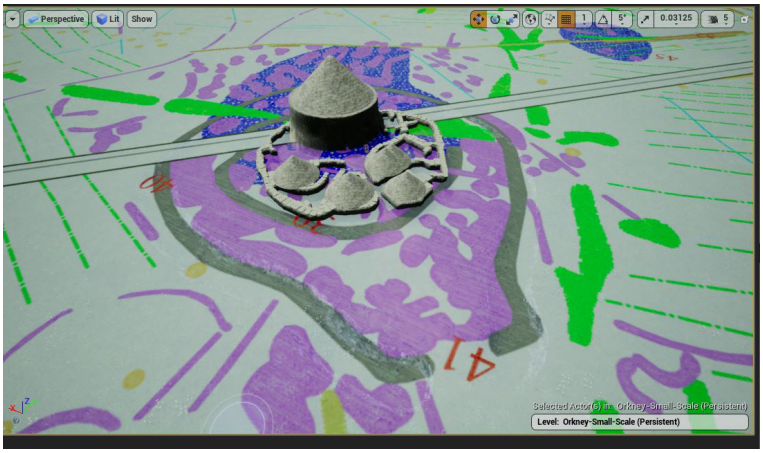

Fig. 2. This shows the overlay of the interpretive map of the geophysical survey results conducted by ORCA in 2002 & 2007 . This shows the relative positioning of the broch and the ditch in regards to the data. Note the overlay was positioned over the landscape using common elements that showed in both, such as the position of the 'fire pit' in the nearby Stones of Stenness.

FLOS PER I MUSEI: SOLUZIONI OPEN PER FORMARE LE COMUNITÀ E GESTIRE I LUOGHI CULTURALI

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Il presente intervento parte dall'esperienza manageriale degli ultimi tre anni dell'autore e intende mostrare una panoramica delle diverse soluzioni open-software e open-hardware utilizzate al fine di implementare le capacità evocative, comunicative, interattive ed economiche del museo. La possibilità attuale di utilizzo di strumenti FLOS per costruire le comunità e gestire i luoghi culturali è varia, seppur non ampia. In particolare si parlerà dell'esperienza dell'autore e del suo gruppo di lavoro sull'utilizzo dei seguenti software: Pannellum per la costruzione dei Virtual Tour del Museo Lanciani e del Museo Nazionale Etrusco di Villa Giulia, Glamkit come piattaforma CMS per la pubblicazione online e LOD del patrimonio museale, QGIS per la mappatura e la ricontestualizzazione dei reperti nel territorio, Pyarchinit per lo studio dei siti territoriali e la loro stratigrafia, Blender per la costruzione di modelli architettonici di monumenti, oggetti, ambientazioni e rendering, Cura per la stampa 3D delle opere ai fini dei percorsi multisensoriali e merchandising e FreeCAD per il rilievo architettonico e il dialogo con i laser cutter. Tuttavia, la possibilità di utilizzo della filosofia FLOS non è unicamente legata all'applicazione, sviluppo e produzione di soluzioni tecnologiche; se progettata in maniera oculata, una strategia manageriale open, può giovare alla gestione delle strutture, incrementare il business e agevolare la costruzione e la crescita numerica e scientifica delle comunità museali.

Nella seconda parte del presente contributo verrà quindi esplicato un modello di managerialità legato in maniera inscindibile alle soluzioni FLOS,

mostrando i modelli di business-plan che ne derivano, con la possibilità di accedere a sempre nuovi impulsi economici e crescita per gli allestimenti. Con pochi accorgimenti e implementazioni tecnologiche le strutture museali possono ospitare laboratori e corsi professionalizzanti FLOS, utili a loro volta per: la progettazione, la costruzione di percorsi multimediali e multi-sensoriali, la prototipazione del merchandising; avvicinando alla struttura nuovi tipi di pubblico, attraendo nuovamente le comunità politiche, imprenditoriali e industriali locali e internazionali.

Si tratterà di un modello sostenibile per la costruzione di reti interpersonali innovative, volto alla crescita delle nuove generazioni e dei professionisti nella conoscenza delle tecnologie in contesti profondamente culturali.

Si traccerà infine la strada futura verso la fusione tra Museo e Fab Lab, per sancire la nascita e la crescita dei FLOS-Museums in grado di ospitare assieme alle opere: incubatori di progettazione permanente, atelier per la costruzione di installazioni e merchandising, padiglioni e mostre temporanee, opifici di sperimentazione di supporti e sistemi espositivi in grado di essere replicati ed esportati, centri all'avanguardia di formazione, valorizzazione, diagnostica, restauro per la conoscenza scientifica dei beni esposti e la crescita delle comunità.

Fig. 1. FOSS-Museum

Fig. 2. Laboratori FLOS all'interno dei musei

Fig. 3 Stampa 3D in scala di un'opera scultorea

2

CREATION, USE AND PROMOTION OF OPEN DATA AND OPEN FORMATS IN ARCHAEOLOGY

FIELDNOTES FOR THE DEVELOPMENT AND PUBLICATION OF OPEN STANDARDS FOR THE VECTORIZATION OF ARCHAEOLOGIC AND ARCHITECTONIC TOPOGRAPHIC LEGACY DATA

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The paper is aimed at sharing with the broader community some methodological issues and practical solutions that have been faced and dealt with while working on the drafting of the Archaeological Atlas of Coptic Literature, in the context of PAThs ERC Advanced project directed by Paola Buzi and based in Sapienza University of Rome.

The premises where canonical: in order to design specific cartographic and topographic themes to be published in the Atlas (https://atlas.paths-erc.eu) a significant amount of previously published maps of various scales had to be digitized and vectorized. This material was quite heterogeneous, under multiple aspects. Scale, graphical styling, topographic accuracy, degree of interpretation, reconstructive hypothesis varied greatly from one map to another. The maps of the buildings related to the Christian cult — basilicas, churches, chapels, etc. — were digitized and georeferenced. This first step of the workflow would require a paper on its own since multiple technical and substantial (i.e. archaeological) issues are involved. The digitization and vectorization process took, on the other hand, the shape of an actual legacy data recovery action aimed at porting to the digital domain paper-based sketches. The most important task was to overcome the risk of creating a CAD-based, muted vector theme, a sort of digital-analogical copy of the paper version. It was decided thus to enrich the vector features with semantics, through the drafting of a simple but powerful schema able to encode concisely but exhaustively all sort of information that a common

archaeological and/or architectonic sketch is able to convey. Moreover, metadata on where the original drawing can be found and on the person who performed the vectorization have been encoded. The resulting protocol named PAThs Simple Vectorization Protocol, or simply SVP, has been released as a Free Cultural Work with the Creative Commons Attribution 4.0 International License.

This methodological approach considers the georeferencing and vectorization processes not as a purely mechanical or join-the-points one, but as a critical archaeologic reading and interpretation of the original drawing and its translation in digital format. The interpretation of the surveyor flowed into the paper-sketch and the one of the operator who deals with many versions of the same context must be clearly set apart in order to be able to easily distinguish the different contributions and possibly integrate more recent works, contributing greatly to the transparency of the scientific process.

When it comes to semantics, the protocol is chronology- and context-agnostic. This means that even if it has been developed to solve a very specific archaeological problem — i.e. the vectorization of sites and buildings related to the cult of the Christian religion in Late-antique and Medieval Egypt — it can be used profitably virtually in any cultural or chronological context. The SVP provides means to thoroughly describe extant or hypothesised structures, their state of preservation and the relative chronology (i.e. phases). The protocol aims to be an objective tool for vectorization, trying not to force over-interpretation when information is lacking, but it is designed also to provide useful tools for multi-layer hypothesis by maintaining the overall transparency of the entire data production and manipulation process.

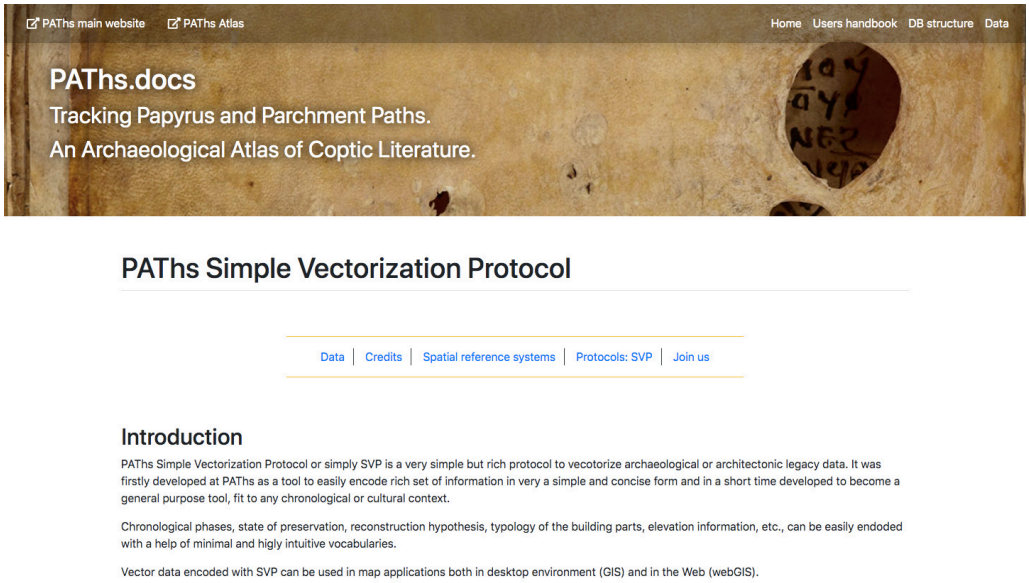

Fig. 1. PATh's data portal. The SVP official documentation page (https://docs.paths-erc.eu/data/svp)

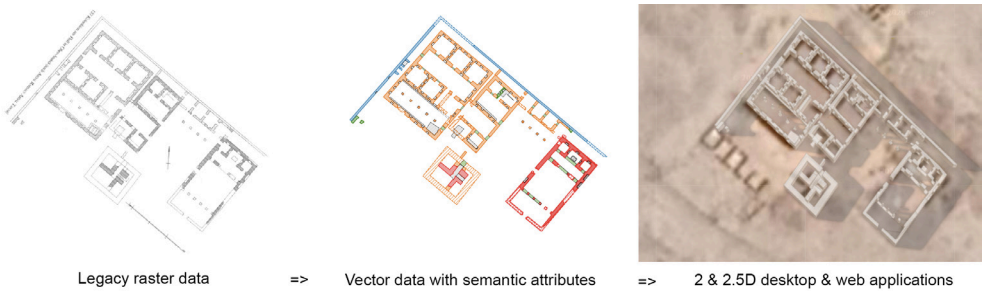

Fig. 2. A graphical example of the SVP

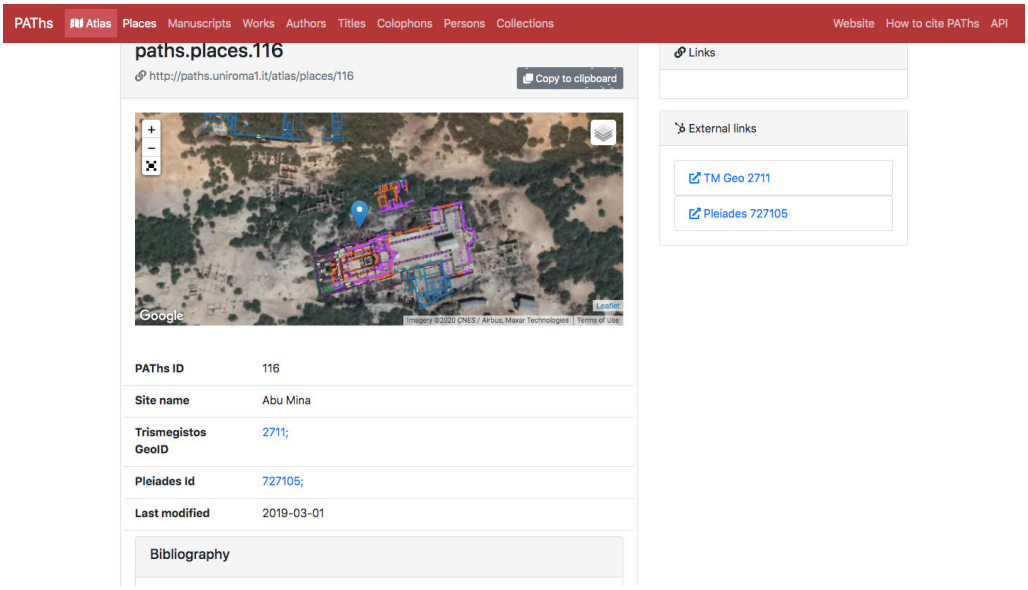

Fig. 3. Actual use of the vector data created using SVP in the web application of the Archaeological Atlas of Coptic Literature (Abu Mina, https://atlas.paths-erc.eu/places/116)

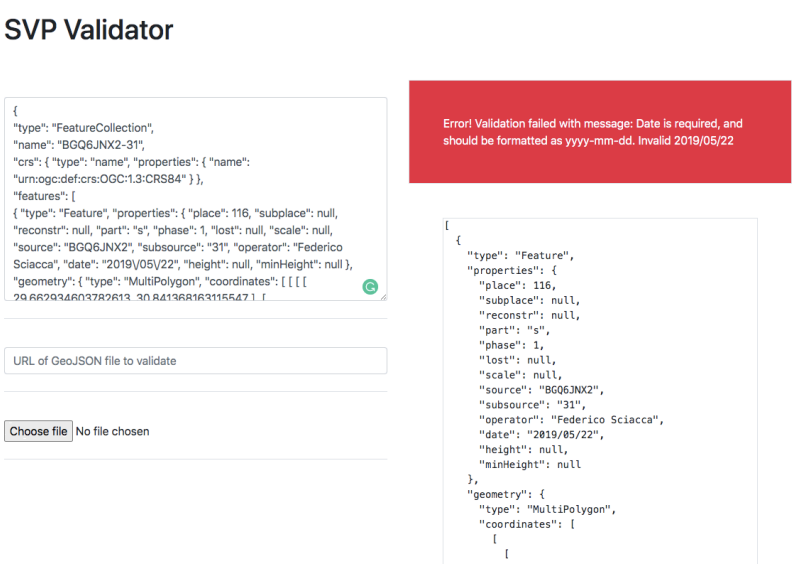

Fig. 4. SVP validation tool created to encourage a strict implementation of the standard (https://paths-erc.eu/svp-validate/)"

OPEN DATA, OPEN KNOWLEDGE, OPEN SCIENCE: UN NUOVO LABORATORIO DELL'ISTITUTO DI SCIENZE DEL PATRIMONIO CULTURALE

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Open Access e Open Data – trasparenza, riproducibilità e condivisione – sono le due istanze fondamentali dell'Open Science, la scienza partecipativa, intesa come divulgazione e partecipazione attiva. Da diversi anni la politica del CNR è orientata verso questa direzione, come testimoniato dalla partecipazione dell'ente a infrastrutture di ricerca digitale anche nel settore dell'Heritage Science, quali E-RIHS (http://www.e-rihs.eu/) e Iperion CH (http://www.iperionch.eu/).

Sostenere l'innovazione nella conoscenza, conservazione e valorizzazione dei beni culturali, sviluppando l'Open Science per la condivisione dei dati scientifici è una delle mission dell'Istituto di Scienze del Patrimonio Culturale (https://www.ispc.cnr.it/it_it/), un hub di nuova formazione, che ha raccolto l'eredità pluriennale della linea di ricerca dedicata all'Informatica archeologica nata agli inizi degli anni Ottanta e poi sviluppatasi intorno alla rivista open access Archeologia e Calcolatori (A&C).

Il paper proporrà alcune riflessioni sul ruolo sempre più significativo delle riviste scientifiche come luogo di pubblicazione dei risultati delle ricerche e di promozione delle buone pratiche della filosofia open. In questo ambito, A&C ha assunto nel tempo un duplice ruolo: da una parte si è proposta come aggregatore internazionale di progetti, idee e riflessioni, dall'altra è stata una fucina di sperimentazione e riflessione focalizzata soprattutto verso Open Science e risorse digitali aperte in archeologia.

Intorno ad A&C si è formato oggi un Laboratorio interdisciplinare di archeologi, filologi, matematici e informatici, la cui opera non si è limitata all'attività scientifica e di redazione, ma si è posta obiettivi più ampi, mirati al monitoraggio e allo studio di tecnologie di gestione ed elaborazione delle informazioni per favorire la fruizione di collezioni di open data in ambiente digitale.

Il repository degli articoli di A&C, conforme al protocollo OAI-PMH, contiene oggi i metadati di più di 1000 risorse digitali, consultabili in accesso aperto dal sito web, per un totale di oltre 15.000 pagine (http://www.archcalc.cnr.it/). Questo ampio repertorio ha avuto anche l'obiettivo di fornire alla comunità scientifica una fonte di informazioni specialistiche accessibili e connesse con altre informazioni in rete, permettendo alla rivista di essere allineata alle più attuali tendenze internazionali verso la scienza aperta e il web semantico.

L'interoperabilità garantita dalla conformità agli standard internazionali per la creazione dei metadati e per la loro esposizione ha consentito ad A&C di contribuire ad iniziative di aggregazione di contenuti culturali digitali. Quello di A&C è il primo dataset relativo alla produzione di una rivista scientifica ad essere stato reso disponibile in CulturaItalia nel 2017 (http://www.culturaitalia.it). Dal 2020 A&C è presente anche nel portale Europeana con oltre 900 risorse (https://www.europeana.eu/) (Fig. 1). Grazie all'attuale lavoro di mappatura dei metadati delle risorse secondo le più recenti linee guida di OpenAIRE (https://www.openaire.eu/), la rivista sarà a breve content provider della principale infrastruttura europea di Open Science per la comunicazione dei risultati della ricerca.

Sempre nell'ottica della condivisione di risorse scientifiche in rete, in occasione dell'uscita del 30mo numero è stata sperimentata l'applicazione ai testi di A&C di strategie di webmapping secondo i criteri offerti dall'open source international tool Recogito (https://recogito.pelagios.org/). Tale mappatura geografica è stata eseguita sugli articoli pubblicati nelle annate edite tra il 2014 e il 2018 e su una selezione di testi (editi dal 1990), in cui si fa riferimento a siti etruschi. La finalità è stata quella di rendere i toponimi citati negli articoli dei linked open data, che risultano consultabili in Pelagios Commons, attraverso il suo motore di ricerca geografico Peripleo (https://peripleo.pelagios.org/) (Fig. 2).

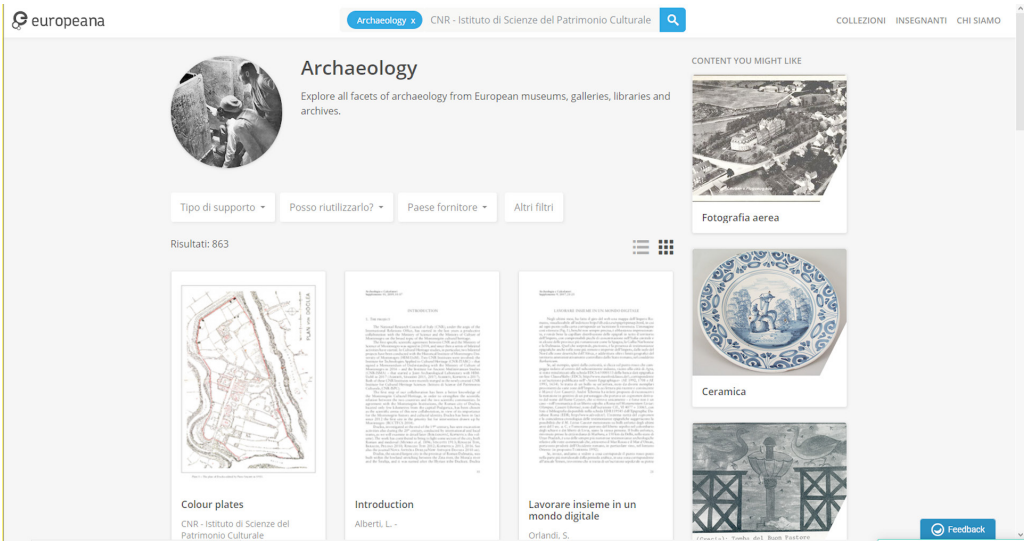

Fig. 1: Archeologia e Calcolatori in Europeana.

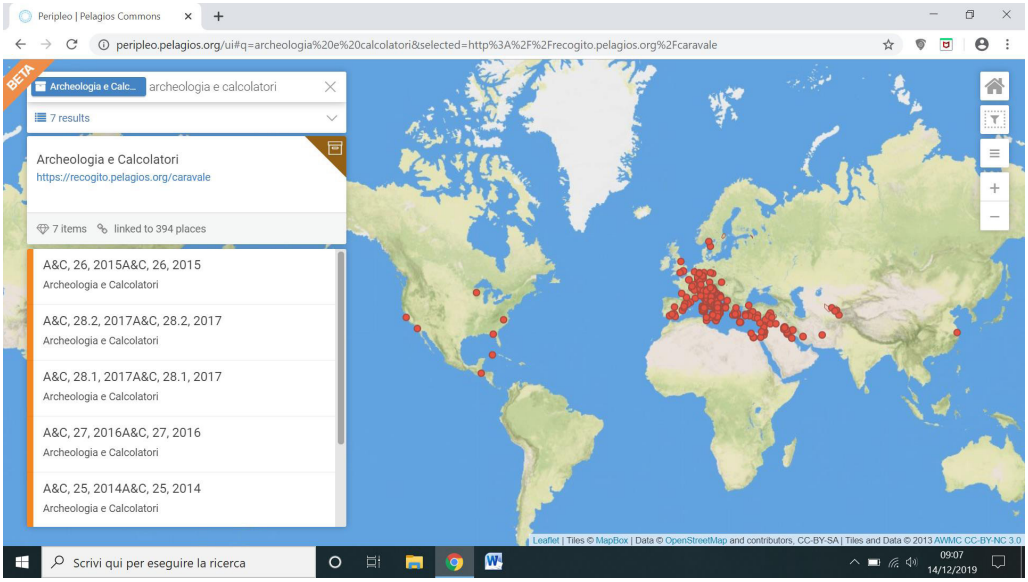

Fig. 2: I toponimi di Archeologia e Calcolatori visualizzati in Peripleo.

ANALISI E CONFRONTO DI FORMATI SPAZIALI APERTI E NON APERTI PER LA RICERCA ARCHEOLOGICA

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Le reti satellitari GPS, le celle radio utilizzate per la telefonia mobile e l'emergente Internet of Things, consentono di tracciare e correlare la posizione di persone e oggetti in modalità talmente precise fino a poco tempo fa impensabili; per questo motivo, all'interno del flusso di dati che vengono raccolti quotidianamente, i dati geo-spaziali occupano un posto rilevante nella prospettiva dei big data.

Nel 2017 l'OGC (Open Geospatial Consortium) ha pubblicato un white paper con l'intento di definire approcci più efficienti per il trattamento dei big

data geo-spaziali. Attraverso l'identificazione di best practice per far fronte alle moderne sfide di gestione di grande quantità di dati, è possibile usufruire di nuovi strumenti e tecnologie per gestire la visualizzazione, l'analisi e l'integrazione dei big data geo-spaziali, riuscendo finanche a individuare correlazioni sconosciute e ad estendere i domini di conoscenza. Un ruolo chiave nel processo di creazione di infrastrutture di gestione dei big data è occupato dagli standard aperti. Tale approccio garantisce l'affidabilità dei dati, permette la loro corretta divulgazione e ne consente un valido riutilizzo in diversi domini di applicazione.

Nell'ultimo decennio, anche nell'ambito della ricerca archeologica sono state pienamente comprese le potenzialità dell'utilizzo dei formati standard per la pubblicazione in rete di banche dati territoriali e dei relativi risultati di analisi geo-spaziali. Parallelamente, si è assistito a una proliferazione di standard e di formati aperti di interscambio, nonché di direttive nazionali ed Europee: tra queste ultime si segnala la direttiva INSPIRE emanata con l'obiettivo di favorire la creazione di una infrastruttura nazionale per rendere omogenee e condivisibili informazioni geo-referenziate di carattere ambientale. L'Open Geospatial Consortium conta, ad oggi, 69 standard per la descrizione di dati geografici. A questi si aggiunge lo SHAPEFILE, un formato proprietario oramai divenuto uno standard per l'analisi spaziale. Con queste premesse, è facile intuire come i ricercatori – anche in campo archeologico - spesso si trovino davanti a una moltitudine di formati, standard e non, tra cui risulta difficile orientarsi nella scelta, soprattutto in funzione della visualizzazione, della long-term preservation dei dati e della interoperabilità delle banche dati geografiche.

Il dato spaziale in archeologia ha un'importanza straordinaria nella ricostruzione del passato consentendo a vario livello di individuare pattern territoriali oppure di localizzare funzioni particolari all'interno delle aree urbane. Per queste esigenze specifiche di ricerca la registrazione spaziale dei dati riveste un ruolo determinante nel processo di ricerca archeologica e quindi di comunicazione soprattutto nell'ottica della condivisione dei dati aperti. Ma l'archeologo stesso, a sua volta, adopera informazioni spaziali già presenti sulla rete e messe a disposizioni da altre istituzioni di ricerca, di gestione o di pianificazione del territorio.

Questo contributo intende fornire un'analisi sugli standard utilizzati nelle banche dati online e nei geo-portali regionali e nazionale, per quel che riguarda le informazioni archeologiche, effettuando una mappatura delle risorse presenti in rete, per individuare gli effettivi livelli di interoperabilità. Particolare attenzione è stata posta al confronto tra i formati standard mag-

giormente presenti nelle infrastrutture digitali per descrivere le singole risorse (es. GML), i geo-database (es. GeoPackage) e la sfera 3D (es. CityGML), individuandone punti di forza e criticità. L'obiettivo è stato quello di evidenziare le caratteristiche tecniche dei formati analizzati, per comprendere quali siano le strategie e le prospettive e come questi dati possano interagire in modo efficace con differenti applicazioni in campo archeologico.

DEVELOPING LONG-TERM INFRASTRUCTURE FOR OPEN ARCHAEOLOGY RESEARCH DATA: iDAI.world

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Benjamin Ducke is based in Berlin, Germany, where he works for the German Archaeological Institute. As Head of Scientific Computing, he supports the design and development of open source software for the DAI's online research data infrastructure (iDAI.world). He also provides consulting services and IT training to DAI staff, project partners and international beneficiaries. His main area of technological and scientific expertise is that of spatial data processing and statistics, including geoinformation systems (GIS), spatial data infrastructures (SDI), remote sensing, image-based (SfM/MVS) 3D reconstruction, sensor data processing and archaeological predictive mapping.

This paper discusses the design and current state of development of iDAI.world (https://idai.world), the open research data infrastructure of the German Archaeological Institute (DAI: Deutsches Archäologisches Institut). The ultimate development goal of iDAI.world is to provide a modular, Web-based FAIR implementation with exhaustive support for all main categories of archaeological research data.

A network of many different departments and research units, spread across several continents, the DAI is an archaeological microcosm in itself, reflecting the diversity of the discipline's practice and research. And iDAI.world, in turn, represents this institution's paradigmatic shift toward digital research and open data infrastructures. Currently available modules cover the following, principle types of research data:

- iDAI.objects (a.k.a. Arachne): object-centric, well-structured datasets of common research categories (sculptures, buildings, building parts, ...), with strong support for secure and fast image hosting (https://arachne.dainst.org)

- iDAI.gazetteer: authoritative registry of ancient and modern places, with a hierarchical data model and support for multiple translations/transcriptions of place names (https://gazetteer.dainst.org)

- iDAI.geoserver: geodata repository that supports seamless upload and management of common GIS data products, as well as data styling and thematic map production; based on GeoNode and Java GeoServer as middleware, and thus implementing OGC GIS protocols (https://geoserver.dainst.org)

- iDAI.field 2: a field data (excavations, surveys, etc.) client with offline and synchronisation capabilities, with a flexible data schema that can be adjusted and extended to suit specific project needs (http://field.dainst.org)

In addition, iDAI.world includes modules for bibliographic research, standardized vocabularies, open access publications and other tools that assist researchers in producing and publishing consistent, interoperable research data.

With its early roots in the traditional server-client architecture of the late 1990s, iDAI.world, through the diversity of its components, reflects the evolution's dynamics of two decades of software development: in-house development vs outsourcing, project-focused and top-down vs needs-driven and agile development, have all been complex issues that played a role in shaping this digital infrastructure. Accordingly, many (sometimes expensive) lessons have been learned, regarding the sustainable and long-term development of open source research software.

The biggest obstacles are often not of a purely technological nature, but related to the effects that technological innovations and disruptions have on research traditions, as well as to the sheer complexity of modern software development.

In a research environment where ideas and opinions ("interpretations"), as well as access to primary sources of information (such as excavation licenses) have traditionally been regarded "academic currency", and where progress and career paths were long associated with personal merit rather than collaborative scientific rigor, the ideals of reproducible research and the sheer scope and demands of open science meet considerable inertia.

On the other hand, writing software is easy (children can learn to program), but designing and implementing digital infrastructures that will (hopefully) one day prove at least as useful and lasting as printed publications, is a tremendous undertaking for which no simple "solutions" exist.

Consequently, some of the most valuable lessons learned within the context of iDAI.world will be shared in this paper, touching on technical as well as economic and social complexities.

THE ARCHAIDE ARCHIVE

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This paper is focused on one of the less-known aspects of the ArchAIDE project: the open data policy and the management of material covered by copyright. The ArchAIDE project developed a system for automatic recognition of pottery with an innovative app for tablets and smartphones. This goal has been implemented through the development of two distinct neural networks for appearance-based and shape-based recognition and lays on the creation of a digital comparative collection, incorporating existing digital collections, digitised paper catalogues and multiple photography campaigns. For achieving the correct management of the material which falls under copyright or database protection, the EU directives on Copyright (2001/29/EC) and Database protection (96/9/EC) were analysed. The scientific research exception permitted the implementation of the project, in particular, (i) as regards the area of copyright: published works, mentioning the source and

the authors' name, can be used to the extent justified by a non-commercial purpose; the use of the structure of published databases can only be used, mentioning the source, to the extent justified by a non-commercial purpose; (ii) as regards the sui generis right: databases can be used, even if scientific research is not its sole purpose, mentioning the source and the authors' name, to the extent justified by a non-commercial purpose. This does not mean the ArchAIDE project necessarily holds the copyright to the newly digitised, remixed data. Whether these data can be made available outside the project would need to be negotiated with each copyright holder. Showing the potential of digitising paper catalogues in a way that demonstrates how their content can be actively reused allows ArchAIDE to open a discussion with publishers and other data providers about the importance of making their resources available in new ways, with a tangible benefit (seeing their data in use within the app), thus furthering the long-term discourse around making research data open and accessible.

Participating in the H2020 open data pilot, ArchAIDE was committed to creating sustainable outputs where the project held the copyright. This included making the interoperable, multilingual vocabularies, and the video corpus created by the project available, as well as the 2D and 3D models created from the ADS archive Roman Amphorae: a digital resource. This aspect of the archive represents a good exemplar of best-practice reuse. When this digital resource was first deposited in 2005, creating automated 2D and 3D models that could be used to create 'virtual sherds' to train the deep learning algorithm could not have been a use envisioned. As 2D and 3D models were created for every type from Roman Amphorae, it was possible to link the two archives, amplifying the usefulness of both. The ArchAIDE archive includes 2D vector drawings in SVG format for download, and 3D models for interactive use within the 3D viewer (created using 3DHOP). The 3D models can also be downloaded for use with 3D software and 3D printing.

It was also hoped the thousands of photos taken by the project for training the algorithms, might result in new comparative collections that could be made freely available as part of the ArchAIDE archive. Still, intellectual property rights in many European countries are restrictive and did not allow photos taken by ArchAIDE partners of sherds held in national and regional collections to be made available. It is hoped that seeing the usefulness of these data within an example application such as ArchAIDE may also help convince the holders of these resources to move towards more open data policies. Finally, the source code and neural network models will shortly be made publicly available as open source.

Acknowledgements. This research was supported by the EU Horizon 2020 grant agreement No. 693548. We thank all the members of the ArchAIDE team (http://www.archaide.eu).

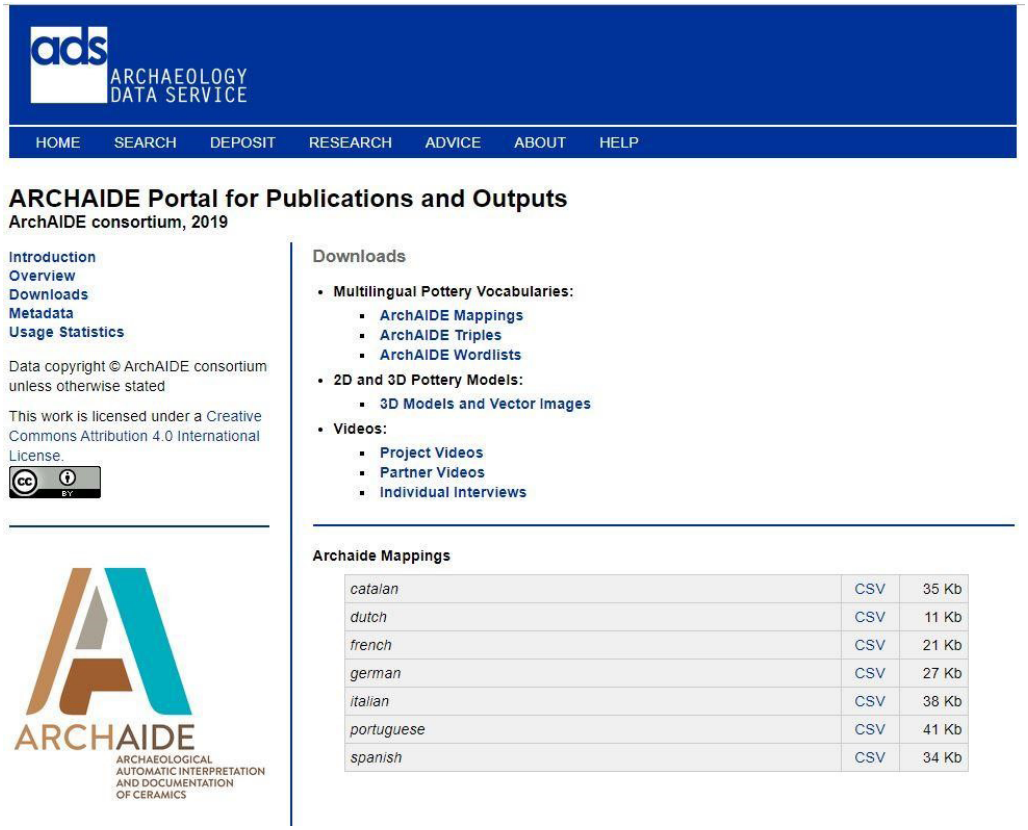

Fig. 1 Screenshot of the ArchAIDE archive: https://doi.org/10.5284/1050896

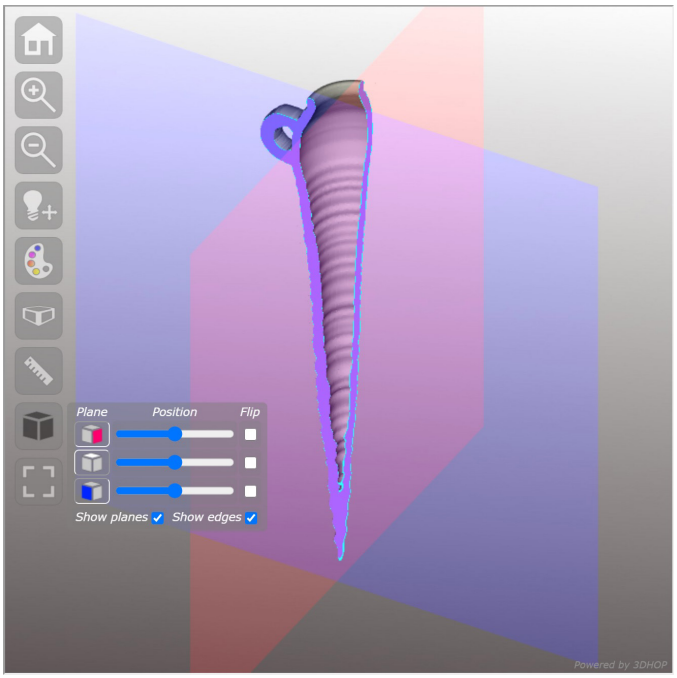

Fig. 2 Carrot Amphora DR103 in the 3D viewer. https://archaeologydataservice.ac.uk/archives/view/archaide_2019/downloads_amphora.cfm?amph=Carrot_Amphora_DR10

Fig. 3 3D printed Roman amphorae from the ArchAIDE archive

FOSS, OPEN DATA E OPEN CONTENTS IN ARCHEOLOGIA: BREVE STORIA, STATO DELL'ARTE E SCENARI FUTURI

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https://www.dcuci.univr.it/?ent=persona&id=4736

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Marco Ciurcina

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I concetti di software libero e copyleft nascono alla fine degli anni '80, quando la diffusione del personal computer e delle prime BBS danno origine a un'utenza privata dell'informatica. Le pratiche e le normative esistenti mal si adattano ai nuovi modelli produttivi e comunicativi proposti dalle nuove tecnologie e si rende necessario stabilire nuove regole in grado di stare al passo con la rapida evoluzione di hardware e software. È così che vengono ideate licenze in grado di tutelare i produttori di software ma al contempo anche di favorire la diffusione e divulgazione delle loro creazioni. Nei primi anni '90, il rapido sviluppo del web crea un nuovo forte divario tra la legislazione esistente e le innumerevoli possibilità di condivisione offerte dalla rete e, anche grazie alla spinta di associazione e movimenti come l'Electronic Frontier Foundation o il movimento per l'Open Access, i concetti di copyleft e di licenza libera si diffondono rapidamente anche a dati e contenuti. Un nuovo punto di svolta si ha circa una decina d'anni più tardi, quando Cloud e servizi web cominciano a entrare nell'uso comune. Il supporto fisico di dati e contenuti non è più detenuto da chi li produce, ma ubicato altrove e l'accesso è regolato da licenze di servizio. Ora ai movimenti e

alle associazioni per i diritti digitali si affiancano spesso Antitrust e Garanti Privacy nazionali, che intervengono frequentemente in casi di utilizzo non appropriato dei dati: la loro tutela rappresenta ora la nuova frontiera per le libertà digitali. Tale repentino sviluppo tecnologico ha portato anche chi si occupa di beni culturali e di archeologia a riflettere su leggi e regolamenti non più adatti alle modalità digitali di archiviazione e divulgazione. Seppure con un certo ritardo, nascono in Italia movimenti a favore dell'uso di tecnologie libere e dell'apertura di dati e contenuti, tra i principali: ArcheoFOSS, che ha impresso una forte spinta alla conoscenza del software libero in ambito archeologico, e il movimento Fotografie Libere per i Beni Culturali, motore di un'importante iniziativa grazie alla quale dal 2017 i beni culturali di proprietà pubblica sono liberamente fotografabili e divulgabili (fatto salvo lo scopo di lucro).

È indubbio che attualmente il software libero sia largamente impiegato nel settore archeologico: solo per citare alcuni esempi, QGIS è tra i software più diffusi negli scavi e negli studi territoriali; Leaflet e Geoserver sono tra le tecnologie Web GIS più utilizzate, etc. Ci si chiede dunque se per i dati e i contenuti relativi ai beni culturali e archeologici l'applicazione di licenze libere sia diffusa quanto l'utilizzo di software libero. L'analisi delle principali pubblicazioni dedicate a questi temi sembra evidenziare come software e dati siano andati fin'ora a due velocità diverse: al grande utilizzo di software libero non corrisponde un altrettanto ampio accesso ai dati. Le principali cause di questo divario vanno ricercate nel contesto storico sopra citato: la spinta all'accesso ai dati ha una origine più recente, inoltre pratiche e leggi ancora non adeguate al ciclo di produzione digitale costituiscono spesso un forte freno all'apertura. Un'ulteriore problematica è quella delle modalità di accesso: spesso i dati necessitano di un oneroso processo di rielaborazione e migrazione per poter essere esposti come "open data" e l'infrastruttura tecnologica disponibile non è adeguata. Non mancano tuttavia in Italia esempi pionieristici che fanno ben sperare, come i progetti SITAR o Mappa. In tale stato dell'arte si innesta una riflessione sugli scenari futuri. Ancora una volta sembra profilarsi una doppia velocità: quella più rapida dell'apertura dei dati, stante un processo in qualche modo già avviato, e quella più lenta della predisposizione di infrastrutture e di servizi con termini d'uso appropriati. La nuova sfida del futuro sembra dunque essere la tutela e conservazione del nostro patrimonio culturale digitale.

TOWARDS AN ONTOLOGY OF THE MUSEUM OF ARCHAEOLOGY OF THE UNIVERSITY OF CATANIA: FROM THE LEGACY DATA DIGITIZATION TO THE SEMANTIC WEB

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Daria Spampinato, researcher at the CNR Institute of Sciences and Technologies of Cognition, located in Catania, is a computer science expert with many years of experience in DH having taken part in various projects for of enhancement and promotion of cultural heritage through the exploitation of technology and digital, including the digital collection of the epigraphs of the Castello Ursino Civic Museum of Catania, through the project EpiCUM (http://epicum.istc.cnr.it) and the BellinInRete project, concerning the semantic organization of the archival and documentary heritage of the Bellini Civic Museum of Catania (http://www.bellininrete.istc.cnr.it). She carries out research as computer science expert in the fields of Computational Humanities, Text encoding, Digital epigraphy, Digital Libraries, Semantic Web and Linked Open Data; she is a member of the Board of the Association for Humanities and Digital Cultures since 2014.

This paper deals with the data management of museum collections using the specific case-study of the Libertini Collection kept at the Museum of Archaeology of the University of Catania. Since the aim of the project is to define forms of long-term preservation of digital data associated with sites and objects of cultural interest, we used the Linked Open Data paradigm

and, more specifically, the Web Ontology Language, the standard language for representing web ontologies, which are digital tools designed for the definition, description, integration and sharing of resources of various domains of knowledge. Such an approach adds a high level of expressiveness for the possibility of using automatic reasoning tools, which allows one to obtain a more complete and comprehensive as well as more complex and efficient form of digital research.

The digitization of the archaeological collection of the Museum of Archaeology of the University of Catania explores innovative models of data entry in order to encourage not only new research by specialists, but also the discovery and interpretation of cultural heritage by a wider audience, including university students who have been directly involved in the process of data entry. All the finds will be made available and reusable online in an open (CC BY-NC-SA 2.5 IT - Creative Commons) and connected format following the spirit of a public, shared and participatory archeology. Moreover, the core of the Museum are the 325 finds belonging to the collection that was donated by G. Libertini to the University of Catania in 1953 (Fig. 1). The collection consists of finds from the Greek and Roman periods (i.e. fine and common wares, epigraphs, terracotta figurines, coins, etc.) mostly unearthed in the archaeological sites of Catania and Centuripe areas. Among these are some noteworthy fakes (i.e., 78 objects forged in the first half of the twentieth century) which for the outstanding level of craftsmanship and the use of authentic molds deceived many archaeologists and art historians.

The decision to publish online the content of the G. Libertini Collection is not only related with the quality of the finds, but also to the consistency of the supporting documentation (i.e., catalogs, transmission letters, photos, etc.). The project aims not only at reconstructing the history of the collection, but also at transforming it into a digital dimension through the processing, recovery and republication of the available legacy data. The project will allow one to identify the context of scattered items and to relate the copy of the item with the original, by means of an appropriate mapping of the ontology with the RDF Pleiades vocabulary, according to the LOD paradigm.

The first step saw the identification of the entities and their organization intoa system that adopts the ICCD standards, with a view to a forthcoming integration with the SIGECWeb (Fig. 2). For the development of an effective and expressive ontological model, the preliminary phase is the normalization of the data acquired through museum resources and their organization into homogeneous and structured collections with adequately refined

level of granularity (Fig. 3). Specific terminological vocabularies of reference will be determined. The areuseful for normalizing data by means ofthe identification of suitable and consolidated existing vocabularies and the definition of new terminological entities. We will then rely on already existing ontologies on inherent domains such as OntoCeramic [1] and EpiONT [2], defined according to the CIDOC standard for the integration of data in cultural and archaeological contexts.

[1] Brancato, R., M. Nicolosi-Asmundo, G. Pagano, D.F. Santamaria, S. Ucchino, "Towards an Ontology for Investigating on Archaeological Sicilian Landscapes, Proceedings of the ODOCH 2019", *CEUR Workshop Proceedings 2375*: 85-90. 2019.

[2] Cantone, D., S. Cristofaro, M. Nicolosi-Asmundo, F. Prado, D.F. Santamaria, D. Spampinato, "An EPIDOC Ontological Perspective: the Epigraphs of the Castello Ursino Civic Museum of Catania via CIDOC CRM", *Archeologia e Calcolatori* 30: 139-157, 2019.

Fig. 1. Museum of Archaeology of Catania University, the G. Libertini collection, selection of some finds from the Greek age (above) and fakes (below).

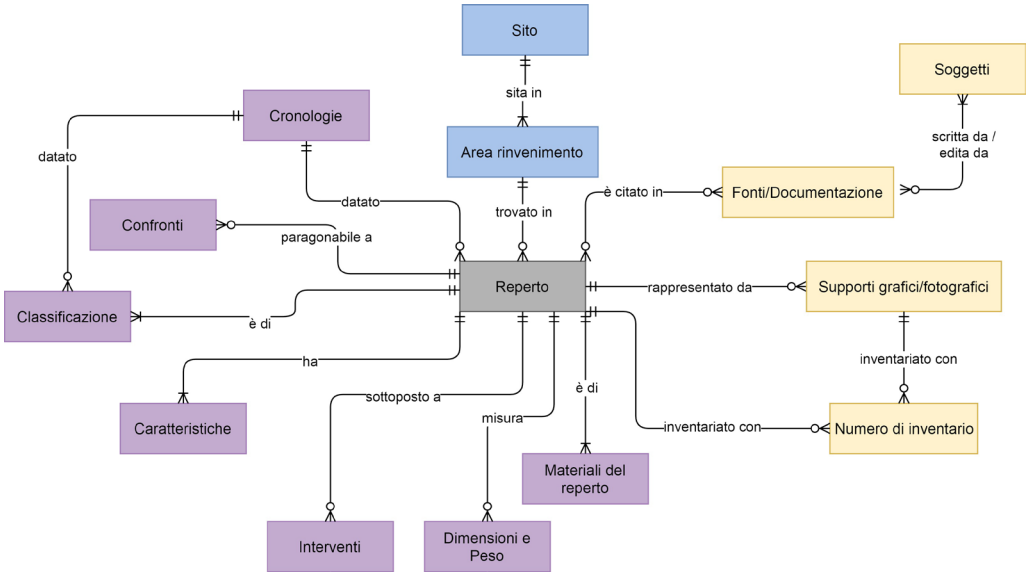

Fig. 2. Museum of Archaeology of Catania University, Entity–relationship diagrams.

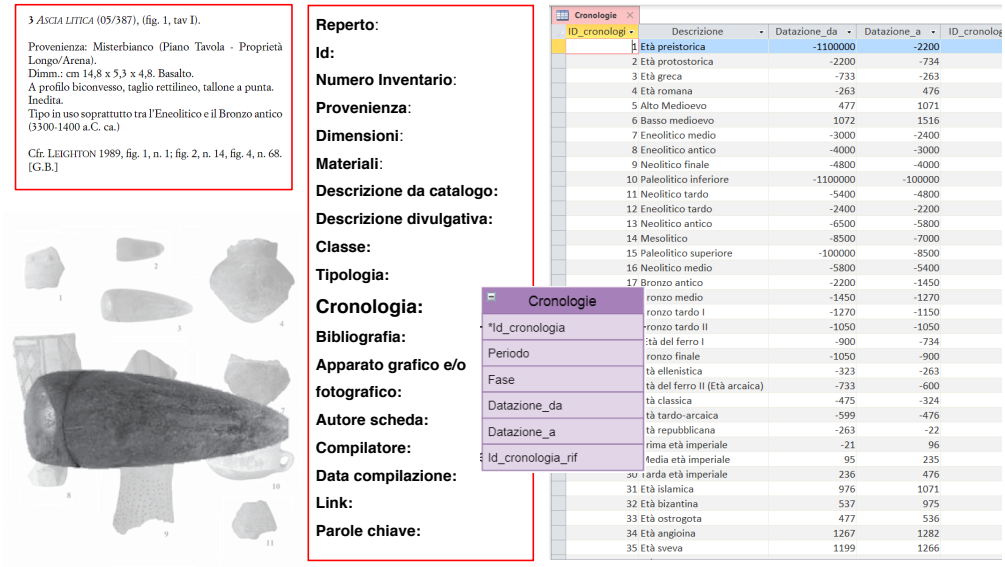

Fig. 3. Museum of Archaeology of Catania University, digitization of chronological data.

DIGITAL EDITIONS OF OBJECTS AND CLASSES: THE CONSPECTUS AS AN ONLINE SYSTEM OF RELATIONS AND REFERENCES

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Katja Rösler is a project team member at RGK Frankfurt concerned with research data management. She has studied Pre- and Protohistory at the Universities of Regensburg and Frankfurt and graduated with a PhD at the University of Freiburg with a specialisation on theories and methods of classification and the history of concepts in Archaeology. Her current research interest is the history of computer use and databases in archaeological research.

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Frederic Auth has studied Software Engineering at University of Applied Sciences Wiesbaden and Provincial Roman Archaeology at Goethe-University Frankfurt/Main. For the last ten years he has been involved in software projects in- and outside of archaeology. Currently he works as a research assistant in a research data management project at RGK Frankfurt. His research interests are digitalisation in archaeology in general, databases of ‚things', open source in archaeology and gis-related analysis methods.

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Kerstin P. Hofmann

Kerstin P. Hofmann is Deputy Director of the RGK. She directs the research area "Crossing Frontiers in Iron Age and Roman Europe (CrossFIRE)" and the research project "Ding-Editionen" of the RGK. She studied Prehistoric Archaeology with a minor in informatics at Kiel and Cologne. One of her current research interests is the analysis of knowledge production and its transformation due to digitalisation.

Editions of objects are a specific form of publication in archaeological science and play a central role in comparative and classifying research. They comprise lists, tables, catalogues, atlases and corpora (Hofmann et. al. 2019: http://nbn-resolving.de/urn:nbn:de:0048-dai-edai-f.2019-2-2236). As part of a research data management project of the Zentralen Wissenschaftlichen Dienste (central scientific services) of the DAI (www.dainst.org), at the RGK Frankfurt we are currently transferring editions of objects to the semantic web and utilising the possibilities virtuality offers. The selection of editions follows three criteria: most importantly the edition has to be widely accepted and continuously used in the scientific community. Hereby substantial metadata can be extracted and there will most likely be a longstanding requirement for the data. Furthermore, the editions should be published in the DAI or its departments so that copyrights and publication rights are ensured. Finally, the data of the edition should be set out in a form that enables them to be transferred to a database (DB), and data related illustrations should be available.

The Conspectus Formarum Terrae Sigillatae Italico Modo Confectae (https://zenon.dainst.org/Record/000255878; in the following just Conspectus) is an edition of objects, i. e. of plain Terra Sigillata (TS) (also known as Samian Ware), that meets the criteria mentioned above. But other than being an edition of objects it is a revision of prior classes and a synthesis of prior classifications: It is an edition of classes.

It was compiled in the years between 1986 and 1990 by leading specialists for TS, all of them members of the learned society Rei Cretariae Romanae Fautores (https://www.fautores.org/). Their aim was to overcome the usual geographically bounded classification that is based on the analysis of production sites, contexts or chronology. Instead they »have tried to systematize that knowledge in such a way that future researchers will find it helpful as a framework within which to arrange their own perceptions and on which to hang future accretions of knowledge« [Conspectus, p. 2] An open and future-oriented framework is a defining component of DBs (Burkhardt 2015: https://doi.org/10.14361/9783839430286-007) – but the data were not recorded in a DB, although the technical possibilities were already at hand in the discipline (Rösler 2016: https://www.academia.edu/38924456/)

Thus, the current transferral of the Conspectus' data into a relational DB is facilitated by their conceptual framework and their system of categories. And beyond the mere reproduction of the conspectus, and by detachment from paper, the data can now be worked with: it can be corrected, updated, added, externally linked, and represented in numerous contexts.

In our contribution to the conference we would like to refer to the following topics:

1. The data of the Conspectus should be presented in a relational DB. As the metadata can and will be represented in other digital environments such as the iDAI.world (https://idai.world/), the classification and classes can themselves be represented in a relational DB. It is the classification system that reflects relations examined by the scientific community, and in our view this knowledge should be displayed as well.

2. The framework of virtuality allows us to play with the representation of data. We would like to introduce a representational tool for the combination of rim-, wall- and base-forms of vessels that is based on open-source software.

3. Open Data should not only mean data for free use, but it should also ensure the provision of access to the origin of the context the data was or is represented in, if possible. In the case of the Conspectus we are working on a historical and epistemological analysis of its development, and we would like to present some results and discuss their contribution to the provision of high quality data.

SPARQLING ᚛ᚋᚂᚐᚌ᚜: PUBLICATION OF IRISH OGHAM STONES AS LOD

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Sophie C. Schmidt, M.A., is a Prehistorian and Computational Archaeologist who focuses on geospatial and statistical analyses and open research practices. She worked as a research associate at the University of Bonn and the Cologne Digital Archaeology Lab (CoDArchLab), teaches courses and workshops on statistics in the programming language R and reproducible research and is interested in archaeogaming, analysing the representation of the past in digital games. She is also a member of the Research Squirrel Engineers working group as well as the international CAA and the German chapter.

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In this paper we present a project by the working group 'Research Squirrel Engineers' (http://squirrel.link) on the digitization and provision of Irish Ogham Stones in Wikidata as Linked Open Data (LOD). Ogham Stones are monoliths inscribed with the Ogham (᚛ᚋᚂᚐᚌ᚜) script, erected in Ireland and the western part of Britain (Wales, Scotland, Cornwall, Devon, Isle of Man) between the 4th and 9th centuries. The standard work on Ogham inscriptions is the Corpus Inscriptionum Insularum Celticarum (Macálister 1945,1949). In it, Macálister establishes the widely used numbering scheme CIIC and describes two different types of words: formula words and nomenclatu-

re words. Examples of formula words are MAQI  (son, e.g. CIIC 203, Q67978531) or MUCOI  (tribe/sept, e.g. CIIC 197, Q69388229). Examples of name components (nomenclature words) are CUNA  (wolf/hound, e.g. CIIC 154, Q68002826) or CATTU  (battle, e.g. CIIC 58, Q70892430). Other names refer to possibly divine ancestors, e.g. the god Lugh (LUC ) appears in many names like LUGADDON  (cf. CIIC 4, Q70899515). The combination of formula and nomenclature words leads to inscriptions that feature kinship or tribal relations. Examples are: X MAQI Y → X son of Y (e.g. Q69389090) or X MAQI MUCOI Y → X son of the tribe Y (e.g. Q69388229). These triples of information lend themselves well to a representation as a linked-graph-network. So do the results of the linguistic analysis of the stones: As the stones are often damaged, different ways of reading and reconstructing them abound. These differing interpretations can be placed next to each other and easily expanded within a graph database system. In addition, personal relationships and spatial topologies can be visualized and analyzed very well with graphs. The major challenge, though, is that all this data is available in books or non-open-access online databases. Therefore, the Squirrels established a workflow for digitising the analogue data and publish the  stones as LOD. The aim of our project is to enable the reproduction of analyses based on the analog CIIC catalog and enhance the database with Linked Open Data available online. By publication as LOD, the data becomes machine-readable, and available for any interested person, thereby also enabling citizen scientists all over the world.

As we know, LOD has become the de facto “quasi-standard” for the storage of humanities data in a semantically modeled cloud. There are several possibilities to host this modelled and published LOD: (a) create your own ontology, formulate a triples creation process and host the triplestore with a SPARQL endpoint or (b) use well-known community based systems, e.g. Wikidata. Strategy A is based on an ontology (https://t1p.de/lnb9) with the publication using a RDF4J triplestore (https://digits.mainzed.org/squirrels). Strategy B uses the community approach: Wikidata. Wikidata allows for attribution, linking to other entities and the specification of provenance and sources. Wikidata data can be filtered, exported and further processed with different programs using SPARQL APIs, such as the SPARQL Unicorn (10.5281/zenodo.3742185).

This paper will give a deeper insight into the two semantic (LOD) modelling and publication strategies. We will discuss the pros and cons as well as the challenges of the strategies. This includes in particular the major challenge and possibility of citizen science vs. data sovereignty.

Fig. 1. University College Cork Stone Corridor, Stone 4, CIIC 81 (CY BY 4.0 Florian Thiery)

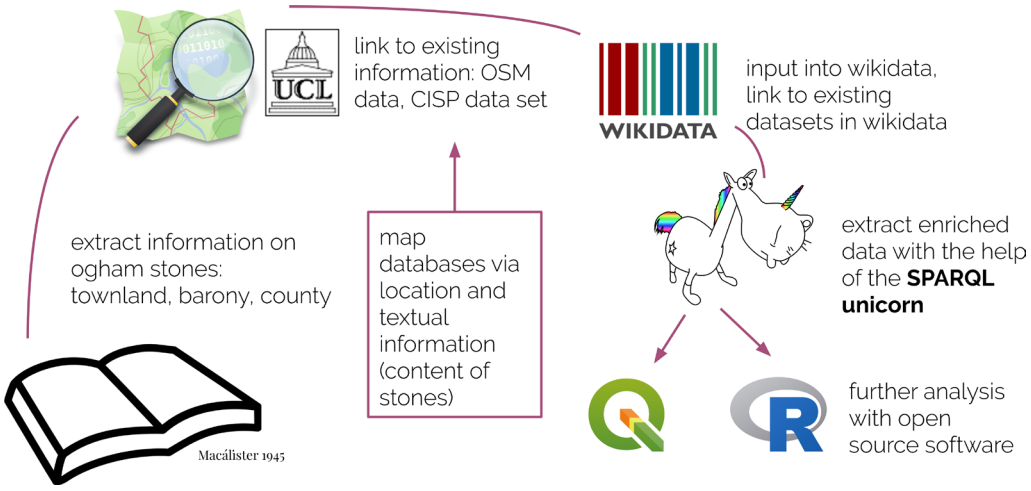

Fig. 2. Workflow for the publication of Ogham Stones in Wikidata (CC BY 4.0 Research Squirrel Engineers)

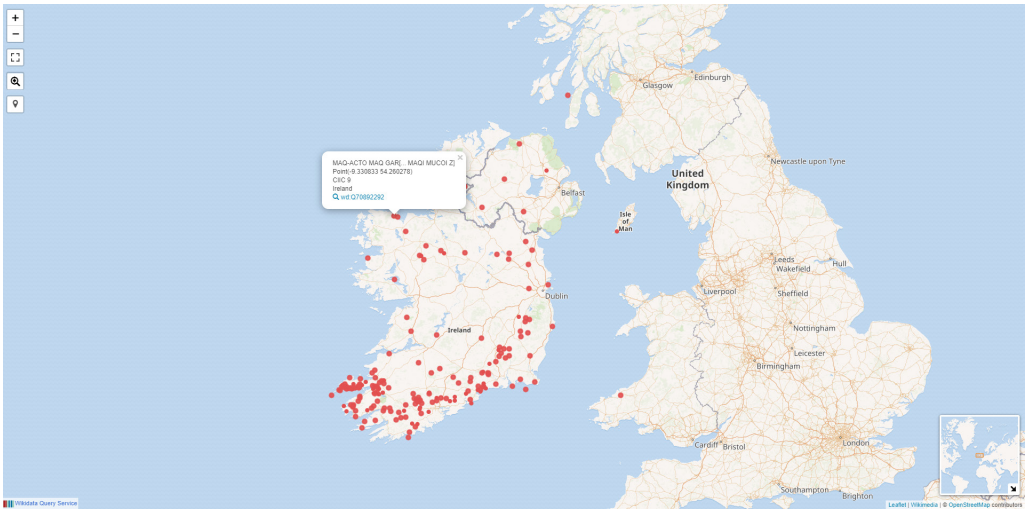

Fig. 3. Ogham resources in Wikidata (CC BY 4.0 Research Squirrel Engineers).

SITAR: A NEW OPEN DATA INFRASTRUCTURE FOR A PUBLIC ARCHAEOLOGY OF ROME

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Mirella Serlorenzi graduated and specialized in Medieval Archaeology at the Sapienza - University of Rome, and trained in the great urban excavations in Rome (Crypta Balbi and Palatine Hill). From 2000 to 2006 she was Archaeologist Director at the Soprintendenza per i Beni Archeologici of Ostia and is currently Archaeologist at the Soprintendenza Speciale Archeologia Belle Arti e Paesaggio of Rome (SSABAP). She was Director of the Museum of the Early Middle Ages (2013-2105), since June 2015 she has been Director of the National Roman Museum - Crypta Balbi and since 2017 Director of the seat of the National Roman Museum - Palazzo Massimo. She is the scientific responsible and coordinator of important archaeological excavations in Rome, both in the Esquiline area (Piazza Vittorio Emanuele II, Piazza Dante) and in other areas of the historical centre such as the Athenaeum and the archaeological complex of Largo S. Susanna. She actively participates in European projects, such as ARIADNE, the project "Atlas des techniques de construction dans le monde romain" of the Ecole Normale Supérieure and the project AREA (Archives of European Archaeology). He participated in the ministerial commissions, appointed by the Minister, for the realization of the Archaeological Information System of Italian cities and their territories, for preventive archaeology and in the technical table of MiBACT on Open data. Since 2007 he has created for SSCol the Archaeological Territorial Information System of Rome, of which he still directs and coordinates the working group. She edited the proceedings of the VII Edition ArcheoFOSS.

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Riccardo Montalbano is an archaeologist specialized in Ancient Topography, currently adjunct Professor of Ancient Topography, Landscape Analysis and GIS at the International Telematic University Uninettuno, GIS expert and senior topographer at the Soprintendenza Speciale di Roma (SITAR), advisor for the Great Marble Map of Rome (Ancient World Mapping Center – Sovrintendenza Capitolina ai Beni culturali), national fellow at the Accademia Nazionale dei Lincei and researcher at University of Pisa. His main interests are ancient urbanism, GIS and territorial analysis and open data in archaeological domain.

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Ascanio D'Andrea works for archaeological and conservation projects in Italy and in the Mediterranean area. He gained experience of a wide range of digital tools for documentation. As a member of the team of the Herculaneum Conservation Project, he had responsibilities for the creation of tools (GIS, 2D and 3D surveys). He has contributed to GCI's Bulla Regia Conservation Project. His experience has been used by several heritage organizations, including contributions to various ICCROM courses, GCI capacity building of site staff in Bulla Regia, MOSAIKON activities in Cyprus and Morocco, the UNESCO Officeand the Arab Regional Centre for World Heritage in Sultanate of Oman.

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Carlo Cifarelli graduated in Computer Science and Digital Communication at the University of Bari (2008). From 2008 to 2013 he worked as a CRM consultant for CONSIP, Banca D'Italia, Selex SeMa and Telecom Italia. Since 2013 he has been collaborating with the communication firm Nwdesigns for the implementation of commercial, ecommerce and management web applications. Since 2014 he has worked as a software engineer for YourPersonal Srl about the YourPersonalJames. com project. In 2017 he joined the Department of Computer Engineering, Automatics and Management of the University of Sapienza in Rome, during the activities of Assessment of the IT platform that underlies the service of Good Electronic Meal for the company Qui!Group. In 2018 he collaborated with Ced Digital & Services (Caltagirone Editor) for the Google Digital News Innovation Fund. Since 2020, he works on the SITAR project as Software Engineer and System Administrator.

SITAR (Sistema Informativo Territoriale Archeologico di Roma - Archaeological Territorial Information System of Rome) has been launched in 2008 by the Soprintendenza Speciale per i Beni Archeologici di Roma in order to digitize and gather all the scientific data coming from the archaeological excavations and the geological research surveys carried out within the territory of Rome and Fiumicino (https://beniculturali.academia.edu/Progetto-SITAR).

Since the beginning, the main goal of the project was to provide to the community involved in the study and preservation of the archaeological and historical heritage of Rome with a useful support for the process of urban co-planning. For this reason, unlike other similar experiences at national and international level, the representation is no longer symbolic, but

the archaeological data are processed in their "planimetric reality", after an accurate georeferencing process carried out by professional archaeologists. Today, the system brings together several types of data, ranging from archival documentation to the single archaeological features found during the archaeological excavations.

After 13 years from the development of the first web application, from May 2018 a system re-engineering was started, aimed at merging the three original applications (WEBAIS, SIGEDO, AMBIENTE TUTELA) into a single system.

The infrastructure is now hosted on the GARR cloud (based on the OS Open Stack) and has a modular architecture, so that each service is allocated on specific "container", as shown in fig. 1. This choice stems from a twofold requirement: on the one hand, to optimize the response to individual requests, and on the other to ensure a specific maintenance of the single services.

Among the main innovations is the creation of a Digital Library, which allows the user to explore the SITAR documentary heritage (maps, drawings, scientific reports), filtering the results through specific parameters (fig. 2). The new Digital Library is served by the open source suite ELK: it uses ElasticSearch as a search engine, Logstash for the index creation and Kibana to generate an effective view on the data. The documents are scanned through OCR and the system can retrieve the keywords used to search within every single document.

The final objective of the new engineering was to align SITAR with the FAIR DATA philosophy and therefore to guarantee an easy and well documented data acquisition. For this reason, SITAR data can now be acquired by any user 1. through download in the main OPEN FORMATS (GEOJSON, GML2, GML3, KML; GEOTIFF, GEOTIFF8, SVG, CSV: fig. 3), 2. through specific requests to the dedicated GEOSERVER instance or, at an upper level, thanks to the REST services (fig. 4) . The publication of the API allows the users to dynamically exploit the SITAR dataset, negotiating the protocol and the format according to its specific needs.

Finally, it is worth noting that the postgres/postgis SITAR database – that currently stores 5.000 excavations, 25.000 archaeological features and 100.000 attachments – adopts CIDOC CRM Archaeo as semantic model and the data have been extracted and represented in RDF, using the XML language.

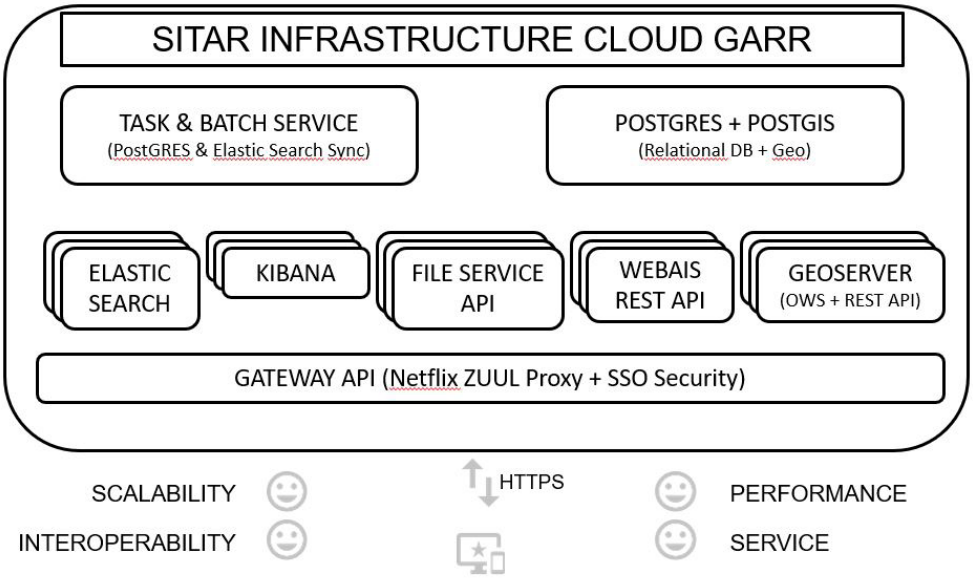

Fig. 1. REPOSITAR Infrastructure architectural diagram.

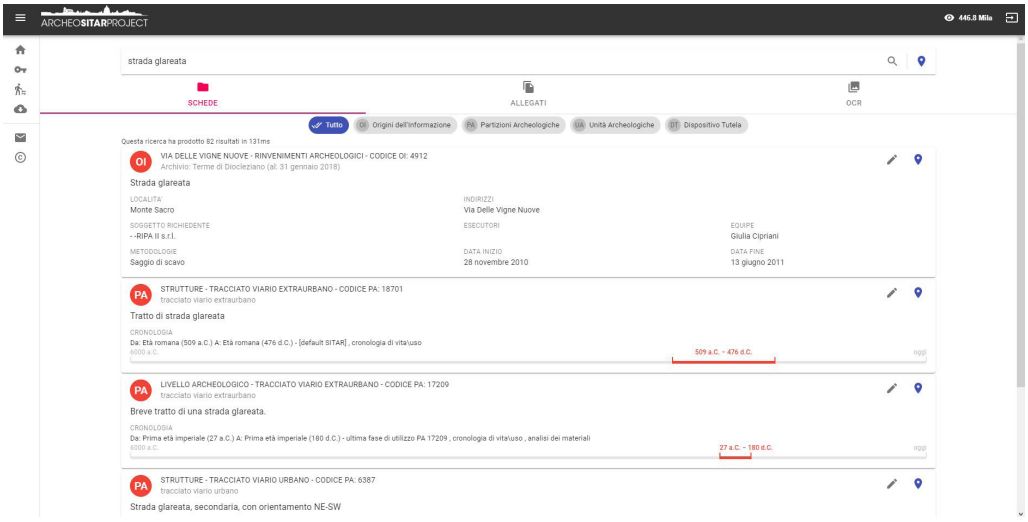

Fig. 2 The new Digital Library.

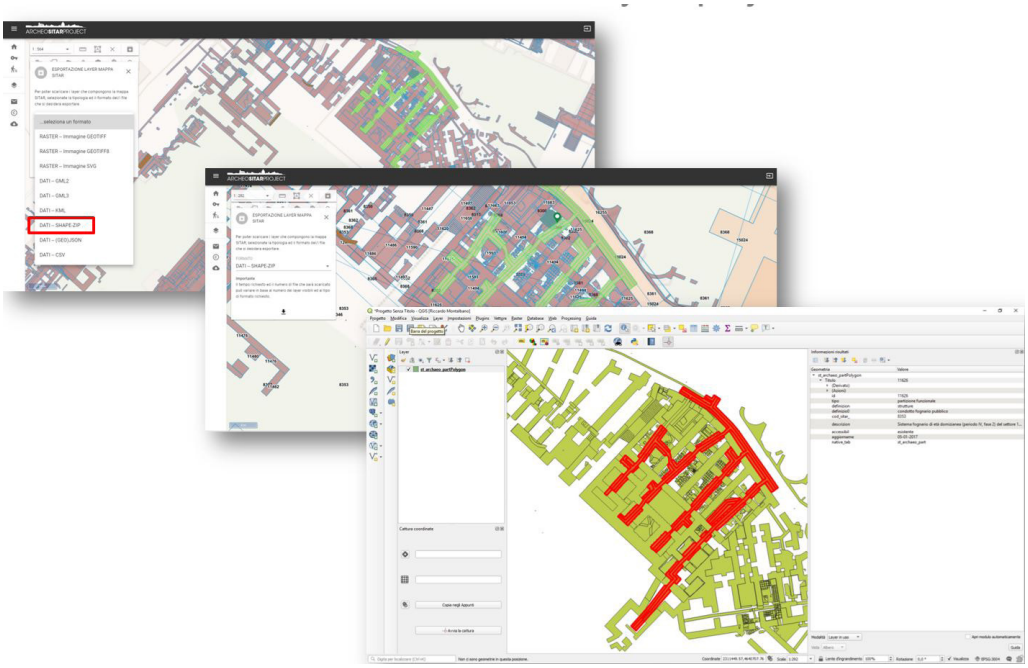

Fig. 3 Workflow for dowloading and reusing the vector geometries and relative attributes table in the most commons geographic formats.

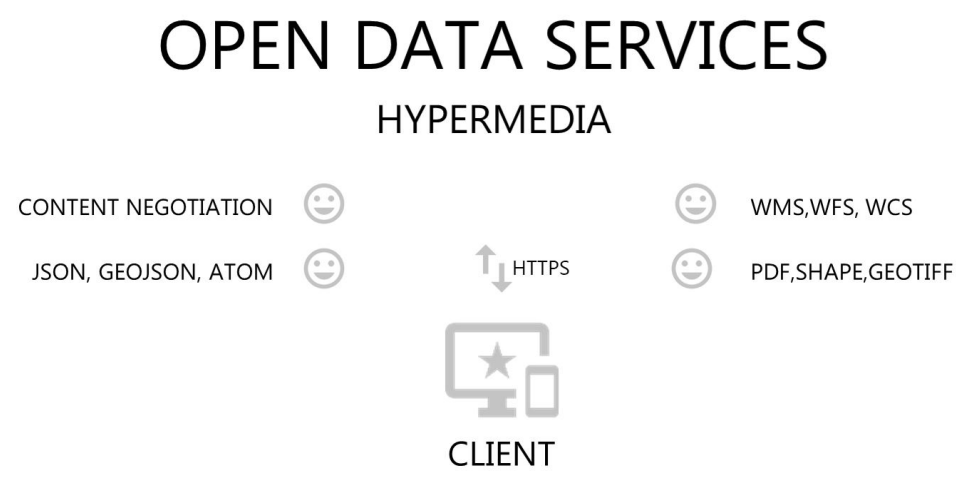

Fig. 4 SITAR open data services.

3

DEVELOPMENT AND CUSTOMIZATION OF FLOS SOFTWARE AND HARDWARE SOLUTIONS FOR CULTURAL HERITAGE

3D SURVEY COLLECTION, UN SOFTWARE PER LA PRODUZIONE DI REPLICHE DIGITALI. IL CASO STUDIO DEL FORO ROMANO DI NORA (SARDEGNA, CA)

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Simone Berto è dottorando presso il Dipartimento di Beni Culturali: archeologia, storia dell'arte, del cinema e della musica dell'Università degli Studi di Padova. I suoi interessi di ricerca riguardano il rilievo archeologico da campo, il survey fotogrammetrico (a grande e piccola scala), la modellazione 3D per i Beni Culturali e il Museo Virtuale. Nelle missioni archeologiche condotte da parte dell'Università di Padova presso il sito del teatro romano di Aquileia (UD) e il sito di Nora (CA) è coinvolto come specialista del rilievo.

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Emanuel Demetrescu, PhD, è ricercatore presso l'Istituto di Scienze del Patrimonio - Consiglio Nazionale delle Ricerche. È sviluppatore python, pilota UAV, specialista in Archeologia Digitale, Archeologia delle Costruzioni, modellazione 3D source-based (ricostruzioni virtuali) e reality-based (creazione di repliche digitali). Le sue principali ricerche riguardano la creazione di collegamenti teorici e metodologici tra la documentazione scientifica nei Beni Culturali e le industrie creative (librerie digitali 3D, musei virtuali, giochi Open World ed esperienze di VR).

L'integrazione del tradizionale rilievo archeologico da campo con la fotogrammetria è un approccio metodologico che, in generale nell'ambito dei Beni Culturali, si è andato via via consolidando soprattutto nell'ultimo decennio. In questo periodo, il continuo e crescente sviluppo tecnologico, la disponibilità di nuove soluzioni software per la fotogrammetria e l'incremento delle performance degli strumenti dedicati all'acquisizione e l'analisi dei dati hanno senza dubbio contribuito alla diffusione di questo approccio combinato. Tuttavia, nonostante l'estrema potenzialità informativa derivata dall'integrazione di questi dati, la scelta dell'ambiente di lavoro all'interno del quale gestire queste informazioni appare ancora al giorno d'oggi una questione aperta, spesso direttamente connessa allo scopo del progetto in cui il dato fotogrammetrico viene impiegato.

In questo contributo si vuole descrivere la metodologia applicata all'interno del software open-source Blender al fine di gestire un intero dataset fotogrammetrico, relativo ad un areale di circa 3000 mq, utilizzato come reference principale per la ricostruzione 3D del complesso forense di epoca romana del sito di Nora (Sardegna, CA).

Tramite una serie di tool utili all'importazione, la georeferenziazione, la gestione, l'editing, la visualizzazione in multirisoluzione e l'esportazione di un rilievo fotogrammetrico, l'addon 3D Survey Collection (3DSC) ha agevolato l'interazione con l'intera mesh fotogrammetrica del foro. La gestione di tale geometria tramite 3DSC ha permesso di pianificare, prima, e realizzare, poi, la ricostruzione dell'intero complesso architettonico rimanendo all'interno dello stesso ambiente di lavoro. Questo specifico addon è stato sviluppato all'interno del Virtual Heritage Lab del CNR ISPC di Roma proprio con l'intento di limitare la segmentazione su più piattaforme software del flusso di lavoro delle ricostruzioni 3D Reality Based, ossia quel metodo ricostruttivo che assume il rilievo tridimensionale come dato di partenza da cui avviare il processo di ricostruzione. L'applicazione di questo approccio metodologico, unito all'uso dell'applicativo 3DSC all'interno di Blender, ha permesso di controllare ogni step del percorso ricostruttivo del foro romano di Nora garantendo un confronto continuo tra il modello tridimensionale e il rilievo fotogrammetrico. L'attuale release di 3DSC è una versione massicciamente riscritta e con nuovi moduli previsti, che la rendono una novità sostanziale a livello software e di workflow rispetto a quella presentata in occasione di ArcheoFOSS 2019.

PUBBLICARE I DATI ARCHEOLOGICI CON A.R.C.A.: STATO DEI LAVORI E PROSPETTIVE FUTURE

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Irene Carpanese si è laureata e dottorata presso il Dipartimento dei Beni Culturali dell'Università degli Studi di Padova. Nel corso degli anni si è specializzata nel settore delle nuove tecnologie applicate alle discipline archeologiche (database, modelli 3D, siti web).

Nel 2014 ha iniziato a prendere forma l'idea che prevedeva lo sviluppo di un software per la pubblicazione dei dati archeologici online. Il progetto si è concretizzato nel corso di un Dottorato presso l'Università di Padova, grazie al supporto congiunto di tre tutor provenienti da settori disciplinari diversi (proff. Maria Stella Busana e Jacopo Bonetto, archeologi classici e il prof. Nicola Orio, ingegnere informatico).

L'avanzare dei lavori è stato periodicamente documentato da pubblicazioni, che testimoniano l'evolversi (a tratti tortuoso) del percorso di ricerca. Nel 2019, con la fine del Dottorato, si è concluso il progetto; dopo aver lasciato decantare il tutto per qualche mese, è ad oggi doverosa un'esposizione dei risultati raggiunti e dei futuri sviluppi possibili, soprattutto a seguito di questa emergenza sanitaria che ci ha imposto una riflessione concreta sull'importanza dell'informatizzazione e l'apertura dei dati in ambito culturale.

Il nome del Progetto, A.R.C.A., è un acronimo delle funzionalità stesse del prodotto, ossia di Archiviazione, Ricerca e Comunicazione del dato in Archeologia, ed è nato fin da subito con lo scopo di essere un software con cui gestire in maniera semplificata i dati archeologici di varia natura (quindi dal dato testuale a quello spaziale, passando anche per i 3D), impostato come prodotto "scalabile", ovvero riutilizzabile per diversi progetti e da differenti Enti in maniera autonoma, e semplice nell'utilizzo, in modo tale da incentivare i detentori delle informazioni ad utilizzarlo per aprire i propri dati in maniera trasparente.

Il software è completamente open source, sviluppato sullo stack MEAN,

composto da un framework, Angular, un server web, Express, su ambiente Node.js. Rispetto ad altri applicativi, la caratteristica che contraddistingue questo lavoro è l'aver scelto di utilizzare uno stack completamente ECMA-Script, che si appoggia a un database di tipo noSQL, in questo caso Mongo. Questa scelta è stata fatta per un motivo ben preciso: l'assenza di schema tipico di un DB non relazionale contribuisce a rendere A.R.C.A. un prodotto flessibile e altamente adattabile per progetti differenti per tipologia e presentazione dei dati, incentivando anche, in uno sviluppo futuro, la comunicazione tra dataset differenti, grazie alla possibilità di inserire i dati di più progetti mettendoli in interconnessione tra loro.

In un momento iniziale era stato diffuso un questionario per comprendere quali fossero le necessità dei possibili fruitori del pacchetto e come fosse percepita la questione dell'apertura dei dati sul web; seguendo le indicazioni estrapolate è stato impostato A.R.C.A. Volendo mantenere questa politica di "progettazione condivisa", al termine del lavoro, è stata impostata un'ulteriore verifica, grazie alla creazione di un test di navigabilità dell'applicativo, finalizzato ad individuare aspetti tecnici problematici e apporre eventuali modifiche.

A progetto concluso si può affermare che A.R.C.A. risulta un buon punto di partenza, cosa che non deve essere vista come un fallimento della ricerca. In questi anni infatti sono state impostate delle solide basi per sviluppare un software che potrebbe avere grandi potenzialità, ma la sua crescita è direttamente proporzionale al suo utilizzo da parte della comunità archeologica. Questo intervento mira dunque a focalizzare i punti di forza del prodotto ma anche le lacune, presenti come in tutti i prodotti, che però possono essere colmate dai fruitori stessi di A.R.C.A. Lo scopo è quello di sollecitare ad una collaborazione collettiva, partendo dal download del codice disponibile online e iniziando ad utilizzare il prodotto cercando di farlo proprio, con modifiche e implementazioni, al fine di caricare i dati per la consultazione pubblica. Questo per fare un passo avanti sì verso i dati aperti ma soprattutto verso i dati condivisi, concetto di fondamentale importanza per la ricerca archeologica.

THE USE OF 3D TOOLS TO IMPROVE THE TRANSFORMATION OF THE ARCHAEOLOGICAL RECORD INTO A VIRTUAL RECONSTRUCTION: EMTOOLS AND EMVIQ OPEN SOURCE SOFTWARE

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Emanuel Demetrescu, Emanuel Demetrescu, PhD, is a researcher at the Institute of Heritage Sciences - National Research Council. He is a python developer, UAV pilot, specialist in Digital Archaeology, Building Archaeology, 3D source-based modeling (virtual reconstructions) and reality-based (creation of digital replicas). His main research concerns the creation of theoretical and methodological links between scientific documentation in Cultural Heritage and creative industries (3D digital libraries, virtual museums, Open World games and VR experiences).

Bruno Fanini

Bruno Fanini, Computer scientist, PhD - focuses his research and development on real-time 3D graphics, Virtual Reality, interaction design and 3D user interfaces at the Institute for Heritage Sciences of the National Research Council (CNR ISPC). He obtained his master of science degree in Computer Science at Bologna University and PhD at Sapienza University (Rome, Italy). He focuses his activities on server-side services, responsive Web3D front-ends and their deployment. He developed several software tools, serious games, web-applications and web services within national and international projects. He is responsible for different projects dealing with interactive 3D visualization, WebXR applications, interaction models and immersive VR through Head-mounted displays. He's involved as coordinator of one unit under SHINE DigiLab (E-RIHS).

Archaeology revolves around a few questions: what was man like, his life and his places over the centuries? Digital archaeology and virtual reconstructions offer concrete tools to take contemporary man back in time and "visit" the places he came from: his past. A real time machine built over 200 years, from splendid painted reconstructions to immersive virtual reality and open world video games.

In recent years the interest of the scientific community in virtual reconstructive hypotheses (the visualization of a context as it must have appeared at a given time in antiquity) has grown. A central aspect in the development

of scientifically correct virtual reconstructive hypotheses is the possibility to manage and publish not only the visual result of the reconstruction but also all the data used to obtain it and in particular the sources, reasoning and interpretations. This type of activity, however, requires complex cross-references of data, even very different from each other (written sources, photographs, photogrammetric 3D models, stylistic comparisons, etc.). In order to achieve this goal, therefore, it is necessary both a theoretical framework and a series of innovative computer tools that can simplify, standardize and make efficient the workflow that leads from the archaeological data to the reconstructive hypothesis: this is the focus of this article.

The proposed innovative tools are based on the Extended Matrix (EM), a formal language able to manage both the archaeological record and to annotate the reconstructive hypotheses that emerged from the early stages of the investigation. In other words, within the EM approach, it is possible to transform the stratigraphic archaeological record into formalized reconstructive hypotheses about how a context must have appeared at a given time in the past. The 3D tools are part of the Extended Matrix Framework: the Extended Matrix tools (EMtools - https://github.com/zalmoxes-laran/EM-blender-tools) and Extended Matrix Visual Inspector and Querier (EMviq - https://github.com/phoenixbf/emviq).

The software mentioned are just ones of the possible practical applications of the Extended Matrix methodology. Thus, the development of these tools followed a bottom-up approach and started from real problems that emerged during the development of some case studies as reported by archaeologists and 3D modelers involved. The software have been released under an open source GPL 3.0 license in order to be used by the scientific community and possibly modified to adapt them to their own case studies within the same methodological frame-work of the Extended Matrix (examples of custom developments currently underway are the use of EMtools for the taphonomic analysis and reconstruction). The article will shortly present examples of workflow on real case studies and technical details related to the operative aspects of the software.

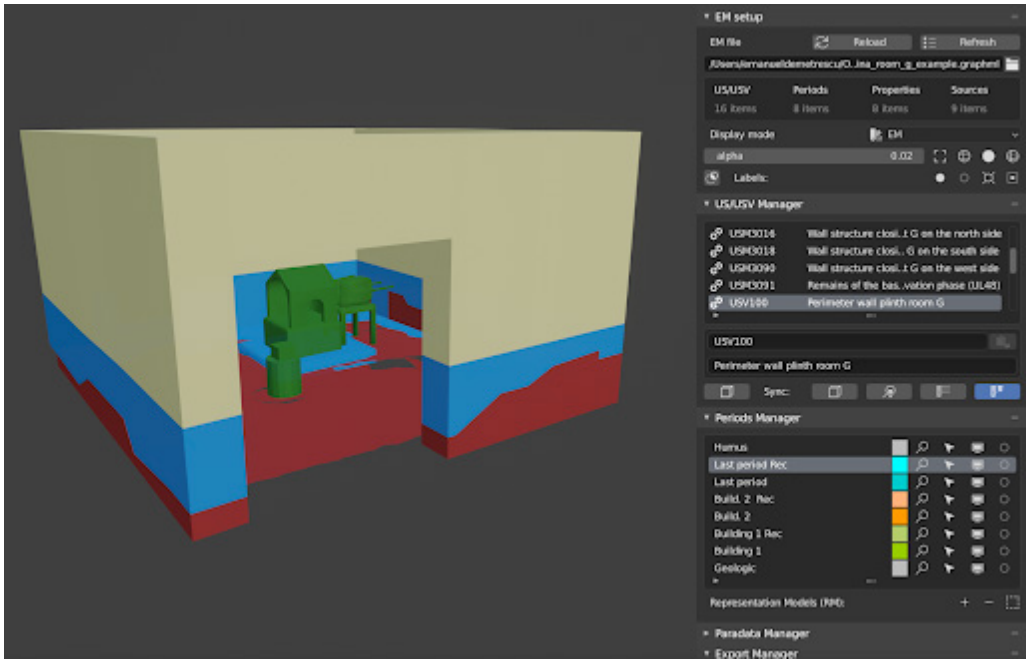

Fig. 1. EM workflow step 2: the final proxy model with the EM colours palette.

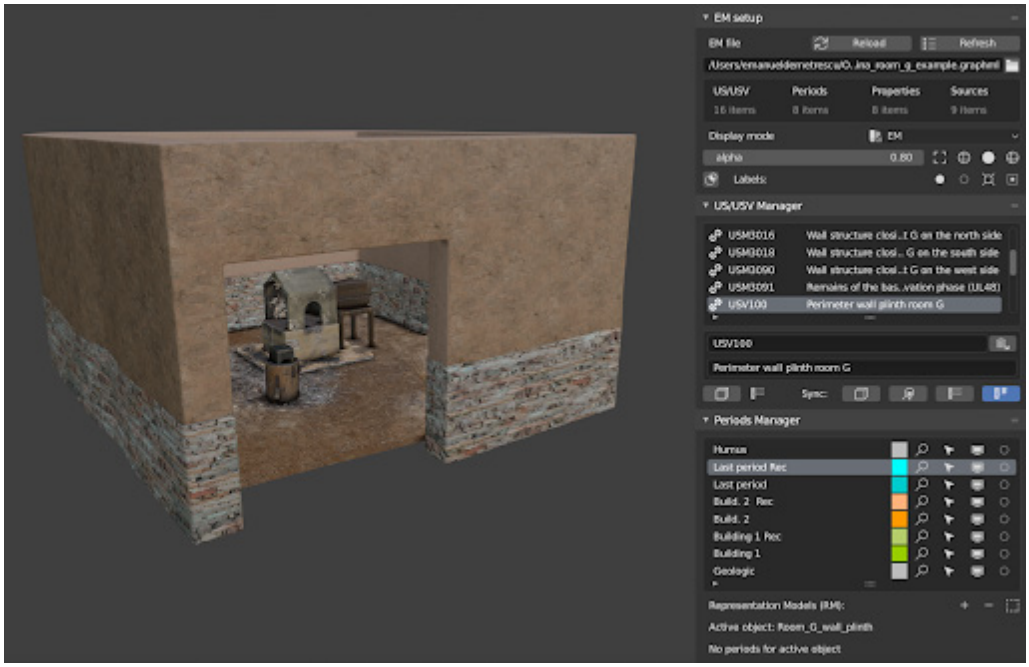

Fig. 2. EM workflow step 3: the final representation model (RM).

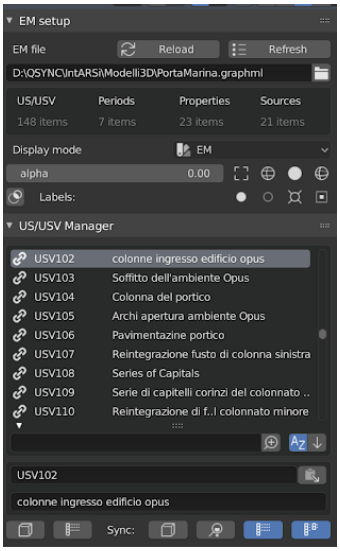

Fig. 3. EM Setup and US/USV manager

Fig. 4. Spherical peeling examples

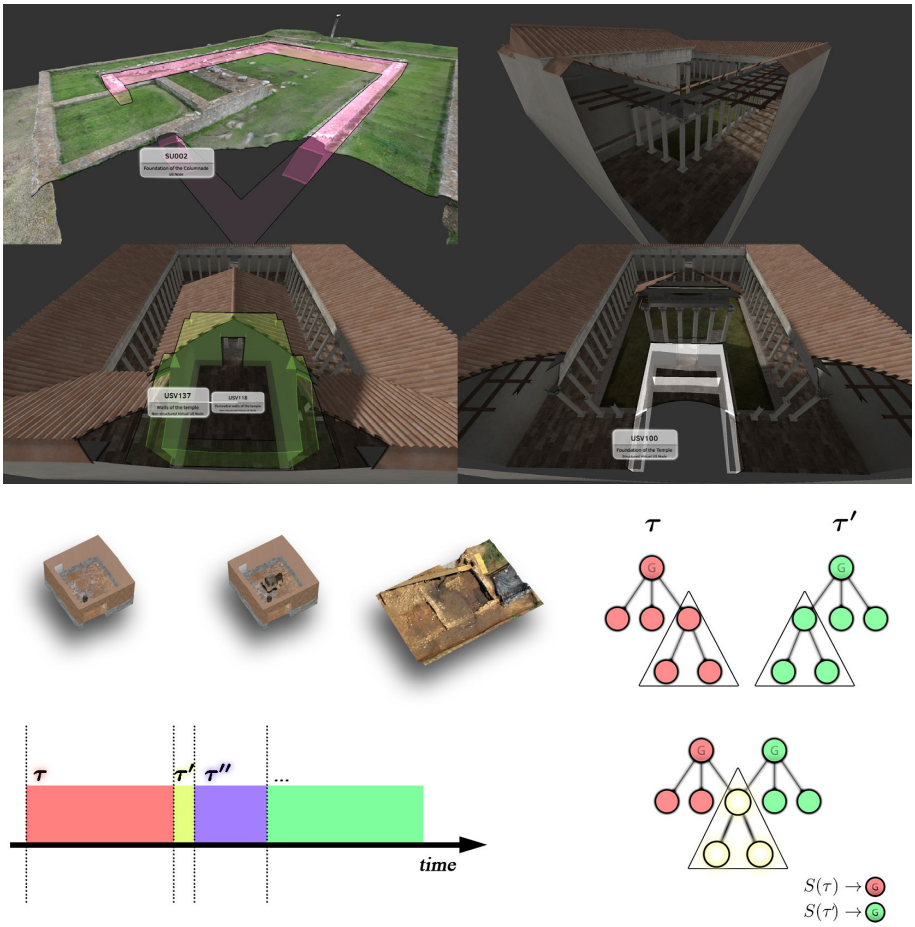

Fig. 5. Representation models for different periods (top left); Timeline (bottom left); Temporal instancing on a sub-graph of τ and τ`

LITTLE MINIONS AND SPARQL UNICORNS AS TOOLS FOR ARCHAEOLOGY

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https://scholar.google.de/citations?user=Ww8a7E0AAAAJ

Timo Homburg studied Computer Science with emphasis on Computational Linguistics, Semantic Web and Chinese studies and in the last years worked in the GIS field to integrate geospatial data with Semantic Web technologies. His PhD thesis deals with semantic geospatial data integration and the quality of geospatial data in this Semantic Web context. Another of his research interests is the Digital Humanities where he published in the area of Digital Cuneiform studies.

Florian Thiery

Florian Thiery is a geodesist by training and Research Software Engineer and founder of the Research Squirrel Engineers working group. He is a member of the Scientific Committee of the Computer Applications and Quantitative Methods in Archaeology (CAA) as well as of the CAA Special Interest Group (SIG) on Semantics and LOUD in Archaeology (SIG-DataDragon) and the CAA Little Minions Working Group. His research focuses on semantics and data modelling, especially Linked Open Data in archaeology. He studied in Mainz (M.Sc.) and worked at the Institute for Spatial Information and Surveying Technology in Linked Data projects like the Labeling System.

In our daily work, some small self-made scripts and home-grown small applications significantly help us to get work done. These little helpers – you can call them "little minions" – often reduce our workload or optimise our workflows. Therefore, the `Computer Applications and Quantitative Methods in Archaeology` (CAA) created a working group on `Little Minions` (http://littleminions.link) focusing on development and customization of FLOS Software for archaeology.

Furthermore, the WWW gives researchers the possibility of sharing their research data and enables the community to participate in the scientific discourse to create previously unknown knowledge. But much of these shared data are not findable or accessible, thus resulting in modern 'unknown data dragons'. Often these 'data dragons' lack connections to other data-

sets. To overcome these shortcomings, a set of techniques can be used: Semantic Web and Linked Open Data (LOD) (https://doi.org/10.5281/zenodo.3345711). This is where the CAA SIG on Semantics and LOUD in Archaeology (http://datadragon.link) comes into play and wants to promote the LOD ideas. One of their tasks is to collect LOD related data e.g. Nomisma, Kerameikos, Pleiades, AtlantGIS, Roman Open Data (http://dragonator.datadragon.link) to be used in research software.

Moreover, there are very cool volunteer community driven data collecting initiatives like Wikidata. The Wikidata community created a lot of tools to interact with the Wikimedia repositories. On the other hand there is a lack of user-friendly, easy to use and openly available archaeology-related tools for LOD as you can be seen in the collection of CAA Little Minions (https://github.com/caa-minions/minions). The Digital Humanities Community may use Recogito or Annotorious, to overcome this bottleneck, but for the archaeological community, the SPARQL Unicorn idea and principles may help (https://doi.org/10.5281/zenodo.3742185).

To summarize the three aforementioned aspects, there is a lack of FLOS GIS Tools for LOD and archaeology. The SPARQLing Unicorn QGIS plugin addresses the problem of the lack of availability of tools for Semantic Web geodata. It allows the execution of Linked Data queries in (Geo)SPARQL to select triplestores and geo-enabled SPARQL endpoints and thus prepares the results of the queries in QGIS for the geocommunity. The plugin currently offers three functions: (a) simplified querying of Semantic Web data sources (b) enrichment of geodata and (c) enrichment and transformation of RDF data.

The first function allows assisted querying of several triple stores, also using columns of custom geo-datasets. Example queries and query templates are given. A concept search simplifies the creation of the SPARQL query, the results are saved as a QGIS vector layer. The Unicorn covers archaeological related triplestores e.g. Nomisma, Kerameikos, Pleiades, and Roman Open Data. The second function allows the enrichment of a given geodataset using Semantic Web resources from the Linked Open Data Cloud, especially Wikidata (e.g. the elevation level of towns along the Roman Limes). Geospatial data is always seen in a context of usage which usually requires additional data from different knowledge domains. Semantically interpreted Linked Data may represent such a resource for data enrichment. Finally, the provision of geospatial and archaeological data into the Semantic Web is of interest. Communities need appropriate tools to convert geospatial information e.g. from GeoJSON into RDF, so that this information might

be represented in a proper way. This is also of interest to the Linked (Geo) Data community whose interest is to reproject and transform geospatial data into other reference systems. The Unicorn is able to do this as well.

Fig. 1 (on the right). SPARQLing Unicorn QGIS Plugin Logo

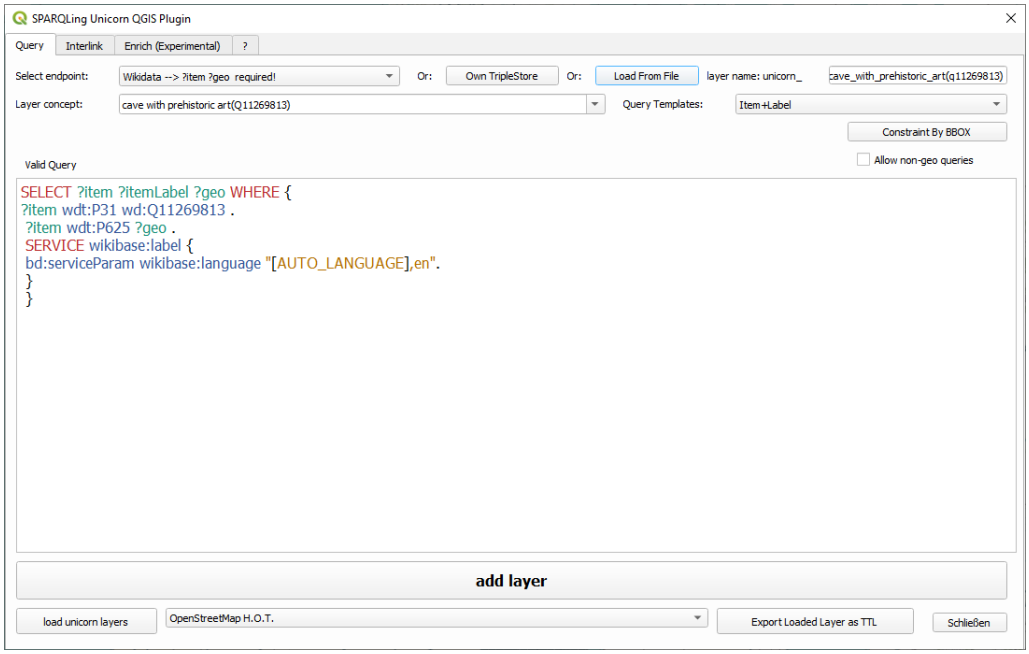

Fig. 2 (down). SPARQLing Unicorn QGIS Plugin Query Dialog

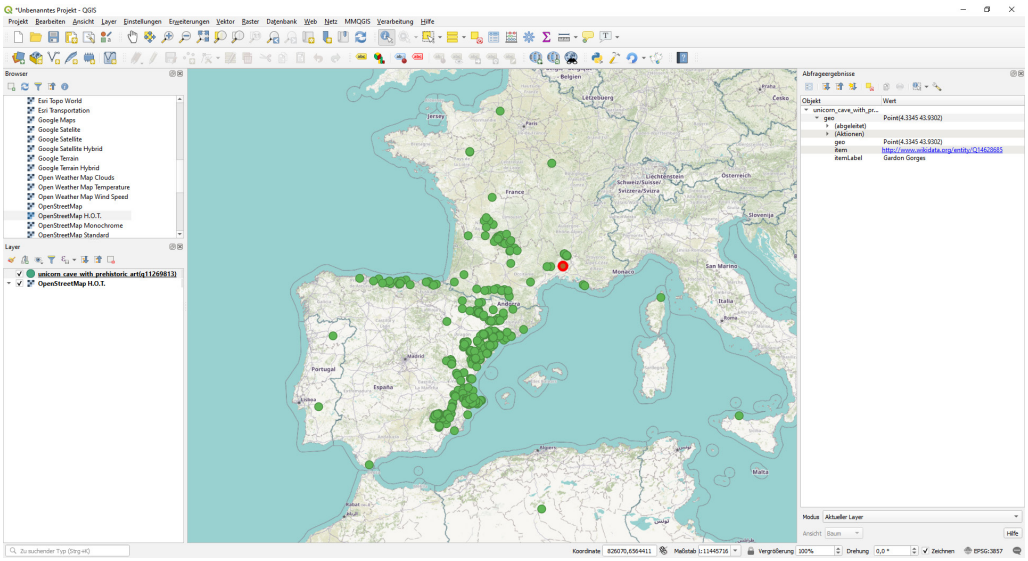

Fig. 3 SPARQLing Unicorn QGIS Plugin QGIS Map with caves containing prehistoric art from Wikidata

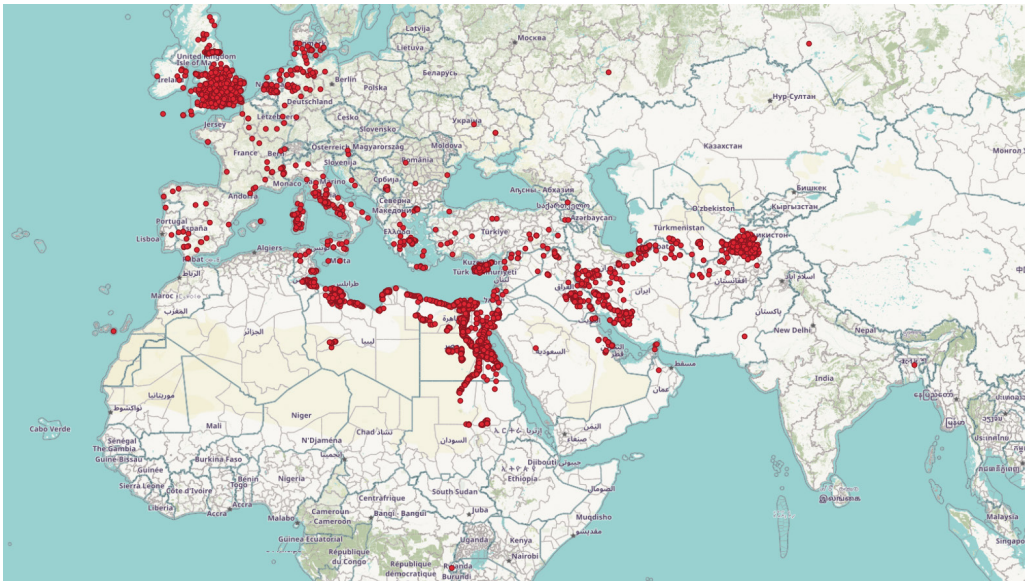

Fig 4 SPARQLing Unicorn QGIS Plugin QGIS Map with Pleiades Places

LEASTCOSTPATH: MODELLING PATHWAYS AND MOVEMENT POTENTIAL WITHIN A LANDSCAPE

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Joseph Lewis, University of Cambridge PhD, is an Archaeology student interested in the Application of GIS to Archaeological Mobility and Settlement Patterns with a focus on spatial uncertainty.

The movement of past peoples in the landscape has been studied extensively through the use of Geographic Information Systems (GIS) and Least Cost Path (LCP) analysis (Batten, 2007; Bell and Lock, 2000; Fiz and Orengo, 2008; Güimil-Fariña and Parcero-Oubiña, 2015; Howey, 2007; Kantner and Hobgood, 2003; Siart et al., 2008; Supernant, 2017; van Lanen et al., 2015; Verhagen et al., 2014; Verhagen and Jeneson, 2012). By using terrain in conjunction with other factors that may have influenced movement through a landscape, LCP models have been used to: identify long-distance routes (e.g. Batten, 2007; Palmisano, 2017); understand road networks (e.g. Bell et al., 2002; Fábrega Álvarez and Parcero Oubiña, 2007; Murrieta-Flores, 2012); and assess factors that were taken into account during route construction (e.g. (Bell and Lock, 2000; Fonte et al., 2017; Kantner and Hobgood, 2003; Verhagen and Jeneson, 2012).

Despite developments in the application of using Least Cost Path analysis to answer archaeological questions (e.g. Llobera, 2015; Verhagen, 2013; White and Barber, 2012), the implementation of these methods remains largely inaccessible, requiring individuals to develop their own solutions. Furthermore, although the methodological issues of using Least Cost Path analysis have been documented (e.g. Herzog, 2010; Herzog, 2011; Herzog, 2013; Herzog, 2014), little has been done to provide open source solutions that incorporate these findings and make them accessible to users.

The R package leastcostpath, developed by the author, is open sourced software for the calculation of Least Cost Paths and their derivatives, as well as providing functionality to calculate slope-based cost surfaces that

incorporate cost functions such as the popular Tobler's Hiking Function. Furthermore, leastcostpath allows for the incorporation of other cost surfaces such as the attraction of features in the landscape, barriers to movement, and movement potential within the landscape. Lastly, the R package leverages the iterative nature of Least Cost Path analysis by separating each step of the cost surface process into separate functions with easily changeable parameters.

Fig. 1 Leastcostpath logo

THE VIRTUAL COUNTRYMAN. A GRASS-GIS TOOL FOR ANCIENT CULTIVATION IDENTIFICATION

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Augusto Palombini, archaeologist, researcher at the Institute of Cultural Heritage Science of the Italian National Research Council, worked in archaeological missions in Italy and Africa. Author of scientific and dissemination works, as well as 3 historical novels. Founding member of the Italian Archaeologists Confederation. His research activity is currently focu sed on landscape archaeology, virtual museums, digital storytelling, computer science and multimedia solutions applied to Cultural Heritage and topographic surveying, particularly dealing with open source software (member of the Italian Scientific Committee on Free and Open Source Software in Archaeology).

As a relevant methodology literature has spread on 3D modeling of ancient buildings and monuments, it has not been the same about the reconstruction of landscape, intended as the whole vegetation cover and the geomorphology, both natural and anthropic (cultivated land).

The author works in a research group which proposed ways to check and reconstruct relevance and distribution of ecosystems, particularly dealing with cultivated areas in relation to demographic data. Such activity was primarily conceived to perform 3D landscape models leaving from GIS maps, through commercial soft ware (Visual Nature Studio, Vue+3dStudio Max, etc.).

Nowadays, the aim is to propose a complete pipeline, to obtain, from digital cartography and anthropic indexes related to social complexity, ecosystems and cultivated areas, creating maps to be used by modeling software to create 3D representation of landscape: a complete open source working chain script-connected through GRASS GIS, Blender 3D, Unreal Engine and the web viewer ATON, as to create a landscape generator covering the whole path from ecosystem theory up to immersive visualization.

Here, an early piece of such a chain is presented: a GRASS_GIS script aimed at semi-automatic predictive detection of cultivated areas.

Taking into account the digital elevation map (DEM), and its derivative features as slope, aspect, solar exposure, the tool creates an ideal cultivation cover map, also influenced by settlements, pathways, water streams , and giving all these aspects a relative weight in relation to social complexity (for instance, a higher weight of paths for statal organized systems and a weaker one for prehistoric ones, closer to the site-catchment model). The tool has been tested, with interesting results, against maps of known archaeological situations.

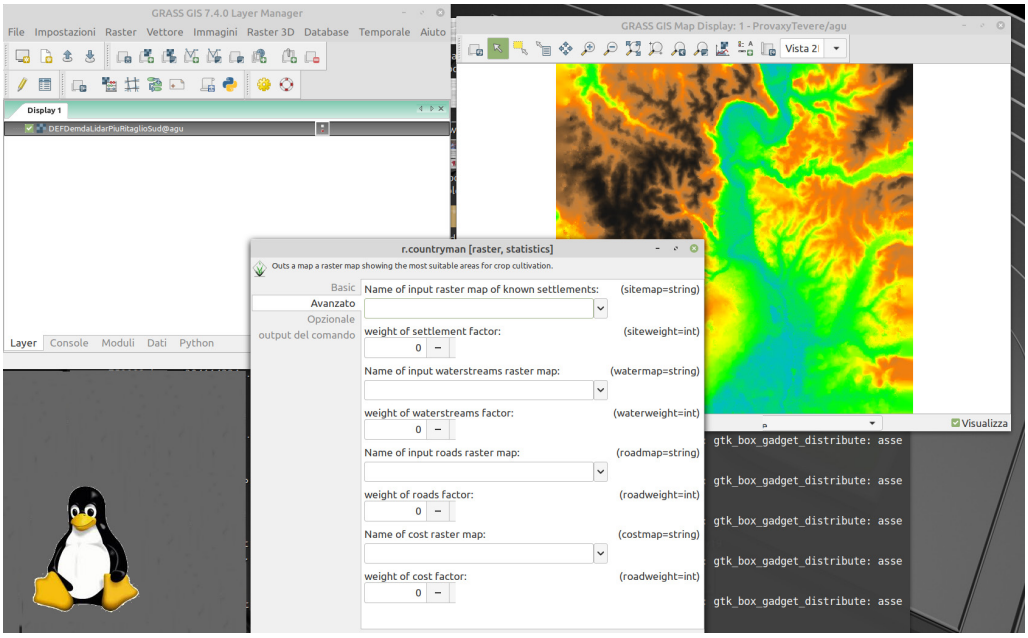

Fig. 1 Fig.1 user interface of the predictive tool (r.countryman)