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Practicing Digital Archaeology at the Vienna Orme and Pesa Valley Project
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Practicing Digital Archaeology at the Vienna Orme and Pesa Valley Project

Between the years 2015 and 2019, the Vienna Orme and Pesa Valley Project of the Department of Classical Archaeology at the University of Vienna had one of its focal points in practicing archaeological fieldwork and post-processing using selected tools of the multitude of computational methods and applications as providing a theoretical framework too for this approach. The aim was to fuse data-driven and digitally practiced archaeological methods with theory in 'digital archaeology.' Eventually, the multi-annual third-party funded project showed how an integrated hybrid digital and analogous approach in landscape and settlement archaeology might be successfully carried out from the beginning to the end.

Keywords: *digital archaeology; landscpae archaeology; settlement archaeology; GIS; data*

1 Digital archaeological studies in Tuscany[1]

It is difficult to define 'digital archaeology' precisely, and many—still unsolved—questions regarding various issues arise when looking at this topic theoretically. Such issues are the general role of computer applications within archaeology and possible relations of archaeological computing to related disciplines like digital humanities in a more detailed view. Further, the potential and limitations of modern technologies in generating archaeological knowledge, the importance of critical thinking about the methods applied digitally, or reflexive considerations on the impact of digital archaeological theory on the subject are discussed.[2] The term 'digital archaeology' itself is thereby known among others like 'cyber archaeology'[3] or 'virtual archaeology'[4] as outlined by L. Grosman, who suggests that

[1] This book chapter is based on the talk 'Practicing Digital Archaeology in Tuscany: Computational Methods and Applications at VOPP' held by the author in course of the VOPP Workshop at the Department of Classical Archaeology at the University of Vienna on June 23rd, 2018. At this place, the author wants to thank Günther Schörner for the invitation to hold a talk at the workshop as well as realizing the whole project 'Val di Pesa and Val Orme as a changing rural landscape: An integrated approach' funded by the Austrian Science Fund (FWF; stand-alone project P 27476) and the University of Vienna. I also thank Folkert Tiarks, who passed away far too soon, for proof-reading.

[2] E.g. Beale – Reilly 2017a; Huggett 2012; Huggett 2015a; Huggett 2015b; Huggett et al. 2018; Huggett et al. 2019; Huvila – Huggett 2018; Papadopoulos – Reilly 2019; Perry – Taylor 2018; Graham et al. 2019.

[3] E.g. Forte 2010.

[4] E.g. Reilly 1991.

> *[… many] groups worldwide almost simultaneously recognized the immense potentialities of computer technology for archaeological research, and this multiplicity of efforts resulted in a confusing multiplicity of terms to describe it.*[5]

Furthermore, some of these terms may stand for specific priorities like the role of the internet or visualizations;[6] other appellations may have been more trending at certain times, like 'archaeological computing', which has been very popular between the 1980s and 1990s.[7] All of these issues mentioned have in common that they treat the impact of digitalization on archaeology in the broadest sense. [8] Digitalization as a social phenomenon

> *[…] represents the integration of multiple technologies into all aspects of daily life that can be digitized.*[9]

This statement can be observed in archaeology too, where digital technologies have been adapted and adopted[10] for all major steps of a research project, ranging from the first input to the ultimate output. Hence, digital technology, respectively particular digital methods, may not be reserved exclusively to a specific archeological sub-discipline, simply because of the ubiquity of digital technologies in the whole discipline, and, even more, in the whole world.[11] This consideration makes it somewhat difficult to think of a distinct concept of 'digital archaeology' as a sub-discipline of its very own, clearly separated from other archaeological branches like classical or Medieval archaeology.[12] Thus, the suitable but straightforward 2006's definition by T. Daly and T. L. Evans is seemingly still valid as they say that

> *[…] Digital Archaeology explores the basic relationships that archaeologists have with Information and Communication Technology (ICT) and digital technology to assess the impact that such innovations have had on the very basic ways that archaeology is performed and considered.*[13]

So 'digital archaeological work' is not only about using digital devices and computational methods in archaeology but also about thinking of how to use them and (maybe even more important) why. Nearly every kind of archaeological research is regularly practiced using di-

5 Grosman 2016, 130.
6 Beale – Reilly 2017b, fig. 1.
7 Huggett 2012, 90.
8 Gattiglia 2015, 113.
9 Gray – Rumpe 2015, 1319.
10 Beale – Reilly 2017b.
11 Caraher 2018.
12 Hagmann 2018a, 9s.
13 Daly – Evans 2006, 2.

gital technologies[14] as tools for the most basic archaeological work tasks, like applying word processing software for writing scientific texts or using digital images for recording archaeological features during fieldwork. Nevertheless, using digital technologies for archaeological activities can be performed unreflected[15] easily since there is nearly always no mandatory need to apply theory as a prerequisite for using digital methods. Consequently, this circumstance may cause inconsistencies regarding the archaeological work's quality because of a resulting and possibly growing distance between the practical work (what are we doing digitally?) and the theoretical frame (why are we doing it digitally?). Consequential discrepancies, such as choosing the wrong digital tools for specific archaeological questions and tasks, resulting in time-consuming, costly, lengthy, and overly cumbersome workflows, may eventually deliver inaccurate results. It is necessary to reduce the distance between method and theory to avoid such adverse incidents using digital technologies[16] by applying both—method and theory—during an archaeological project. As significantly outlined in the innovative 'Open Digital Archaeology Textbook' one can therefore consider that all

> *[…] archaeologies can be digital, but not all archaeologies are Digital Archaeology.*[17]

Furthermore, one can emphasize that theory—aside from methodology and just actively using digital technology—is an integral part of 'digital archaeology'[18]. In conclusion, 'digital archaeology' may therefore be thought of as a term that describes the phenomenon of integrating digital technologies into archaeology, either[19] on a practical-methodological and a theoretical meta-level.[20]

The Vienna Orme and Pesa Valley Project, carried out by the Department of Classical Archaeology at the University of Vienna between the years 2015 and 2019, had one of its focal points in practicing archaeological fieldwork and post-processing using selected tools out of the multitude of computational methods and applications as well as providing a theoretical framework too for this approach.[21]

2 Framework

'Doing archeology digitally in Tuscany' means at the Vienna Orme and Pesa Valley Project the attempt to fuse data-driven and digitally practiced archaeological methods with theory in 'di-

14 Costopoulos 2016.
15 For a sophisticated reflexive approach see e.g. Berggren et al. 2015.
16 Llobera 2012, 495.
17 Graham et al. 2019, https://o-date.github.io/draft/book/so-what-is-digital-archaeology.html.
18 Perry – Taylor 2018.
19 Zubrow 2006, 22.
20 Hagmann 2018a, 9s.
21 For computational methods see Huggett 2018.

gital archaeology'.[22] The Vienna Orme and Pesa Valley Project as a multi-stage project is based on a collaborative and holistic approach.[23] Various methods were applied to gather information by studying the archaeological material and producing archaeological data in a digitally executed research process.[24] The International Standards Organisation (ISO) defines 'data' as

> *reinterpretable representation of information in a formalized manner suitable for communication, interpretation, or processing*[25]

and 'information' as

> *[…] knowledge concerning objects, such as facts, events, things, processes, or ideas, including concepts, that within a certain context has a particular meaning.*[26]

Data—described through complex and differentiated concepts within archeology—are understood within the Vienna Orme and Pesa Valley Project framework to be any analog and digital products of archaeological activities that carry information. Analog data are retro-digitized in the project in an additional step in contrast to 'digital-born' data produced digitally from scratch.[27] New and heterogeneous, multidimensional archaeological data were obtained in the course of the Vienna Orme and Pesa Valley Project by different types of scientific fieldwork, mostly systematic field surveys and geophysics. [28] Geoarchaeological examinations provided further information to the past environment.[29] Open government data (OGD)[30] were used mainly to obtain aerial images, LiDAR data, and topographic survey data for various mapping and remote sensing tasks.

Spatial and non-spatial data represent the archaeological information within the Vienna Orme and Pesa Valley Project-setting: vector (points and polygons) and raster datasets are connected to space and describe, for example, the location of findspots, the shape of the surveyed fields, or the earth's surface at the area of interest. Non-spatial data as qualitative and quantitative information of the archaeological material and other related features of interest are described by attributes usually stored using tables.[31] A geographic information system (GIS) served as the central spatial relational database for these diverse datasets and was used for all

22 Data driven: Gattiglia 2015, 113; digitally practiced: Raunig – Höfler 2018 Caraher 2018.
23 Hagmann et al. 2017.
24 McManamon et al. 2017, 239 fig. 1.
25 International Organization for Standardization – International Electrotechnical Commission 2015.
26 International Organization for Standardization – International Electrotechnical Commission 2015.
27 Citation of phrase: Erway 2010; Huvila 2018, 30; Lock 2003, 1–12.
28 Schörner – Hagmann 2015.
29 Salisbury – Draganits, this volume.
30 Barnickel – Klessmann 2012.
31 Conolly – Lake 2006, 12; Wheatley – Gillings 2002.

major project phases.[32] Despite possible limitations and critical issues using GIS,[33] a GIS is capable of managing such datasets and therefore plays an immanent role in the project. The project's workflow was thus characterized by systematically applying proprietary as well as free and open-source software (FOSS): QGIS (QGIS 2.14.x–2.18.x.) has been used as software for GIS-related tasks mainly alongside to ESRI ArcGIS (ESRI ArcGIS 10.1–10.5.) to provide maximum flexibility and efficiency.[34] In general, the workflow follows the IMAP model (input, management, analysis, presentation) for basic structuring of the workflow since all main tasks of a GIS are described through this concept.[35]

3 Input, management, and analysis

Although today mobile computing is often applied to stationary projects, i.e. excavations,[36] mobile devices have been used in archaeological field surveys regularly for years.[37] For the Vienna Orme and Pesa Valley Project, a hybrid workflow has been applied; therefore, data were recorded analogously and digitally. For the analogous recording of the collected survey finds and units, standardized preprinted forms on special waterproof papers capable of archival storage were used. Mobile devices like notebooks, PDAs, tablets, and smartphones were used for advanced management tasks during and immediately after fieldwork as well as for surveying mainly. Post-survey tasks were carried out as hybrid workflow too, integrating the analogous recording sheets, the collected finds as well as the digital data.

Depending on the methodological approach, either handheld GPS or RTK-GNSS devices were used to record and steak out the single survey units in the field. The spatial information was first stored using ESRI Shapefiles and later exported to a GeoPackage (an open SQLite[38] container). Each transect's specific surface conditions were selectively recorded by photographs using digital single-lens reflex (DSLR) cameras. Open geodata like aerial images or cadastral maps were extensively used in the project since Tuscany's regional government systematically provide extensive OGD.[39] Other datasets like LiDAR data for the Pesa valley were retrieved from official federal providers free of charge.[40]

After collecting the archaeological artefacts according to the applied on- and off-site field survey methods and supplying them in find bags, data regarding the archaeological artefacts were recorded by hand using waterproof markers on the standardized recording sheets, which provide thematically grouped sections for manual data entry on each form. Thereby the sec-

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32 Bevan – Conolly 2002; Neubauer 2004.
33 Brouwer Burg 2017.
34 Bibby – Ducke 2017; Ducke 2015; Hagmann et al. 2016.
35 Behncke et al. 2009, 306; Ehlers – Schiewe 2012, 5.
36 Austin 2014; Gordon et al. 2016.
37 E.g. Campana – Sordini 2006.
38 SQLite, <https://sqlite.org/index.html> (27.01.2019).
39 Trevisani – Sassoli 2014.
40 Ministero dell'Ambiente e della Turtela del Territorio e del Mare 2019.

tions of the standardized forms correspond to respective tables of the database.[41] After fieldwork, the written information was retro-digitized by the team members daily, using tablets and uniform digital templates for data input. For attribute data, a relational database management system (RDBMS)[42] was used to index and manage the survey data on the tablets in the field. The database contains, therefore, archaeological information like absolute numbers of the respective survey finds per survey unit as well as administrative data like the identifiers of the single team members and the date of fieldwalking. Aside from information collected in the field during the survey, the database contains further entries related to the project's metadata, like the detailed schedule of the different campaigns and other organizational records. Later in the course of the project, all data entries have been moved to the GeoPackage database used in QGIS, allowing to store spatial and non-spatial information in one light-weight and platform-independent serverless database, which may also be used on mobile devices too.[43] During fieldwork, the University of Vienna's open-source cloud storage[44] has been used aside from two external hard drives for backup of all data daily. After each campaign, all data are regularly backed up using the university's own scalable online storage space.[45] All work was further done in strict compliance with legal requirements, especially regarding privacy policy and fulfillment of the General Data Protection Regulation (GDPR) of the European Union to ensure maximum protection of data privacy at all times.

On the one hand, data queries were exported as tabular data, for example, to spreadsheet programs for further analysis, like in the case of pottery studies. On the other hand, the edited queries were imported again to the database after accomplishing the desired tasks. Afterward, the edited records were joined with corresponding spatial datasets in a GIS and used for spatial analysis of on-site find scatters combined with geophysical datasets and their respective interpretation.

Furthermore, aside from commonly used office software, specialized software solutions, like for geophysical data processing, were used to a varying extent by the project members:[46] for example, scientific papers, references, and publications related to the project were organized using bibliographic management software.[47]

Based on the data and computational methods, GIS-based spatial analysis has been used to supplement data-driven work with material culture. [48] Using paperless, digital mapping, and interactive maps, this procedure resulted in deep mapping combining various aspects of statistically analyzed and classified on-site find scatters combined with other data sets. [49] In

41 Dell'Unto et al. 2017, 638–640.
42 Microsoft Access 2010–2016; Gattiglia 2018; Ramsay 2015; Ryan 2004.
43 External services like WMS and big LiDAR or aerial imagery datasets provided as OGD are still managed separately at the moment due to performance reasons and technical limitations.
44 u:cloud pro, <https://zid.univie.ac.at/en/ucloud-pro/> (02.02.2019).
45 Share-Service of the University of Vienna, <https://zid.univie.ac.at/en/share/> (02.02.2019).
46 E.g. Geoscan Research Geoplot 3.x, which has been used for processing magnetic survey data.
47 Swiss Academic Software Citavi 4.x–6.x.
48 Huggett 2018.
49 Hacıgüzeller 2019.

that sense, complex multi-layered on-site distribution maps representing different types of information within the context of time and space were made.[50] Integrated work with digital/analog archaeological data and constant mutual exchange of various experts resulted in an ongoing review of the data. The constant adjustment and verification of information derived from hybrid data sources like written analogous recording sheets and database entries regularly compared with the collected artefacts stored in the depot generated reflexive loops regarding archaeological knowledge production.[51] Other reflexive approaches were applied through video recording from different perspectives during selected survey campaigns.[52] Such videos enable a highly detailed recording of the pedestrian survey workflow itself and, for the future, in-depth analysis of the principal surveying activities.[53]

4 Presentation

The research data output includes scientific papers about data management[54], multiple maps as well as a curated and publicly available collection of selected scientific papers about digital archaeology at the online platform ScienceOpen[55]. In terms of teaching two master theses concerning digitally practiced settlement archaeology, supervised by the project lead Günther Schörner, were written in the course of the project, reflecting various theoretical and methodological issues. [56] Furthermore, students were systematically involved as employees in the various project tasks. Besides, deepening open science activities were carried out, including the broad topic of digital public archaeology.[57] All work has been carried out in collaboration with the respective departments for public relations and data management at the University of Vienna. Finally, special attention was paid to long-term archiving of research data using the University of Vienna's system PHAIDRA, [58] since

> *[…] data repositories are a central part of scientific investigations serving as sources of background research and new hypotheses, as well as curation facilities in which newly generated research data are deposited at the end of an investigation. Repositories are needed not just for data preservation, but to ensure that data are easily discoverable, accessible, and usable as sources for new research.*[59]

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50 Aldred – Lucas 2019; Gillings et al. 2019, 4. 8; Lewis 2018.

51 Taylor et al. 2018.

52 Morgan 2018.

53 Chrysanthi et al. 2016.

54 Trognitz et al. 2017.

55 Hagmann 2017–onwards; Hagmann 2017b.

56 Hagmann 2017a; Woller 2017.

57 Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities, <https://openaccess.mpg.de/Berlin-Declaration> (08.10.2018); Open Science Network Austria (OANA), <https://www.oana.at/> (12.10.2018); Tonta et al. 2015; Wilson – Edwards 2015.

58 Hagmann 2017c; Hagmann 2018b.

59 McManamon et al. 2017, 239.

Therefore, the steadily growing collection 'Vienna Orme and Pesa Valley Project' provides sustainable access to long term archived and project-related datasets.[60] As part of the initiative 'Roman Rural Landscapes, ' which refers to different field research projects lead by Günther Schörner at the Department of Classical Archeology of the University of Vienna, a project webpage has been set up for the long-term.[61] The web page is used to create an integrated open-access data portal based on the University of Vienna's structures for the research data's long-term publication. Rather than storing data 'distanced' in a repository disconnected from the project's online presence, the project activities are presented along with research data online at the same place on one landing page.

One further focal point has been science-to-science as well as science-to-public communication.[62] Hence social networking sites like Facebook, Instagram, and Twitter were used to update project activities and edutainment mainly. [63] To enable access to various research outputs for a broad audience, well-established scientific social network sites such as ResearchGate or Academia and other open access platforms like Zenodo were used mainly in addition to PHAIDRA and the university's institutional repository u:scholar[64].

Several preparations were made to create a corporate identity, designing a characteristic and uniform style regarding presentations and social media posts, increasing the recognition factor of all project-related outputs. They consisted mainly of the systematic creation of standardized and project-specific templates for presentations and cartographic works for project team members, based on the university corporate design.[65]

5 Conclusion

Especially regarding the data record, analogous executed methods like using standardized recording sheets proved useful, flexible, and versatile. The recording sheets serve as an additional analogous backup and are relatively inexpensive to purchase, although waterproof specialty paper capable of archival storage has been used. Nevertheless, additional work has been necessary to retro-digitize the analog data stocks, which must be considered an additional cost factor. The additional work step also created another potential source of error because of typos or incorrect data entries due to poorly legible handwriting. Thus, data maintenance and error correction entailed an increased effort. It remains unclear whether such a workflow will be

60 Schörner et. al 2018.

61 Roman Rural Landscapes 2018. Website, <http://rrl.univie.ac.at/> (08.10.2018).

62 Hagmann 2018a.

63 Roman Rural Landscapes. Facebook page, <http://www.facebook.com/rrl.univie> (02.02.2019); Roman Rural Landscapes. Instagram, <http://www.instagram.com/rrl_univie/> (02.02.2019); for a theoretical view: Aksakal 2015.

64 Hagmann 2018c; Hagmann 2019; Third Mission an der Universität Wien, <https://thirdmission.univie.ac.at/> (02.02.2019); Academia 2018; u:scholar. Institutional Repository der Universität Wien, <https://uscholar.univie.ac.at/> (27.01.2019).

65 See the 2015's template for ESRI ArcGIS e.g. used for the map in Hagmann et al. 2017 or a derivate used in Woller 2017. The template introduced in 2018 for QGIS used in this volume mainly (e.g. the contributions by N. Kirchengast and H. Schörner) is made available via PHAIDRA: Schörner et al. 2018.

used in future projects, especially considering the ever-increasing availability and self-evident use of mobile smart devices as cognitive artefacts used for archaeology.[66] Future developments in intelligent personal assistants coupled with the ever-increasing availability of mobile internet (like the future establishment of 5G networks) and alternative types of smart devices like wearables are likely to open up various new perspectives in the (near) future,[67] which are not yet foreseeable today, but which may well point to a further decline in analogous methods. Nonetheless, digitization of the recording sheets marked a crucial step in the process, enabling further data-based digital processing of the GIS-based data and analysis. The project created an extensive digital data stock and showed further the need for a robust framework for sharing and archiving these datasets.

Regarding the possibilities for providing such a framework, a webpage and different (scientific) social networking sites were used for prompt sharing of different project outputs on the one hand. On the other hand, a repository (PHAIDRA) suitable for sustainable long term archiving was used to provide open research output access as part of the project's online presence. All in all, the multi-annual third-party funded Vienna Orme and Pesa Valley Project eventually showed how an integrated hybrid digital and analogous approach in landscape archaeology might be successfully carried out from the beginning to the end.

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[66] Huggett 2017.
[67] Kim et al. 2017.

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