Results of a photogrammetric building survey as an example for FAIR 3D data

Claudia MÄCHLER, Department of Classical Archaeology at the Technical University of Darmstadt, Germany
Andreas NOBACK, Department of Classical Archaeology at the Technical University of Darmstadt, & University and State Library Darmstadt, Germany

Keywords: *Research data management — Photogrammetry — Reconstruction — Daylight simulation — Ancient Orraon.*

CHNT Reference: Mächler, C. and Noback, A. (2022). 'Results of a photogrammetric building survey as an example for FAIR 3D data', in CHNT Editorial board. *Proceedings of the 27th International Conference on Cultural Heritage and New Technologies, November 2022.* Heidelberg: Propylaeum. DOI: xxxxxxx. <style CHNT_Citation_Reference>

Introduction

The FAIR data principles provide *general* guidelines for the management and stewardship of scientific data. But within the development of suitable solutions for research data management it is necessary to understand the life cycle of *specific* data. An example and a common case in the field of cultural heritage is the exchange of 3D data from photogrammetric acquisition and laser scanning. So, what needs to be provided to meet general FAIR standards for this specific kind of data?

In this contribution the topic of FAIR 3D data reflects experience from the ongoing development of a domain specific data repository within the "FID BAUdigital" and is exemplified using the data processing within the interdisciplinary project "ΦΩΣ 4D – A tool for affordance-based daylight analysis in ancient houses by means of simulation".[1] In this context, 3D models of architectural remains serve as a basis for reconstruction models for daylight simulation. In a further step, these are spatially (GIS) and chronologically (building/use phases) overlaid with archaeological finds and simulation results in order to gain knowledge on daylight-dependent options for the use of ancient living spaces.

In two cases of Roman housing existing data could be used. For an additional case study of Greek residential architecture, a building survey was conducted by the research group itself. Therefore, the authors are in the position to understand the provider perspective as well as the creator and user perspective. Contrasting those views, a best practice example for data acquisition, publication and metadata provision shall be drafted.

[1] Fachinformationsdienst BAUdigital: https://www.fid-bau.de, ΦΩΣ 4D project, Technical University of Darmstadt, Department of Classical Archaeology: https://www.archaeologie.architektur.tu-darmstadt.de/forschung_klarch/forschungsprojekte_klarch/phos_4d_klarch.en.jsp.

3D data in research data management – the provider perspective

While providing repositories and supporting open licensing foster the accessibility and reusability of research data in general, findability and interoperability need individual solutions. And while general purpose repositories are established on institutional, national and international level, discipline and method related specializations of repositories, data containers and metadata standards are currently under development.[2]

Repository providers alone can hardly meet the demands of heterogeneous domain specific data and metadata. Communities have to get involved to identify necessary metadata for search and interoperability, and to establish exchange formats. The same is true for defining quality requirements and foster the acceptance of data publication as original scientific contribution.

A photogrammetric building survey in Orraon – the creator perspective

Fig. 1 The ancient city of Orraon (© Claudia Mächler, Department of Classical Archaeology at the Technical Univeristy of Darmstadt)

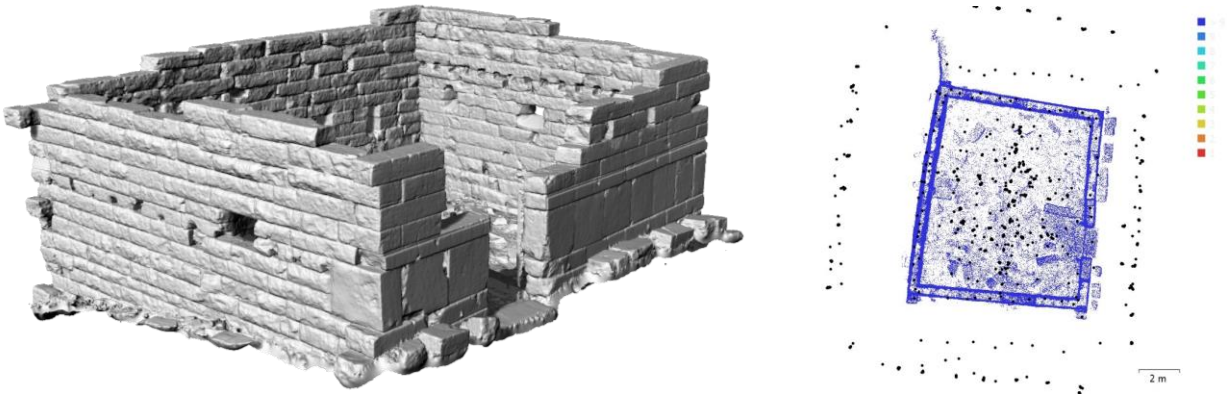
New 3D data was created from a photogrammetric building survey of the Late Classical residential architecture in the ancient city of Orraon (Greece, Epirus, Fig. 1). The condition of the individual dwellings and the research questions mentioned in the introduction already resulted in wide-ranging

[2] For example: baureka.online (https://baureka.online/de), DFG 3D-Viewer (https://architekturinstitut.hs-mainz.de/projekte/dfg-3d-viewer/), IDOVIR (https://www.dg.architektur.tu-darmstadt.de/forschung_ddu/digitale_rekonstruktion_ddu/idovir/idovir.de.jsp) or within NFDI4Culture (https://nfdi4culture.de/what-we-do/task-areas/task-area-1.html).

preconditions for the type and amount of required 3D data to be held in repositories, since the applied methods are necessarily reflected in the research data.[3]

Therefore, in the case of Orraon, efforts were made from the very beginning not only to ensure the general accessibility and reusability of the collected data, but also to meet the more specific needs of findability and interoperability. This included the development of a spatial database that allows querying any existing textual, graphical or geometric information on the dwellings from literature, archival sources or autoptic examination. To ensure the quality of the photogrammetric data (Fig. 2), the site's appearance and the weather conditions were documented as well as the local measurement grid, the accuracy of the georeferencing, the distribution of photo targets, the camera model and its lens distortion parameters et cetera as well as the accuracy of the final photogrammetric model itself. Since both the resulting models and all raw data were stored in open, long-term archivable formats wherever possible, the technical requirements for FAIR 3D data are met.

Beyond that, however, more general questions of desirable – and currently actually feasible – metadata annotation in 3D models will be addressed[4], as will be the question of standards for photogrammetric documentation work in the context of cultural heritage and building archaeology. Finally, based on the Orraon case study, a list of data types will be compiled, that must necessarily be stored together as a closed dataset, because only like this the appropriate, scientific and FAIR use of the 3D data for future research can be guaranteed from the creator perspective, too.



a) *b)*

Fig. 2 Orraon, House D: a) Solid photogrammetric model showing the different types of surface treatement techniques such as rough-split, picked or smoothed; b) Simple survey statistics with indication of the camera positions (from drone and ground) and image overlap. The camera positions show for example, that – whereever the natural surroundings allowed it – a fixed distance to the object was maintained in an effort to guarantee a consistent quality of the resulting photogrammetric model (© Claudia Mächler, Department of Classical Archaeology at theTechnical Univeristy of Darmstadt)

Daylight simulation of ancient housing - the user perspective

Finding suitable data for the Roman case studies proved challenging, since knowledge about and access to data often enough relies on personal relations. For the definition of appropriate case stud-

[3] Rodríguez-Gonzálveza, P. et al. (2017) 4D reconstruction and visualization of cultural heritage: Analyzing our legacy through time, in: ISPRS-Archives – Volume XLII-2-W3, 609–616.

[4] Cfr. for example, Homburg, T. et al. (2021), Metadata schema and ontology for capturing and processing of 3D cultural heritage objects, in: Herit Sci 9:91, 1–19.

ies in the planning phase of any project relying on primary 3D data already gathered, a central database or repository – preferably at a European or international level – with the possibility to search data by location, quality, coverage, 3D preview and licence would be beneficial. Data collected for one purpose does not always fit another.

In the specific case of the project high resolution 3D data of ancient residential architecture was needed for the detailed examination of architectural features relevant for lighting and the development of reconstruction models. Further, accurate georeferencing and additional information about the building history were important.

From these specific requirements a more general perspective will be deduced focusing on the interaction options between the user and the providing platforms. For example, the possibility to download the original data from a local or central repository would ease data exchange. An applied open access licence would provide dependability – especially for the long term. In addition, an option for direct contact would allow cooperation and individual agreements between data creators and users. For dissemination a licence to publish derivatives and link the resulting models with the original 3D data is a requirement for scientific transparency. A possibility to update or comment the original data would allow to add findings.

Conclusions

Bringing together the different perspectives it becomes clear that the handling of FAIR 3D data should be understood as a dynamic, multi-stakeholder interaction process. The application and development of photogrammetric acquisition has to be driven by the methods applied to the data. Best practice has to include standards for data publication and licensing. Research data management needs to be understood not only as providing infrastructure but as active brokering between data providers, data creators und data users. Only given this standardised data structures and APIs for inter-repository exchange can help aggregating specific information or technical metadata solutions that can help fitting the heterogeneous demands during acquisition and search.

All these very encouraging developments toward FAIR data should be accompanied by a serious dialogue on good scientific practice and performance, and also by rethinking funding principles and practice. As all things digital, the reuse of digital data leads to a further differentiation of labour and specialisation within cultural heritage science that may lead to an imbalance between groundwork and innovative research. The privilege of access to cultural heritage, the avoidance of unnecessary damage to the site, the amount of tax money spent on labour and equipment are good arguments for FAIR data publication. In principle, the use of FAIR data necessitates the publication of own results as FAIR data as well.

Funding

The building survey of Orraon is funded by the Federal Ministry of Education and Research (BMBF) within the project “ΦΩΣ 4D – Werkzeug zur Affordanz-basierten Tageslichtanalyse in antiken Häusern mittels Simulation”. Andreas Noback’s work within the FID BAUdigital is funded by the Deutsche Forschungsgemeinschaft (DFG #432774435).

Conflict of Interests Disclosure

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Author Contributions

Conceptualization: Claudia Mächler and Andreas Noback
Data curation: Claudia Mächler and Andreas Noback
Funding acquisition: Franziska Lang
Investigation: Claudia Mächler and Andreas Noback
Methodology: Claudia Mächler and Andreas Noback
Project Administration: Claudia Mächler
Validation: Claudia Mächler
Visualization: Claudia Mächler
Writing – original draft: Claudia Mächler and Andreas Noback

References

Ducke, B., Fritsch, B., Schilling, M. (2021), Qualitätssicherung von 3D-Modellen für die Online-Publikation, in: Forum for Digital Archaeology and Infrastructure 1, 1–30 (DOI: https://doi.org/10.34780/bi19-9w1a)

Hardesty, J., Johnson, J., Wittenberg, J., Hall, N., Cook, M., Lischer-Katz, Z., Xie, Z., McDonald, R. (2020), 3D Data Repository Features, Best Practices, and Implications for Preservation Models, in: Findings from a National Forum. College & Research Libraries 81(5), 789–807

Homburg, T., Cramer, A., Raddatz, L., Mara, H. (2021), Metadata schema and ontology for capturing and processing of 3D cultural heritage objects, in: Herit Sci 9:91, 1–19 (DOI: https://doi.org/10.1186/s40494-021-00561-w)

Rodríguez-Gonzálveza, P., Muñoz-Nietoa, A.L., del Pozoa, S., Sanchez-Aparicioa, L.J., Gonzalez-Aguileraa, D., Micolib, L., Gonizzi Barsantib, S., Guidib, G., Millsc, J. Fieberc, K., Haynesd, J, Hejmanowskae, B. (2017) 4D reconstruction and visualization of cultural heritage: Analyzing our legacy through time, in: ISPRS-Archives – Volume XLII-2-W3, 609–616