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Date of secondary publication: 04.07.2023

Version of Record (Published Version), Article

Persistent identifier: urn:nbn:de:bvb:473-irb-599714

Primary publication

Tenschert, Ruth; Pallas, Leander; Bellendorf, Paul: Stone walls, characters, moos and trees : multilevel documentation of inscriptions and graffiti from different centuries in a former sandstone quarry. In: The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences. XLVIII-M-2-2023 (2023), S. 1549-1555.
DOI: 10.5194/isprs-archives-XLVIII-M-2-2023-1549-2023

The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume XLVIII-M-2-2023
29th CIPA Symposium "Documenting, Understanding, Preserving Cultural Heritage:
Humanities and Digital Technologies for Shaping the Future", 25–30 June 2023, Florence, Italy

STONE WALLS, CHARACTERS, MOSS AND TREES – MULTILEVEL DOCUMENTATION OF INSCRIPTIONS AND GRAFFITI FROM DIFFERENT CENTURIES IN A FORMER SANDSTONE QUARRY

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KEY WORDS: Graffiti, inscriptions, 3D-Documentation, weathering, stone decay, climate change.

ABSTRACT:

The Fingalshöhle near Illesheim, Germany, is today both an archaeological and a cultural heritage site. This paper will show the application and analysis of the combination of terrestrial laser scanning (TLS) and high resolution structured-light-scanning (SLS) as a multilevel documentation approach to help preserve this unique location with its graffiti and inscriptions from the past 300 years. The site is a decommissioned sandstone quarry which has been gradually taken over by nature. The quarry served as field quarters for troops during several wars, with soldiers carving inscriptions into the sandstone walls. In the later 18th and 19th centuries, the site attracted visitors, who also immortalised themselves. These witnesses to the site's diverse history are threatened by the ever-increasing overgrowth of the quarry, and above all by weathering processes impacting the unprotected stone. Photographs show that over periods as short as the last 15 years, climatic effects have completely obliterated some inscriptions. The characters are thus slowly but steadily being erased. Since the decay could only be stopped with massive interventions to the quarry itself, the aim is that a documentation should preserve, at least in digital form, the current state, giving future generations the opportunity to experience and explore this multi-layered site. As well as recording the vulnerable inscriptions, the digitising process can in some cases make even the most severely degraded inscriptions legible once more. The processed data serves as documentation for the municipality, and can be used for future research approaches and monitoring purposes as well as dissemination.

1. INTRODUCTION

1.1 The site

3D technologies offer great advantages for the documentation of cultural heritage sites and especially for barely readable inscriptions (Tenschert et al 2018). The so called Fingalshöhle near Illesheim in Bavaria, Germany, is today both an archaeological and an historic cultural heritage site (Umweltatlas Bayern 2022, BLFD 2022). This paper will show the application and analysis of the combination of terrestrial laser scanning (TLS) and high resolution structured light scanning (SLS) as a multilevel documentation approach to help preserve this unique place with its graffiti and inscriptions from the past 300 years.

Figure 1. One of the sandstone walls of the quarry in July 2022, illustrating the challenge of moss and lichen.

The site is a decommissioned sandstone quarry, which has over the past several centuries, been gradually taken over by nature and the surrounding woods (Fig. 1 and 2). According to basic historical research, it is known that the site was still in use after the stone mining ceased: During the Thirty Years' War (1618-1648), and later from 1806 on during the Napoleonic Wars (1804-1815), the quarry served as field quarters for troops. There the soldiers carved many inscriptions and dates into the sandstone walls in both French and German. In the later 18th and 19th centuries, the site attracted visitors from the nearby castle, who found in this place an example of the wild landscape which was popular with the Romanticism movement at that time (Schultheiß 1986).

Figure 2. View into the area of the decommissioned quarry in March 2023.

1.2 Effects of weathering and climate change

The testimonies to the site's diverse history are now threatened by the ever-increasing overgrowth of the quarry, and above all by weathering processes affecting the unprotected stone, intensified by the effects of climate change. Photographs show that even over periods as short as the last 15 years, climatic effects have completely obliterated some of the inscriptions. In addition, the walls are becoming more and more overgrown with moss and lichen (Fig. 3), a well known problem for stone cultural heritage exposed to an outdoor climate (Daly 2019, Drewello 2004, Drewello and Drewello 2007, Drewello and Drewello 2013, Wilhelm et al 2020, Cozzolino et al 2022).

Figure 3. A stone wall of the quarry with graffiti and biological coating (moss, lichen, small tree) and water drainage traces especially on the right side.

The main problems of the stone walls in the former quarry are erosion, mechanical damage and biological colonization, as well as moist areas due to water drainage as categorised in the ICOMOS glossary on stone deterioration patterns (ICOMOS 2010). Some bigger parts have even spalled off in the last few years (Fig. 4). Therefore the inscriptions and graffiti in the area of the former quarry are thus slowly but steadily being erased.

Figure 4. Stone wall with graffiti, bullet holes and a big spalled of part.

The impact of climate change is becoming more and more important for the preservation of cultural heritage, both stored indoors and exposed outdoors (Bertolin 2019, Daly 2019). The site of the Fingalshöhle is an example where intervening in the ongoing decay processes due to weathering and the expansion of the surrounding forest is not possible for several reasons, such as the protection of the outdoor environment and the uniqueness of the site itself.
Since the decay and deterioration of the stonewalls could only be stopped with massive interventions to the quarry itself, for example the construction of a roof, the aim of this work in progress is that a basic documentation should preserve, at least in digital form, the current state. This would give future generations the opportunity to experience and explore this multi-layered site.

1.3 Historic graffiti and inscriptions

Inscriptions and graffiti have been a popular but also challenging object of study due to the great variety in size, shape and location. While inscriptions are often found, for example, on buildings (with a specific date) or gravestones, graffiti can be found nearly everywhere. Graffiti can be defined as marks that are scratched, drawn, or otherwise applied to a surface. They can consist of characters, paintings, sketches or meaningless lines (Historic England, 2021, p. 1). While today, contemporary graffiti can be considered harmful to historic buildings, and may therefore have to be removed (Historic England 2021), they can also be works of art or at least culturally significant and therefore worthy of protection (Forster et al 2012).
Historic graffiti can serve as a valuable source of information for the history or use of a building at a certain time. They can be witnesses of visitors, or date interventions in a building or site and are therefore as important as inscriptions in understanding the complex history of sites.
Traditionally, the method of documentation was manually tracing with paper and pencil (Valente and Barazzetti 2020).
The digital (3D-) documentation of inscriptions and graffiti still faces a variety of challenges, like the size and depth of the letters or drawings (Tenschert et al 2018, Valente et al 2019) or the fragile surface and material they are scratched in, for example frescos (Valente et al 2019, Valente and Barazzetti 2020) or shiny, polished marble (Tenschert et al 2018, Abate and Trentin 2019).
A common research question concerning graffiti and inscriptions is to decipher and date the characters or drawings. Some case studies aim to decide whether the currently understood content and date are correct (Tenschert 2019). The main aim of (3D-) documentation and research on inscriptions and graffiti is often to make faded or faintly discernible scripts readable, ideally using non-contact methodology (Papadaki et al 2015, Greco and Flouda 2017, Tenschert et al 2018).

2. MULTILEVEL DOCUMENTATION

2.1 Terrestrial laser scanning - TLS

There are numerous ways to document sites with inscriptions and graffiti, and for this case study a multilevel documentation workflow was used. Due to the size of about 1225 square meters and complex shape of the quarry walls, an initial terrestrial laser scan was carried out. A Faro Focus S350 was used for 20 scanning positions. Each scan was carried out using the device's parameters of 1/2 (resolution) and 2 (quality), resulting in approximately 174.8 million. points per scan, with a 3D point distance of 3 mm at a distance of 10 m.

The positions for scanning were selected to cover all parts of the five stone walls. To minimize the obstruction of the laser beam due to leaves and branches of the bushes and trees the work was done in the wintertime when the vegetation is less abundant. The 20 individual scans where registered in Faro Scene software (Version 2020.0.7) using the point cloud registration algorithm, and colour was applied using the images taken by the scanner's built-in HDR-camera. To increase the quality of the resulting point cloud, the scanning data was cleaned manually afterwards: Trees and bushes were removed in the areas next to

the stone walls (Fig. 5). In addition, points recorded at a sharp angle to the walls were erased, to reduce noise on the surface and to improve the visibility and clarity of the inscriptions and graffiti. Afterwards an overall project point cloud was computed, with filtering to provide an even point density and to remove less accurate points recorded over a certain distance from the scanner. This point cloud is used to generate orthophotos of the stone walls.

Figure 5. Overview of the quarry; point cloud from the TLS-data (left), ground floor-section of the point cloud at the level of the stone walls (right).

2.2 Structured light scanning - SLS

While the TLS-data serves as an overall documentation of the complex site, it is also a basis to geo-reference the high resolution structured light scanning data of the more delicate inscriptions and graffiti that are barely readable or threatened due to their exposition and location. As discussed by Valente et al (Valente et al 2019), graffiti can be extremely difficult to document. In the case of the quarry these difficulties are not caused by poor visibility due to outdoor lighting conditions (shade, sunshine), bad stone surface conditions, moisture, minimal scratch depth, multiple layers of writing and particularly in this case, the growth of lichen and moss and natural erosion (Fig. 3,4, 6).

Figure 6. Almost illegible graffiti due to biological coating.

The high resolution scanning was carried out with an Artec EVA scanning device using Artec studio 15 software. The settings ensure a 3D point distance up to 0.5 mm. The resolution was chosen to ensure that even filigree scratchings are properly recorded. The recording was performed either while the area of interest was in shadow, or using an umbrella to shield the surface from bright sunlight. The filigree and organic structures on parts of the inscriptions and graffiti covered with moss and moist areas were difficult to capture (Fig. 6). Approximately 30 vulnerable inscriptions and graffiti have been documented using SLS. For each data set a global registration and outlier removal was performed in Artec Studio to enhance the quality of the resulting mesh from the software’s sharp fusion-algorithm.

Close range photogrammetry (Samaan et al 2016, Valente et al 2019, Valente and Barazzetti 2020) was considered but it was decided to use SLS with the above-mentioned device and software in order that real-time feedback could verify on site whether or not the recording was successful and sufficient. Using RTI to record the inscriptions as suggested in previous research (DiBaise Sammons 2018) was also considered, but was considered impractical due the relatively poor conditions of some parts of the stonewalls and the outdoor environment with uncontrollable lighting - even indoor conditions with ambient light can decrease the effectiveness of the RTI method (Valente et al 2019).

2.3 Orthophotos and 3D surface comparisons

To make the TLS and SLS datasets interoperable orthophotos were generated:

- The 3D models from the SLS scanning were exported using the .stl file format and then imported into Aspect3D v 16.5 rev. 8586 (Arctron GmbH). The textureless 3D-surface of the models was virtually illuminated to improve the visibility of the characters and numbers.
- Orthophotos of the TLS point cloud were generated in FaroScene 2020.0.7 using the Orthophoto plug in. Each wall was processed separately, displaying either a greyscale or coloured view of the registered data. For some areas it was more useful to use just a single scan for the orthophoto to avoid noise on the surface from the vegetation close to the stone walls.

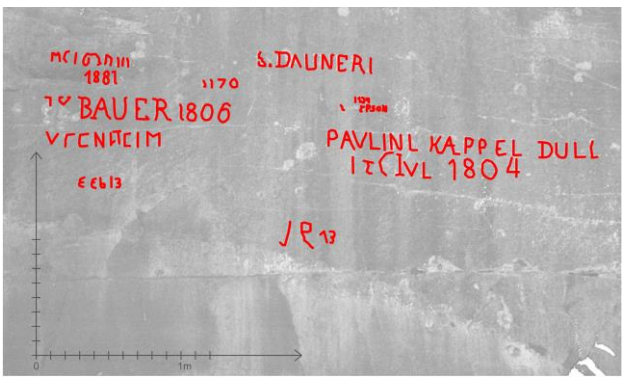

Figure 7. Orthophoto of the TLS-data with transcription of the readable inscriptions and graffiti.

The orthophotos are scaled and help to locate the inscriptions and graffiti on the stone walls. (Fig. 7) With the orthophotos of the high-resolution 3D-models, more inscriptions and graffiti can be identified and read, with the virtual raking light helping to make the characters more visible. The two types of orthophotos can be superimposed to locate the high resolution models (Fig. 8) and can be used to create drawings of the writings and dates.

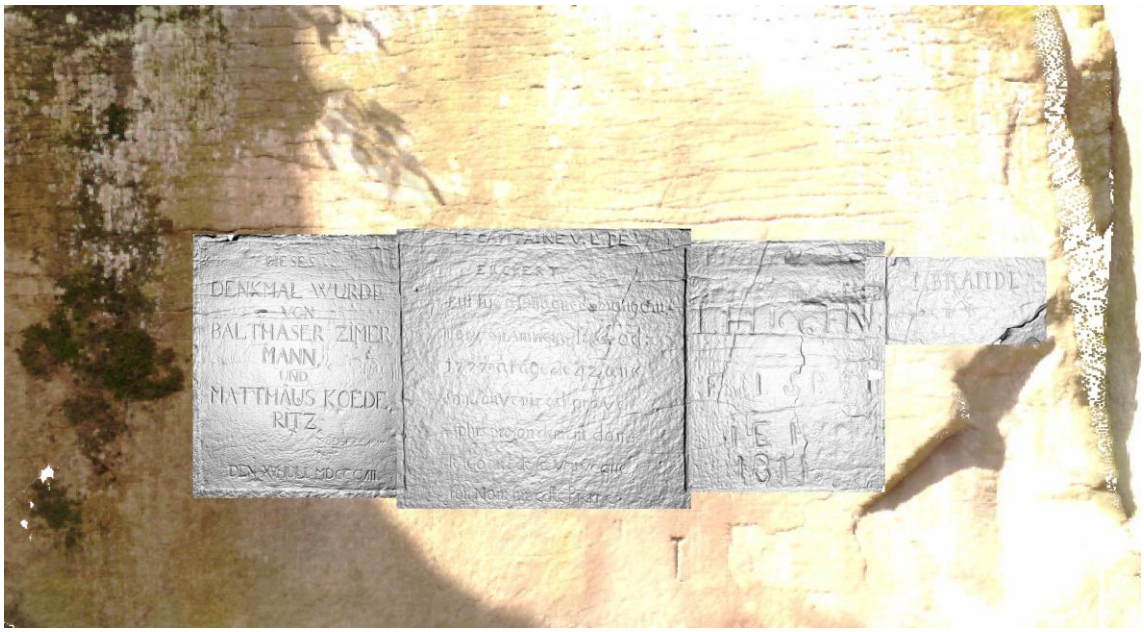

Figure 8. Superimposed orthophotos from the texturised TLS data (point cloud) and the textureless 3D surface model (SLS, illuminated with raking light).

Another way to better visualise the inscriptions and graffiti is a 3D-surface comparison to a plane surface that is displayed in a false colour image. The 3D comparisons were created using GOM Inspect 2022 (Zeiss Quality Suite 2022) (Fig. 9). This methodology could also be used in the future, to monitor the decay process of the site.

3. THE INSCRIPTIONS AND GRAFFITI IN THE FINGALSHÖHLE

3.1 The stonewalls of the abandoned quarry

So far no overall documentation of the site with its inscriptions and graffiti has been carried out, only a very rough description from the 1980s (Schultheiß 1986) and a basic photographic documentation by the local administration.

The multilevel documentation has already revealed new findings. Before, it was unclear where the characters were located and how they are distributed over the existing five sandstone walls in the abandoned quarry. Orthophotos of the 107 m of stone walls show that only three walls are covered with inscriptions and graffiti (wall 2, 3 and 5) (Fig. 10). These are almost vertical and the surface is largely smooth without traces of craftsmen’s tools.

One wall is tremendously overgrown with moss (wall 1), and there are only a few large crosses visible on that wall. It is doubtful whether more characters would be found under the moss. A smaller wall (wall 4) in the back of the site shows only traces of manual stone mining and stone processing with stonemason’s tools. Why these two walls have not been used for graffiti or inscriptions cannot be explained without further research into how the quarry was used. For example, did temporary buildings prevent access to these walls when troops were quartered in the quarry?

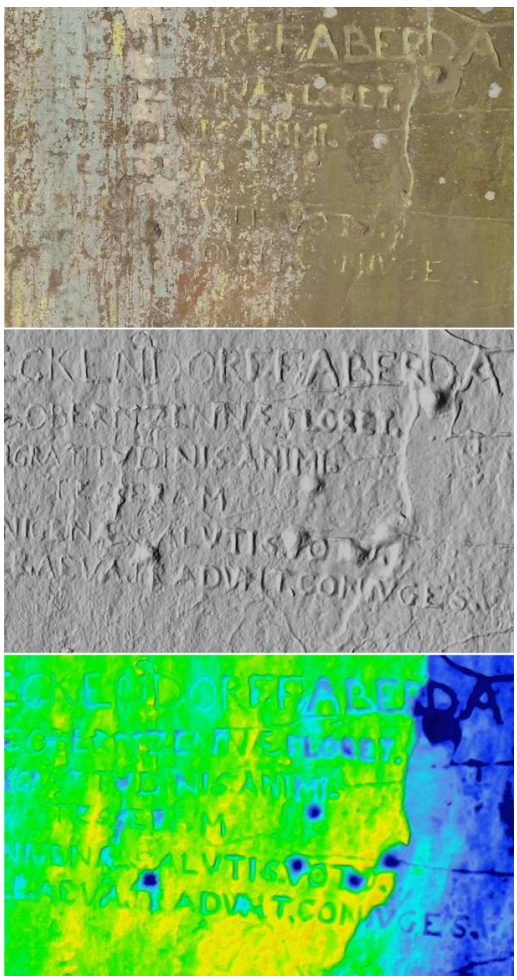

Figure 9. Detail orthophotos of the SLS-data of a memorial inscription on the western wall (wall 2) to enhance the readability of the inscriptions (from top to bottom): textured 3D model, textureless 3D model with raking light, depth map from a 3D comparison to a base-level (also usable for future monitoring).

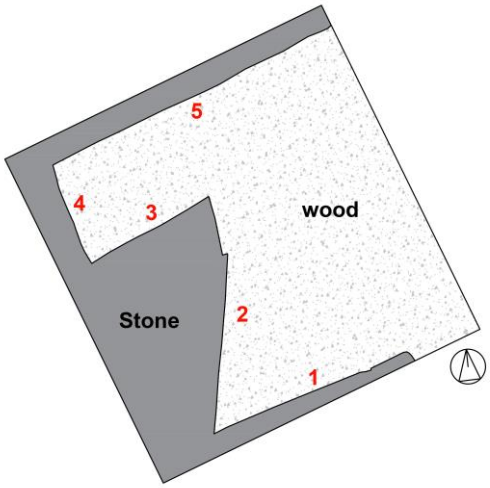

Figure 10. Schematic floor plan of the area of the quarry. 1-5 stone walls; Inscriptions and graffiti only on wall 2, 3 and 5.

3.2 Size, shape and content of the graffiti and inscriptions

As mentioned above, three of the stone walls show different kinds of inscriptions and graffiti. The size, arrangement and depth of the carvings differ widely. Some of them are scratched into the sandstone walls very deeply, some are well arranged with small sketches or drawings, some are dated, and some are quite delicate and filigree (Fig. 11).

Figure 11. Deeply scratched graffiti mentioning “H. v. Seckendorff”, with a more delicate example above “G. Krahiser v. Sontheim”

Besides the various inscriptions and graffiti there are also bullet holes and traces of installations illustrating the history of the site in times of war etc. Some of the inscriptions and graffiti are clearly visible but some are unreadable either on photographs or with the naked eye. The content of these was only revealed using the high resolution data from the SLS. The larger examples, on the other hand, can be read using the orthophotos from the TLS point cloud.

The inscriptions and graffiti have neither a specific order or systematic arrangement, and some even overlap each other (see for example Fig. 13 small letters beneath “Canonnier”). Although they differ greatly in size, shape and content, it is possible to group some together:

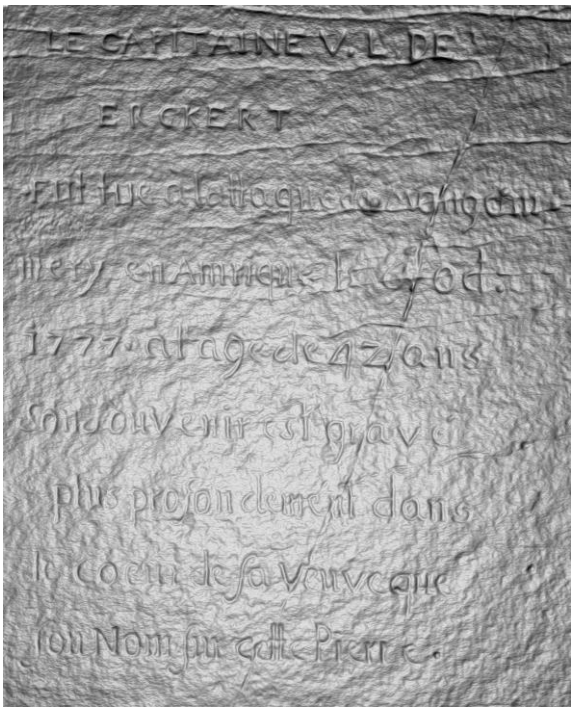

Figure 12. French memorial inscription for a fallen captain dated 1777.

First there are inscriptions with a military context. They serve as witnesses of the quarry’s use as troop quarters for both German and French troops. These are scratched very precisely and accurately. Two of the examples in French were described by Schultheiß (Schultheiß 1986) (Fig. 12 and 13)

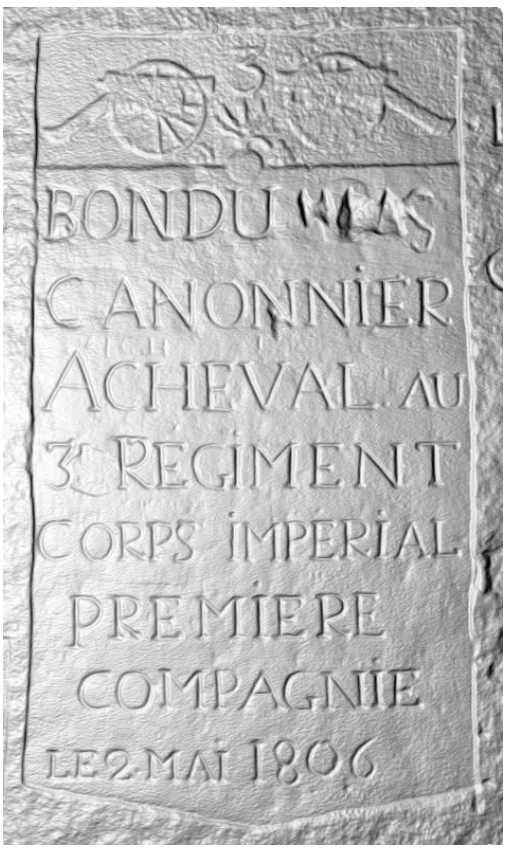

Figure 13. Second French inscription dated 1806

Second are the graffiti from visitors during the 19th century, often including a name and sometimes a place where the person came from (Fig. 7). These visitors immortalised themselves with engravings in a variety of sizes and arrangements.
Thirdly, there is graffiti from the 20th century with the name of the visitor and the year. These seem to take less account of existing inscriptions than the others and are sometimes written over existing letters.
Some inscriptions – mainly the ones with a military background - also include small sketches or drawings, like weapons or other tools (Fig. 14).

Figure 14. Graffiti showing name “I.Brandl” and a drawing of two crossed sabres(?).

An example of graffiti and inscriptions with nearly unreadable characters and dates is located on wall 2 and engraved in an emblem: the characters in the first line are NÖLP, which can be identified in the photograph, but the date below is indecipherable. Using the textureless 3D surface model it can easily be read as 1831 (Fig. 15).

Figure 15. Comparison of almost illegible graffiti on the left (photograph) and, on the right, virtually illuminated 3D surface model.

4. CONCLUSION

For the multilevel documentation approach of this research TLS and SLS was used. This combination was chosen to create both an overall documentation of the entire site and a detailed documentation of the most vulnerable inscriptions and graffiti. This approach enables further investigation of this site in the future, even after weathering effects and the damage due to moisture and natural erosion will have inevitably caused even more deterioration. The current state of the site was documented to preserve it, in digital form at least for the use of future generations. The processed data of this ongoing research also serves as a basic documentation of the current state of the site for the local municipality, and can also be used for future research approaches from different disciplines, for example for historians to tell a more detailed story of the site. The superimposed orthophotos are interoperable and easy to use, and can be complemented with photographs or further measurements.

The dataset can also serve as a basis for condition monitoring, measuring the weathering effects and ongoing decay processes in the site. Ultimately, the digital models could also be used for public dissemination, communicating information about the history of the site to visitors using displays and, for example, QR codes linking to online resources. This might be future work to be carried out by the local administration in cooperation with the authors.

5. FUTURE WORK

The aim for future work with the data is to make it available as an open access resource for researchers and the public alike. Data will be stored with the local municipality and it is also planned to store it in a digital archive or repository, for example the FD-repository of the University of Bamberg, which is currently under construction. This will ensure long term accessibility and longevity of the 3D documentation, and enable sustainable use in to the future.

ACKNOWLEDGEMENTS

Our special thanks go to the municipal administration of Illesheim, the administration Burgbernheim and the forest cooperative Sontheim for the support to document the site, especially Mr. Scheibenberger, Mr. Rank and Mr. Wodniak. In addition, the authors also thank the Bavarian State Office for the Preservation of Monuments (BLfD) for supporting the project.
Furthermore we would like to thank our colleagues John Hindmarch and Jonatan May as well as the Centre for Heritage Conservation Studies and Technologies (KDWT) for their support.

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