Built Heritage

RESEARCH ARTICLE Open Access

Harnessing digital workflows for the understanding, promotion and participation in the conservation of heritage sites by meeting both ethical and technical challenges

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Abstract

The current application of digital workflows for the understanding, promotion and participation in the conservation of heritage sites involves several technical challenges and should be governed by serious ethical engagement. Recording consists of capturing (or mapping) the physical characteristics of character-defining elements that provide the significance of cultural heritage sites. Usually, the outcome of this work represents the cornerstone information serving for their conservation, whatever it uses actively for maintaining them or for ensuring a posterity record in case of destruction. The records produced could guide the decision-making process at different levels by property owners, site managers, public officials, and conservators around the world, as well as to present historical knowledge and values of these resources. Rigorous documentation may also serve a broader purpose: over time, it becomes the primary means by which scholars and the public apprehends a site that has since changed radically or disappeared. This contribution is aimed at providing an overview of the potential application and threats of technology utilised by a heritage recording professional by addressing the need to develop ethical principles that can improve the heritage recording practice at large.

Keywords: Documentation, Recording, Cultural heritage, Best practice, Ethical commitment, Digital workflows

Introduction

This contribution is the result of over two decades of heritage recording professional practice, training guidance and research experience. It also relates to work conducted on ethics as a Guest Scholar at the Getty Conservation Institute (GCI) during the winter of 2019 (Fig. 1).

This paper provides the role of visual information digitally gathered of historic conservation, with an eye to national and international standards for such work. It also provides a framework and workflow to understand the relationship between heritage recording and ethical conservation decision-making. Furthermore, this paper does not discuss the technical challenges of recording heritage places or the public engaging with social media to understand heritage places but centres the discussion on the specific role of the 'heritage recording specialist' that conduct the work according to good practice.

As already indicated by Manžuch, the 'growing number of case studies on the ethical issues faced in cultural heritage digitisation calls for a discussion of this generally neglected dimension of digitisation. Implicit and explicit assumptions also support the importance of the ethical dimension that well-established approaches to ethics in archives, libraries, and museums do not work with digitisation' (Manžuch 2017, 3).

The literature research involved substantial review of existing ethics principles and codes of professional practice, which are currently available to heritage specialists, ranging from the International Council of Monuments and Sites (ICOMOS) Ethical Principles (ICOMOS 2017) to the

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Fig. 1 3D scanning underground cavities of the Tomb of the Kings, Cyprus (2019) (Source: the authors)

Fig. 2 Documenting an archaeological site using different recoding techniques (Source: the authors)

academic literature, to the Royal Institution of Chartered Surveyors' (RICS) Global Professional and Ethical Standards (RICS (Royal Institution of Chartered Surveyors) 2018). From the review, categories and relevant obligations of heritage recording specialists were identified (Fig. 2). This issue is further discussed in the 'Developing an Ethical Framework for Heritage Recording' section of this article.

For example, in any professional association that serves the public interest, members have to abide by several ethical principles, and this is currently missing in the heritage recording field.

Finally, the obligations will be illustrated with a case study to show how designing coherent presentations by integrating information gathered through these techniques of built heritage can allow the decision to be made and promote stakeholder engagement in the conservation of sites.

Key definitions

- Digital heritage recording: as opposed to hand (or traditional) heritage recording, this type of recording includes all forms of digital data capture, ranging from photographs to rectified images, CAD to photogrammetry, total stations to 3D laser scanning, and voice to video (Letellier et al. 2007).
- Heritage record: the technical dossier of a cultural heritage place, prepared by heritage recording specialists and consisting of measured drawings, photographs, and technical analysis. It provides necessary basic data for conservation and monitoring activities, as well as posterity records for public archives (Letellier et al. 2007).
- Digital workflows: the methods or approaches utilised by heritage recording specialists to carry out the digital heritage recording of a heritage place (Letellier et al. 2007).
- Heritage recording specialist: a professional expert in measured survey and photographic techniques who provides heritage records of heritage places (Letellier et al. 2007).
- Heritage recording: the graphic and/or photographic capturing of information describing the physical configuration, evolution, and condition of a heritage place at known points in time (Letellier et al. 2007).

Risks to built Heritage: physical integrity under threat

Undoubtedly heritage places are under constant threats from a variety of risks, such as climate change causing natural disasters and increasing weathering; also, development

Fig. 3 Damage to earthen architecture structures from strong rains, Ouarzazate, Morocco (2016) (Source: the authors)

Fig. 4 Decorated surfaces in the Bamiyan Buddha's threated by looting (2003) (Source: the authors)

pressure, uncontrolled tourism, pollution, improper site management, negligent rehabilitation/maintenance interventions, looting and conflict. For example, uncontrolled visitors and lack of identification of cultural heritage resources, such as at archaeological sites in Sudan. Also, the effects of climate change on speeding the erosion and deterioration of carved cliffs in Petra (Jordan), increase of rainfall affecting earthen architecture at the Kasbah of Tourist (Ouarzazate, Morocco) (Fig. 3) and floods in Venice (Italy). Unexpected seismic activity adds to the sudden or partial destruction of masonry temples that were rehabilitated with incompatible interventions.

Nevertheless, less evident is the abandonment and lack of maintenance of heritage places that are not recognised as having outstanding universal value; these are hidden but represent a substantial problem affecting a large number of places worldwide.

In recent years, not-for-profit and for-profit organisations have launched several initiatives to digitally record these sites under threat from conflict and climate change, which have yielded several projects. For instance, an academic initiative is The Endangered Archaeology in the Middle East and North Africa (EAMENA), which 'has developed a methodology for the identification, documentation, analysis, and monitoring of sites across the region to aid heritage professionals in these efforts, using remote sensing techniques along with traditional archaeological research and prospection methods to collect data, which are stored and managed in a custom-designed database adapted from open-source Arches software (Fig. 4). In addition to these activities, the EAMENA project has initiated an international conference series and training workshops to support and establish partnerships with heritage professionals and institutions across the region' (Sheldrick and Zerbini 2017, 238).

The not-for-profit organisation, California-based CyArk has dispatched surveying teams and drones to sites as varied as temples in Myanmar, Neolithic monuments on Orkney and the Stonewall monument in New York, collecting millimetre-precise survey data that can assist conservation (Dickson 2019). Iconem, a French start-up created in 2013, has been working in conflict areas, such as Palmira, Aleppo and Mosul in recent

Fig. 5 Recording decorated surfaces in the valley of the Queens, Luxor Egypt (2017) (Source: the authors)

years. They have used drones to map the extent of damaged areas. Apparently all of these plans will soon be available for the general public online on a special platform which will constitute a unique virtual archaeological encyclopedia (MediaGeo 2018).

A tangible threat is the continual pressure of meeting sustainability policies by trying to adapt historic structures to meet unrealistic 'contemporary performance goals' (Carroon et al. 2006) or conducting seismic upgrades that can jeopardise their heritage character forever by trying to manage the change wrongly.

A good example to prepare a comprehensive framework for identifying those factors that can affect heritage places and develop digital recording strategies accordingly is to use the UNESCO resource manual on Preparing World Heritage Nominations (UNESCO 2011), which identifies five main factors that can be documented, evaluated and monitored, such as:

(i) Development pressures (e.g. encroachment, adaptation, agriculture, mining);
(ii) Environmental pressures (e.g. pollution, climate change, desertification);
(iii) Natural disasters and risk preparedness (earthquakes, floods, fires, etc.);
(iv) Visitor/tourism pressures; and
(v) The number of inhabitants within the property and the buffer zone.

These aspects are usually considered in each nomination file and allow assessment of the impact on the authenticity and integrity of sites and how this can threaten the important 'Outstanding Universal Value (OUV)'.

For example, if uncontrolled tourism pressure is a threat, the development and deployment of automated sensors to detect the number of visitors during peak hours on a particular site and simultaneously monitor the indoor environment (relative humidity, temperature, etc.) linked to a Geographic Information System (GIS) will yield more conclusive information to adopt policies restricting the number of tourists than conducting an expensive project using very sophisticated devices to capture millimetre accuracy of a historic surface. However, for monitoring the millimetre loss of a historic decorated surface, a sophisticated capturing approach such as photogrammetry or 3D scanning might be necessary to evaluate and monitor this deterioration pattern (Fig. 5).

In the opinion of the author, the disconnect between the usability of the heritage record to inform the decision-making process to manage change effectively in

heritage sites, such as rehabilitation, adaptive reuse, seismic upgrade or simple maintenance is more relevant than just making a vaulted record that would allow a site to be preserved in digital form.

Another threat is diluting efforts, such as the search of hidden chambers adjacent to Tutankhamun's tomb using expensive and sophisticated Ground Penetrating Radar (GPR) and from High Frequency (HF) acquisitions finally yielding, with a high level of confidence, that Reeves' theory concerning the existence of hidden chambers adjacent Tutankhamun's tomb is not supported. Without counting the time and funding utilised for this endeavour, one could think that there are other hundreds of Egyptian tombs that could use GPR for understanding their state of conservation and informing better conservation therapies.

Pace increasing in technology development, longevity and reliability of digital records

Historically the heritage recording activities included assessment reports, measured drawings, photography, photogrammetry, non-destructive investigation and other techniques to set the foundation of knowledge for what needs to be addressed and how to approach treatment. However, new technologies are opening up a realm of possibilities to digitally record historic building that have made documentation efforts more efficient, more thorough and allowed for them to be more expansive. With the rapid pace in which these technologies are advancing and changing it is essential that continued encouragement for dialogue about the applicability and effectiveness of these tools in stewardship of our historic resources is considered of paramount importance.

Increasing pace of innovation

In 2003, the author conducted a comprehensive recording of the Cultural Landscape and Archaeological Remains of the Bamiyan Valley to prepare a measured drawing indicating the location of the sites affected by destruction, access roads and other activities. In addition, a topographic map to calculate the debris remaining on the two main buddha statues destroyed by the Taliban was prepared.

For this job, a Total Station was used (Fig. 6). This device allowed measuring a point every six seconds with adequate precision and the project took about three weeks of intensive work and one month of processing. Now, in 2019, for the archaeological site of Paphos in the same three weeks deploying Unmanned Aerial Systems, 3D Scanners and photogrammetry, a team led by the authors was able to capture substantially more and complete information of this site, which is about the same size as Bamiyan. Millions of points were captured and a huge dataset was delivered for the management of this property (Fig. 7).

Posterity, reliability and longevity of digital records

Guaranteeing that digital preservation of information gathered by heritage recording specialists and organisations should be available for posterity to researchers and the public is a basic obligation. From the ICOMOS Charter of Venice (1964) on to the latest CIPA Symposium in 2019, the issues of the need for adequate provenance information (metadata, ontologies, accuracy reports, etc.) and longevity (and integrity) of digital data is being discussed.

In particular, the ICOMOS Charter of Venice (1964) article 16 suggests that the 'record should be placed in the archives of a public institution and made available to research workers. It is recommended that the report should be published' (ICOMOS 1964). In most cases, this is not achieved or guaranteed.

The explosion of data gathering has produced a highly fragmented and overwhelming amount of heritage information (e.g. 3D Point clouds databases) available on the web and elsewhere. The quality of this data is also questionable.

The development or evolution of digital libraries to offer storage on digital repositories based on cloud technology seems an adequate approach to ensure that the heritage information generated by the private sector, educational institutions, government and non-governmental organisations can be hosted for posterity, as well as, offering standards and guidelines on how that data is characterised.

These innovations in storage and characterisation of data can potentially offer adequate answers to the following issues:

- Overcome localised heritage information produced locally by different groups and organisations;
- Lack of dissemination and transparency;
- Heritage information systems are primarily not based on recognised heritage data structure standards;
- The disconnect between information users and providers;
- Lack of interoperability;
- Lack of standardised methodologies and terminology;
- Issues of heritage information longevity;
- Commonly cited and interrelated challenges;
- Lack of a shared methodological approach;
- Lack of recognition and protection.

Perpetual access to this data is required, and the ability to update the data available in case modifications to the site need to be recorded. Providing information to expand the life span and adaptability of heritage sites, as well as, to overcome obsolescence (functionality and adaptability, sustainability) and the technical challenges associated with this (durability, knowledge and experience of material conservation, repair versus replacement) is also required.

Fig. 6 Using a Total Station to record the deterioration of the Bamiyan Valley (2003) (Source: the authors)

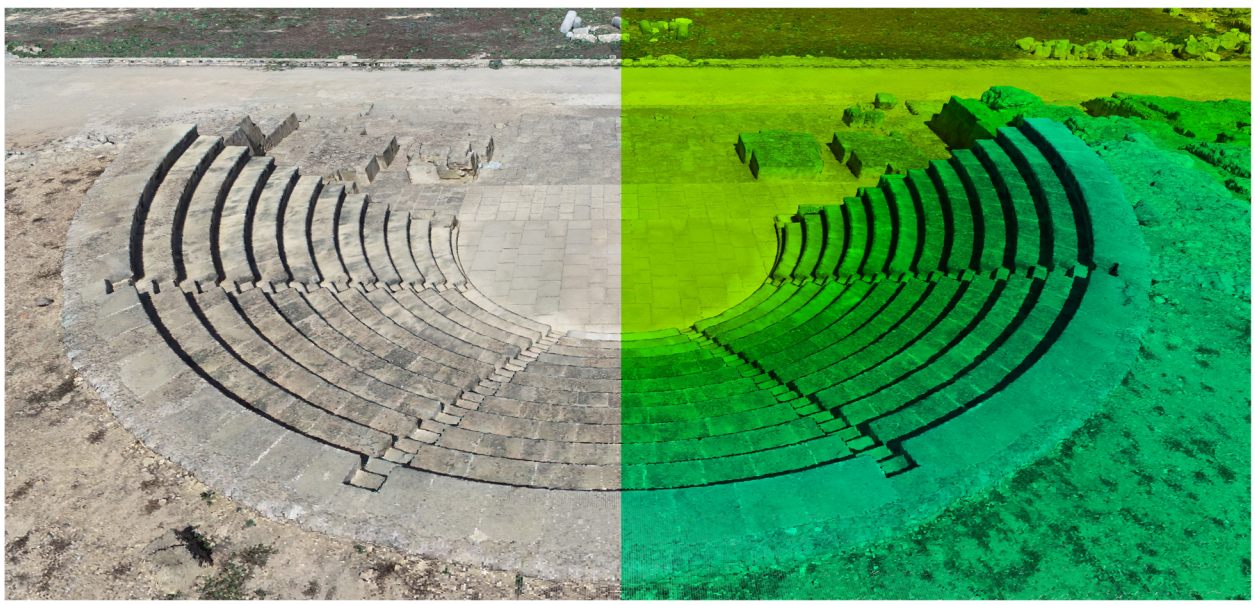

Fig. 7 3D photogrammetric mesh of the Nea Paphos Archeological Site (2019) (Source: the authors)

Ownership, digital appropriation and preservation

Issues surrounding the implication of ownership, appropriation and preservation of information as a result of conducting digital recording activities in heritage places are raising emerging questions and trends that the field has not understood and therefore not addressed.

In this sense, one of the bottleneck obligations deals with the dissemination and the obligation to ensure the transmission of information to present and future generations (Fig. 8).

A light in the tunnel is the brilliant work of the Archaeology Data Service (ADS), and English Heritage, the two organisations that have collaboratively conducted a project that sets out a programme for investigating preservation (storage methods), reuse (usability) and dissemination (delivery mechanism) strategies for exceptionally large data files generated by archaeologists, researchers and cultural resource managers undertaking fieldwork and other research (ADS and English Heritage 2007). However, currently there is little understanding of the implications for cost and good practice in data preservation, dissemination, reuse and access. This lack of understanding is potentially exacerbated by the proprietary nature of formats generally used by the new research technologies now being used in archaeology and cultural resource management.

The project seeks to answer immediate questions regarding cost and to develop recommendations and strategies for archaeologists, researchers, cultural resource managers and archivists dealing with 'Big Data'. The project recognises that computing capacity, both to create and to archive data, will continue to rise.

This project exemplifies obligations to ensure that 'complete, durable, and accessible records' (ICOMOS 2017) are 'kept in a central repository' (Letellier et al. 2007). In this interface, the heritage records are described, stored and retrievable, guaranteeing their longevity for posterity (Cormier 2017).

Also, in a partnership between York University and Historic England (formerly part of English Heritage), the two organisations have developed a sustainability strategy to ensure that digital records processes and outcomes are preserved for transmission to future generations (Denard 2009).

Developing an ethical framework for Heritage recording

This section discusses the development of an ethical framework applicable that can be adopted by heritage recording specialists in their conduct, responsibilities and professional practice to benefit the public and communities. This framework is based on existing work by

Fig. 8 Ortho-corrected image from aerial photogrammetry of the Bhaktapur Durbar Square after the earthquake (2017) (Source: the authors)

Fig. 9 View of the Aion House, Nea Paphos archaeological Site (Source: the authors)

the author, and it is illustrated using a firsthand case study conducted by Carleton Immersive Media Studio in recording the Paphos Archaeological Site in Cyprus (Santana Quintero et al. 2019).

Improving the work of heritage recording specialist allows for better planning, recording, processing and dissemination of digital workflows for the conservation of historic places. Also, digital products produced will be enhanced, including procedures for sharing and preserving records among heritage organisations around the world.

Furthermore, the development of an ethical framework can contribute to the better design, planning, implementation and information-sharing of digital workflows for heritage conservation in several important ways:

- To assist heritage recording specialists in meeting obligations that will improve the role of digital information in the decision-making process for the conservation of heritage places;
- Terms of reference for the design and implementation of digital workflows in the conservation of heritage places;
- To update the ICOMOS Principles for the Recording of Monuments, Groups of Buildings and Sites (1996) to address new challenges and opportunities presented by digital information in the conservation of heritage places;
- To prevent the use of digital workflows that might negatively affect the communities associated with heritage places;
- To improve the collegiality of heritage recording specialists and encourage the exchange of practice points between members, making digital workflows more effective and sustainable;
- To improve information sharing among stakeholders and the public in general who uses digital workflows for the conservation of heritage places; and
- To provide a framework for the preservation of digital records produced by these workflows that will allow for future accessibility.

It is important to point out that there are a number of potential beneficiaries to the correct application of an ethical framework in heritage recording:

- The heritage recording specialist, as explained extensively in the literature review, will benefit from the possibility of practising her/his work without prejudice and in a collaborative manner;
- The public in general, including communities who live on heritage sites and those who are interested in the conservation of cultural heritage;
- Cultural heritage organizations, including for-profit, not-for-profit, government, intergovernmental, academic and funding agencies.

The production of this deliverable was explained in the project report, meeting the obligation to 'be transparent' in the working procedures used so that the work is understood (Royal Institution of Chartered Surveyors 2018).

Categories for an ethical framework

For this approach, six ethical categories were selected from the ICOMOS Ethical Principles (ICOMOS 2017) and the Canadian Association of Heritage Professionals (CAHP) Code of Professional Conduct and Ethics (Canadian Association of Heritage Professionals 2019). These represent the most common ethical issues identified in the literature:

- Related to ethical conduct;
- Related to best practices;
- Related to cultural heritage;
- Related to the public and communities;
- Related to other heritage recording specialists; and
- Related to qualifications.

Ethical conduct

This category relates to the professional behaviour of specialists when conducting their activities: showing respect, integrity, impartiality, accountability and maintaining open, upright and tolerant attitudes. This also addresses issues related to conflicts of interest.

Related to best practices

This category relates to the professional advice and services that heritage recording specialists render to potential clients or community stakeholders. Also, it relates to the accessibility, retrieval and posterity of records produced by specialists for the enjoyment of future generations.

Related to cultural heritage

This category relates to respect for the values and integrity of cultural heritage, as well as preparedness in case of deterioration or damage.

Related to the public and communities

This category relates to the acknowledgment of the role of the public and communities in the conservation of cultural heritage. It also relates to the promotion of heritage recording among the public and the transmission to present and future generations of the information documented. Also, issues concerning the privacy rights of communities to share knowledge about their heritage and rights-based approaches are considered.

Related to other heritage recording specialists

This category relates to the behaviour of recording specialists towards other experts in the cultural heritage field, in terms of collegiality, consideration, exchanging of expertise and mentoring of others. Recognising and respecting differences of opinion, interdisciplinarity and solidarity are also included.

Related to qualifications

This category relates to the need for heritage recording specialists to have appropriate qualifications, such as certification or university training. In addition, it relates to the commitment of heritage recording specialists to professional development and their participation in specialist conferences in order to present their approaches and obtain valuable feedback.

Fig. 10 The digital workflow for digital documentation. On the background some images of the Paphos archaeological park (Source: the authors)

Fig. 11 UAS mapping of the archaeological site (Source: the authors)

Illustrating a digital Heritage recording workflow and ethical obligations in Heritage recording: Nea Paphos documentation project

A clear example of obligations related to the 'best practices' category is the production of 'high quality' digital records. In the ReACH Declaration (Victoria and Albert Museum 2017), this concept is defined as 'with a level of quality sufficient to constitute a representation … as faithful as possible'.

Further, with respect to the degree of quality, it is also important to take into consideration the following methodological obligations:

- Abide by principles of objectivity, reliability and validity of scholarly claims (Münster et al. 2016);
- 'Appropriate scope, level, and methods of recording' should be applied and 'records must clearly and accurately identify and locate the heritage places' (Letellier et al. 2007); and
- Use the best approach and justify (ICOMOS 2017).

Furthermore, this obligation can be linked to ethical conduct issues, such as 'objective, rigorous and scientific' methods (ICOMOS 2017) and providing the best service, advice and support according to the terms of agreement (RICS (Royal Institution of Chartered Surveyors) 2018).

To illustrate these obligations, in 2018, the GCI commissioned the Carleton Immersive Media Studio (CIMS) to record the as-found condition of Nea Paphos archaeological

Fig. 12 Team recording the exposed mosaics with diffused lighting (Source: the authors)

Fig. 13 Example of an ortho-corrected image showing the mosaic tesserae for conservation (Source: the authors)

site to produce a high quality on digital record for the conservation of this important property (Fig. 9).

According to Ace et al. (2019), Nea Paphos is one of the three UNESCO World Heritage sites in Cyprus, as listed in 1980 under criteria III and VI. As stated by UNESCO, 'Paphos, situated in the District of Paphos in western Cyprus, is a serial archaeological property consisting of three components at two sites: the town of Kato Paphos (Site I), and the village of Kouklia (Site II). Kato Paphos includes the remains of ancient Nea Paphos (Aphrodite's Sacred City) and the Kato Paphos necropolis known as Tafoi ton Vasileon ('Tombs of the Kings'), further to the north (UNESCO 2018).'

The Roman site of Paphos has been a point of collaboration for the Department of Antiquities of the Republic of Cyprus (DoA) and the GCI since the mid-1980s beginning with the project to conserve the Orpheus mosaic (Stanley-Price 1991) by detaching it using the rolling technique while training conservators in the region. An assessment of the mosaic followed this work in 2005. In 2014 the DoA and the GCI cooperated in delivering a training course on conservation and management of archaeological sites as part of the GCI's MOSAIKON initiative (http://www.getty.edu/conservation/our_projects/education/mosaikon).

As a result of the subsequent meetings between the GCI and the DoA and the successful collaboration to record the conditions of the Orpheus and the Amazon & Heracles mosaics in 2017, the GCI and the DoA are pursuing a sustainable future for the World Heritage Site of Nea Paphos and its Necropolis, known as the Tombs of the Kings, by preparing a Conservation and Management Master Plan (CMMP) for the site.

Developing an appropriate Heritage recording scope

As well as the digital record of the as-found conditions of the site, the broader intent of the CMMP is to 'undertake comprehensive planning for the conservation and management of the World Heritage site of Nea Paphos and its Necropolis, with selective implementation of components of the plan', according to Martha Demas of the Getty Conservation Institute. She continues that the outcome should be 'an enduring and vital future for the site'. This involves the following aspects:

- Comprehensive assessment of values, conditions and needs;
- Mapping of the entire site;
- Conservation, presentation and documentation of mosaics;
- Design of shelter prototype for mosaics;
- Visitor management;
- Site stabilisation, presentation & interpretation;
- Protection of the natural environment;
- Management capacity.

Therefore, according to the ethical categories related to best practices and conduct to inform the conservation process, the approach for digital workflows to document the site developed by CIMS had the following aims:

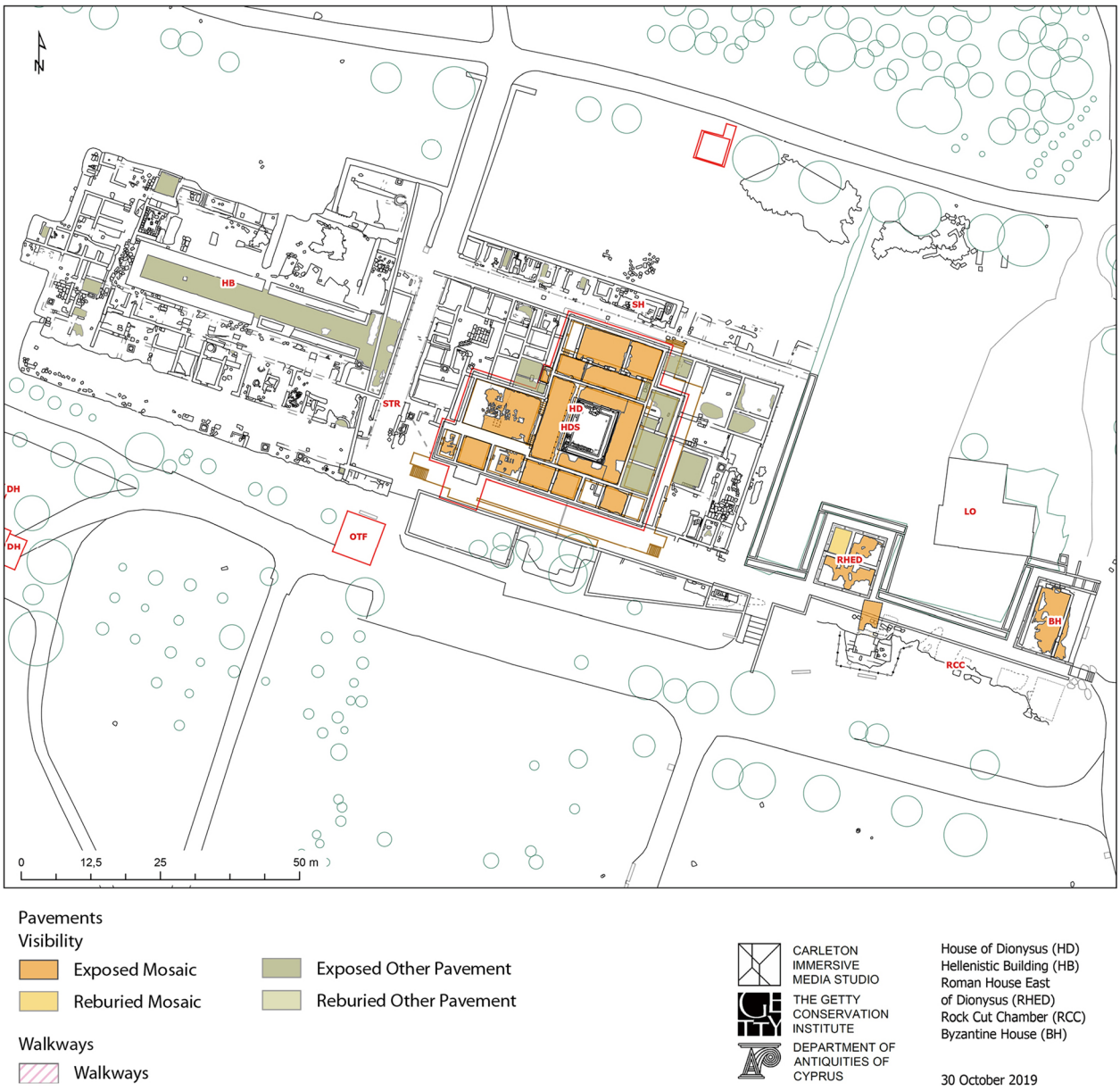

Fig. 14 Example of a measured drawing integrated into the GIS (Source: the authors)

- Accurate acquisition of the current state of conservation of Nea Paphos with the use of appropriate and suitable technology;
- Plan and implement recording and mapping activities aimed at the production of metric records to facilitate the conservation planning of the mosaics at the site and the broader conservation and management of Nea Paphos;
- Design and produce a Geographic Information System for the site; and,
- Provide local staff with a meaningful learning experience in the use of GIS, as well as the specific recording and mapping technologies used in the project.

In this particular aspect of the project planning, an important ethical obligation has been met to ensure that the CIMS team will 'provide best service, advice and support according to the terms of the agreement', therefore 'always provide a high standard of service: always ensuring that your client, or others to whom you have professional responsibility, receive the best possible advice, support or performance of the terms of engagement you have agreed' (RICS (Royal Institution of Chartered Surveyors) 2018).

Development of a comprehensive and effective digital workflow

Having in mind the obligation to produce a high-quality record, the digital workflow was developed in five phases of work: (1) Planning, (2) Acquisition, (3) Processing, (4) Validation, and (5) Dissemination.

The planning phase involved defining the scope and deliverables of the recording and training activities, as well as logistical arrangements of equipment and transportation.

The fieldwork, or acquisition phase, involved the implementation of the developed strategy based on multiple tools, focusing primarily on the archaeological site and the Basilica of Chrysopolitissa area. The broad-scale recording also covered the Tombs of the Kings and Fabrika areas, to be further documented in future phases of the project (Fig. 10).

The geomatics team established a reliable control network across the entire site using a variety of survey tools. The survey network allowed for the final deliverables to be georeferenced and incorporated into the GIS. This team included a senior geodetic specialist who worked with the Cypriot Land Survey Department to produce the network. The documentation team performed the terrestrial photogrammetric and 3D scanning survey of the site feature, collected digital information and processed the deliverables.

Documentation techniques included the use of an Unmanned Aerial System (UAS) to capture aerial photography for photogrammetric use (Fig. 11). Flights at 20 m and 50 m were taken. The 20 m covered exposed archaeological areas and 50 m covered the entire site.

On average, two 3D scanners were used to fill in areas not visible from the aerial view, such as underground, under trees and inside buildings.

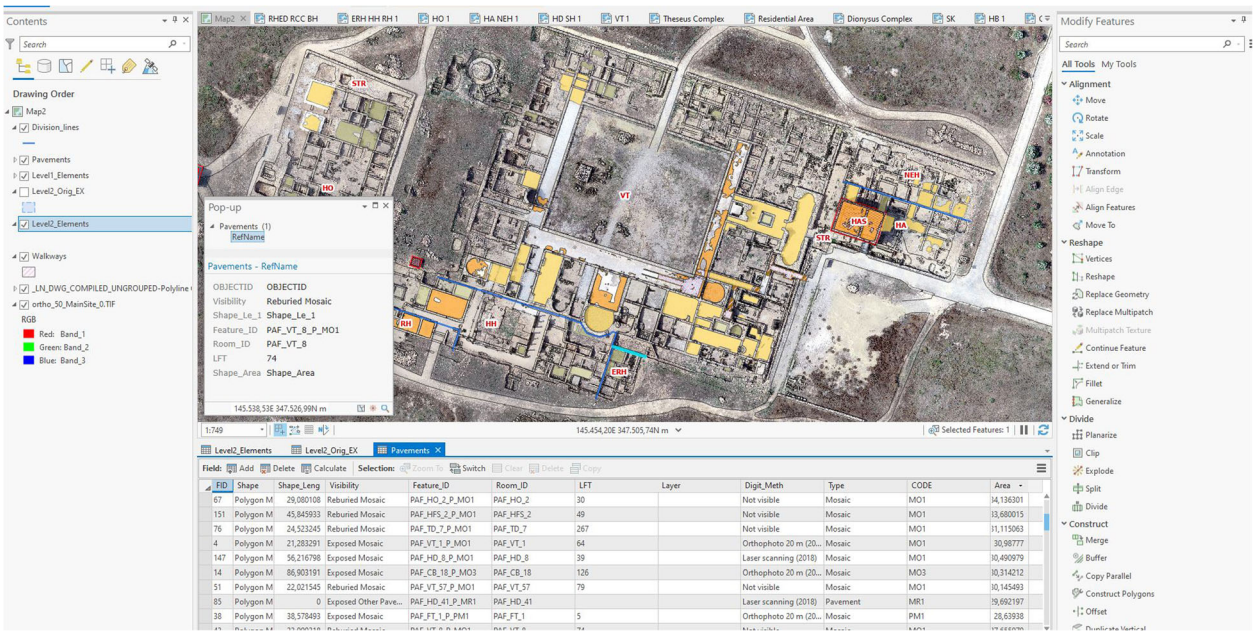

Fig. 15 Screenshot of the GIS showing attributes of exposed mosaics in their archaeological context (Source: the authors)

High-resolution photographs of the exposed mosaics were captured using a handheld DSLR camera for terrestrial photogrammetry. In particular, to obtain a reliable ortho-corrected image of exposed mosaics, the CIMS with DoA experts developed an approach that involved night photography to ensure even lighting and exposure.

In this process, the use of flashes and umbrellas to diffuse lighting was implemented (Fig. 12). In the second phase, nearly 20,000 images were taken for four nights covering more than 30 mosaics. Many things to consider logistically when on-site included batteries, memory cards, wearing socks to respect mosaic, removing bugs/stones; one person with the camera, two helpers ensuring consistent angle and distance of the umbrellas. Control points to process the photogrammetry were measured with the Total Station.

The use of different techniques allowed producing records at different levels of detail according to the sensitivity of the information to inform the conservation process (Fig. 13).

The quality and accuracy of the outputs were validated throughout the entirety of the project beginning with pre-processing and various checks throughout the

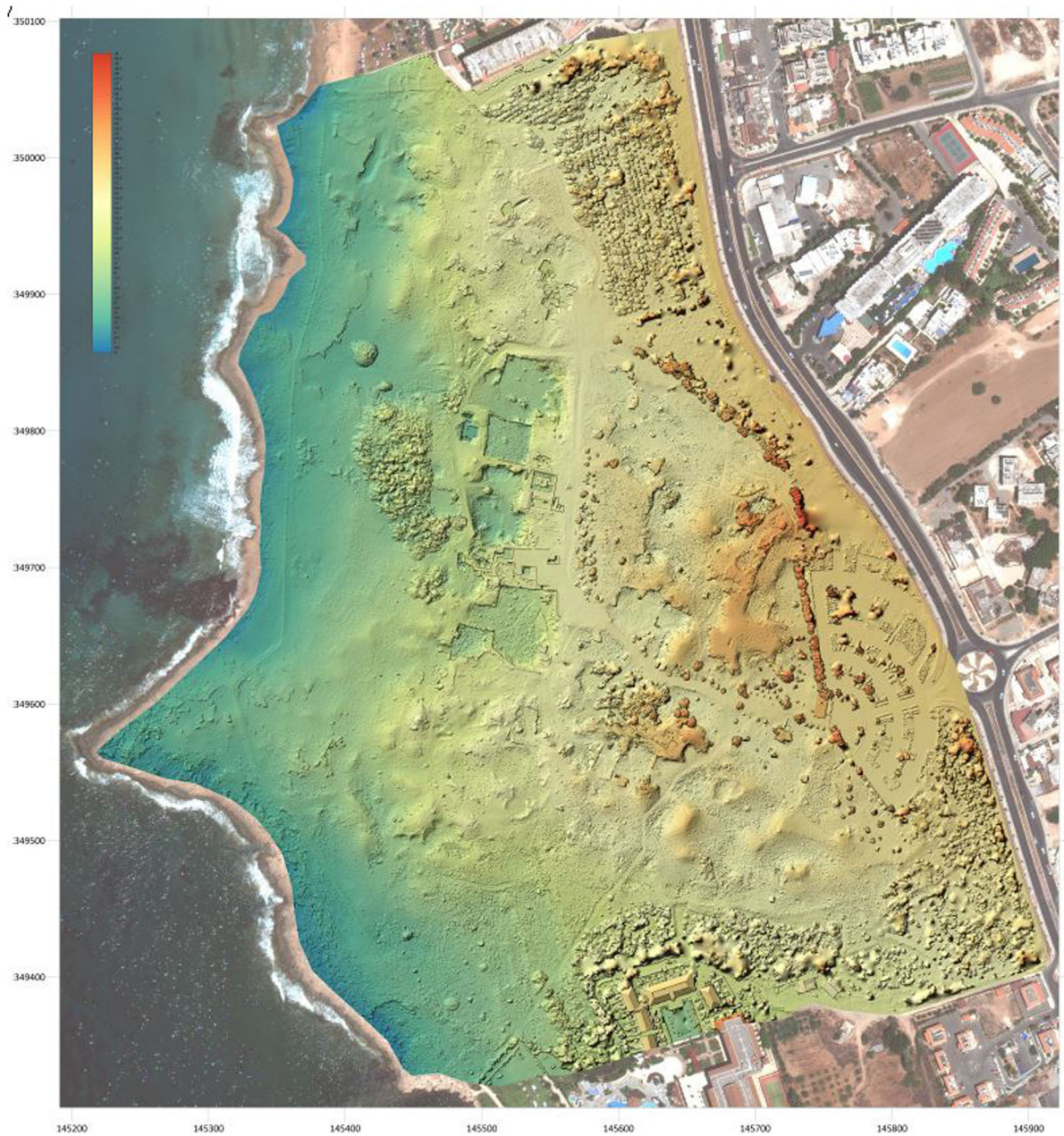

Fig. 16 Digital terrain model of one of the property's components (Source: the authors)

acquisition phase. Validation through the processing phase was done through numerous emails, on-site field checks and conference calls between CIMS, the GCI, and the DoA to verify decisions and discuss complications.

The project outputs were disseminated through numerous forms of digital deliverables and protocols in addition to personnel training and capacity building workshops.

Production of measured drawings

As Howard suggests, recording and description of a monument are quite separate from interpretation; that the former is intended as an accurate (within the limits set for the survey) statement of the current form of the archaeological structures, while the latter may change (and quite properly so) in the light of developments in the wider study of sites (Howard 2006).

For the preparation of line drawings, an accurate base record was produced from the photogrammetry and 3D scanning. This permitted limiting the degree of interpolation needed between the site and readable measured drawings that reflect the needs of the GCI and DoA for this project.

Fig. 17 CIMS and DoA teams collaborating in documenting the site, integral part of training efforts (Source: the authors)

Information system

GIS have become an essential tool in the research, management and conservation of archaeological sites. A GIS combines the collection of geographic data and other sources of information to generate/simulate scenarios pertinent to the site. The final GIS data were generated considering future use with different GIS software. The choice was to use traditional cartographic formats in a way that operators with commercial GIS software (e.g. ESRI ArcGis Pro or ArcMap), free or open-source GIS software (GRASS, QGis, etc.) or remote sensing packages (ERDAS, ENVI, PCI Geomatics, etc.) can handle the different files, without preliminary conversions (Fig. 14).

The different data were produced in the Cyprus reference system, starting from the GNSS coordinates measured in RTK. Raster and vector files have the reference system associated with the different files (e.g. 'prj' for vector formats) so that automatic georeferencing is possible after importing specific files.

The measured drawings divided by building or area were also integrated into the GIS (Fig. 15). The compiled line drawing is pre-loaded into the ArcGIS file with line weights and line types adjusted. Within the line drawings folder, one can also find a PDF describing the naming convention of CAD layers and a plot style file, which is set up to allow you to plot from AutoCAD with the proper colours and line weights.

A relational database has been set up to allow rapid information retrieval as well as the opportunity to add additional data. The proposed solution is a geo-database, which means that a geometric representation of specific objects is added to the GIS project. The visual-geometric representation allows users to access the database without working directly on the database tables. The structure of the database is based on a multi-level approach that starts from the wider 'objects' to the different elements (for instance: buildings ➔ rooms ➔ pavements) that belong to the previous level using a sequential strategy.

The previous products are only a subset of the produced deliverables. Other files were included in the GIS. For instance, aerial images produced in different years were provided by DoA. The official UNESCO boundaries available as a shapefile were provided by the DoA. Control points as shapefile with additional links to the witnesses of some specific points were established. Files related to water drainage and stream computation were made available as a raster file (slope) and vector shapefile (the computed streams). Also, hot spots with 360 degrees panoramic images have been linked to the GIS (Fig. 16).

Also, to provide better integrity to the dataset, the project team decided with the assistance of DoA to rectify pre-existing aerial photographs or drawings. These are just some examples that prove the richness of the final GIS database.

Capacity building

The Nea Paphos projects also involved a comprehensive training programme for Cypriot experts of the DoA, these experts where involved in every phase of the workflow to enable them to continue the documentation process after the CIMS team will leave (Fig. 17).

The time allocated for capacity building was equal to the time of acquisition and partially processing, which allowed meeting a very important ethical obligation to commit to providing training. This activity aligns with the ICOMOS Ethical Principles 'need for capacity building' (ICOMOS 2014) and the Seville principles statement 'heritage recording is a discipline that requires specific training' (International Forum of Virtual Archaeology 2011).

Conclusion

The collaborative approach developed for the recording of the as-found condition of Neo Paphos for its conservation and management planning has been very successful. It helps to illustrate how heritage recording ethical obligations can be met, in particular dealing with the production of an accurate heritage record, as well as ensuring the capacity of the Department of Antiquities in Cyprus to continue the work.

The Paphos example also serves to bridge the heritage recording work and ethical obligations. Many other case studies could be developed so that a comprehensive framework for encompassing relevant duties of heritage recording specialists involved in the conservation of heritage places can assist in improving the practice.

One of the critical goals of the framework is to ensure that the records produced are shared in the present and the future using sustainable strategies. This work emphasises the need to develop ethical benchmarks for utilising digital workflows that will respect the cultural heritage values of sites and the communities associated with them while allowing for the dissemination and secure storage of digital knowledge about places.

Further steps

Developing an inclusive and useful ethical framework for practitioners, which could be the basis of policy documents and doctrines requires a solid participative process. For this reason, it is planned to conduct the following activities:

- Organising several panels involving heritage recording specialists;
- Compiling and producing a publication with best (or good) practice examples that illustrate the fulfilment of obligations to meet the ethical principles; and
- Developing, updating and launching new doctrinal documents to assist heritage recording specialists with their work. Based on this, develop a ranking system to assess and accredit organisations recording heritage places.

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Competing interests

The authors declare that they have no competing interests.

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