From Ruins to Records: Digital Strategies and Dilemmas in Cultural Heritage Protection

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Abstract

This article examines the critical role of digital data in the preservation and protection of cultural heritage, particularly in contexts of armed conflict, climate change, natural hazards, and other human-induced threats. It explores how digital tools—such as remote sensing, open-source platforms, and 3D reconstruction—support risk preparedness, response, post-disaster recovery, and forensic documentation. Data management systems are central to risk mitigation efforts, enabling effective monitoring, assessment, and reconstruction of cultural heritage. Yet, the article also highlights significant challenges related to access, data sovereignty, intellectual property rights, and the equitable distribution of benefits—especially in the Global South. These efforts are further complicated by technical limitations, political constraints, and the persistent digital divide between the Global North and South. Ethical concerns surrounding digital heritage management—such as questions of control, decontextualisation, and the potential for digital colonialism—are critically examined. Drawing on case studies from the Global South and the Middle East and North Africa (MENA) region, the article sheds light on the complex intersections of conflict, climate change, and digital technologies in heritage preservation. It advocates for more inclusive, collaborative approaches to data management and for context-sensitive strategies that align technological innovation with principles of justice, equity, and human rights—ensuring that digital tools empower local communities rather than reinforce existing inequalities.

Keywords: Digital heritage; Heritage documentation; Remote sensing; Digital colonialism; Cultural heritage and conflict; Global South; Digital Ethics

Data, the methods by which it is collected, and its subsequent management are critical for assessing, preparing for, safeguarding, and mitigating risks to cultural heritage, particularly in the context of natural hazards, climate change, and armed conflict. Reliable data inform evidence-based risk modelling, damage assessment and disaster loss accounting, and forensic investigations of heritage destruction, all of which are integral to implementing sustainable disaster risk management. Employing standardised approaches and tools to gather, record, and disseminate information on risks to cultural heritage and heritage assets vulnerabilities is essential for refining and verifying risk assessment models. Such data further enable the formulation of realistic risk scenarios and the development of robust, evidence-based strategies for risk reduction (Romão and Rouhani).

Cultural heritage assets are particularly vulnerable to natural hazards, including flooding and earthquakes, necessitating robust risk assessment frameworks to mitigate potential damage. A multilevel approach to large-scale natural hazard risk assessment for cultural heritage should incorporate multiple stages of data collection and vulnerability analysis (Moratti et al.).

In this context, European Union member states are required to develop flood hazard and risk maps, as well as flood risk management plans that explicitly consider cultural heritage (European Commission). However, effectively assessing and managing disaster risk across extensive collections of cultural heritage assets presents significant challenges. Cultural heritage sites are uniquely complex, rendering conventional large-scale approaches inadequate. At the same time, conducting asset-specific data collection and detailed vulnerability assessments for every heritage site on a national scale is impractical due to the substantial resources required, even within the EU and other regions of the Global North (Rui Figueiredo, Xavier Romão and Paupério).

Pre-disaster baseline information containing details about the form, quantity, and condition of cultural heritage assets is likewise indispensable for evaluating the repercussions of disasters on service provision, governance, and overall impact. This will inform post-disaster needs assessment for the culture sector, and cultural heritage recovery and reconstruction (GFDRR et al.). Moreover, historical data on damage and losses provide vital insights for calibrating and validating disaster risk models. Effective data management ensures that information remains accessible and reusable, thereby promoting collaboration among diverse disciplines and organisations—an essential factor in managing responses to natural hazards.

A range of digital technologies, including Geographic Information Systems (GIS), mobile applications, machine learning, and cloud computing, is increasingly integrated into systems designed to monitor and mitigate

natural hazards, underscoring the indispensable nature of data management. Satellite imagery and remotely sensed data bring an unprecedented opportunity to archaeology and the cultural heritage sector for monitoring changes at the landscape and site level, enabling the interpretation of cultural heritage, as well as risk and condition assessments, and identifying potential hazards and their respective probabilities. Data management systems aim to bolster systemic data sustainability as well as the physical stabilisation of heritage through reactive, proactive, and responsive measures. They also supply requisite information to support the reconstruction of physical heritage and to document what exists, what existed, or what may not be present within collections, records, or physical structures.

At the core of data collection, interpretation, analysis, and management lies the transformation of geographical data into archaeological and cultural heritage data. This process presents numerous challenges across technical, methodological, ethical, and political dimensions.

Ensuring data accessibility and reusability on a practical scale necessitates clear allocation of rights and adherence to established standards for open-access licensing. Nevertheless, the ethical dimensions of data collection and management must also be considered, ensuring that data are used responsibly and that local communities' rights are respected, thus avoiding digital forms of colonialism. Traditional knowledge may be embedded into local disaster risk reduction measures, thereby reducing costs by diminishing reliance on external expertise. As such, the development of data management systems ought to include genuine stakeholder engagement, ensuring that resultant databases are both effective and sustainable, while accounting for the specific context's needs, capabilities, and limitations. In doing so, data-driven strategies can be devised that protect cultural heritage without compromising local values and practices.

Remote Sensing

Over recent decades, the advancement of technology and the increasing availability of open-source satellite imagery have significantly expanded the scope of risk and threat assessments for cultural heritage. Remote sensing provides invaluable tools for identifying and monitoring both anthropogenic and natural threats to heritage sites on a global scale. Enabling rapid documentation, remote sensing has been employed by heritage specialists and archaeologists since the twentieth century. The field has evolved beyond simple manual site identification towards more sophisticated methodologies for assessing hazards that impact, or have the potential to impact, preservation efforts. Various forms of satellite data facilitate the examination of the Earth's surface, enabling the analysis of both natural and human-modified environments. These techniques allow for the efficient surveying of vast areas, including regions that are otherwise inaccessible due to ~~natural~~ disasters or armed conflicts. As a result, remote sensing methodologies are now extensively applied, playing a transformative role in landscape archaeology and cultural heritage management.

Remote sensing data, alongside drone-based photogrammetry, has proven instrumental in evaluating damage to sites threatened by natural hazards, human land-use activities, and armed conflict. Additionally, satellite imagery has been effectively utilised to assess flood risks and damage modelling to urban structures and historic city centres and buildings (Gerl, Bochow and Kreibich). Declassified imagery from Cold War-era United States satellite programmes has emerged as a valuable resource for landscape archaeology and studies of land use and environmental change (Rayne, Rouhani and Makovics 117). The significance of this data lies in its ability to capture landscapes prior to contemporary transformations that have obscured numerous archaeological sites and heritage features. Remote sensing techniques are also extensively employed in the monitoring and documentation of archaeological sites and cultural heritage at risk due to large-scale development projects, such as dam construction (Rouhani and Nazari; Zaina and Tapete).

High-resolution imagery provides heritage professionals and researchers with detailed visual access to smaller sites, allowing for precise measurements and multi-spectral visualisations, thereby enabling more advanced analytical approaches. The vast repository of available data, when coupled with continuous improvements in computing power, presents increasingly sophisticated means of managing cultural heritage. Consequently, satellite imagery analysis is not only a tool for heritage documentation but also an essential component of risk preparedness and strategic planning.

Big data analytics and remote sensing technologies facilitate the near real-time detection of conflict-affected areas, offering significant value for the monitoring of World Heritage Sites classified as "In Danger", particularly in regions such as the Middle East. These advanced methodologies contribute to the development of early warning systems, enabling proactive intervention to safeguard world heritage from irreversible damage before it materialises (Levin et al.).

Integrating diverse datasets, such as GIS, remote sensing, historical maps, and excavation records, necessitates standardisation and thorough cross-referencing. However, this process is often complicated by variations in data formats, coordinate systems, and metadata structures. A significant challenge in archaeological information management, even within Europe, is the lack of coordination in establishing sustainable spatial data frameworks (McKeague et al.). These complexities pose even greater obstacles in the Global South, particularly in regions affected by crises, where the long-term sustainability of digital spatial information and technologies remains a critical issue.

Socio-political dynamics play a critical role in shaping the accessibility and application of satellite imagery and remote sensing in complex geopolitical contexts and conflict zones. These challenges encompass data restrictions, issues of national sovereignty, ethical concerns, and the potential for data misuse.

A pertinent example is the impact of the Kyl-Bingaman Amendment (KBA) in the United States, which, until recently, imposed limitations on the availability of high-resolution satellite imagery of Israel and Palestine (Zerbini and Fradley). Although non-U.S. satellite providers now offer higher-resolution data, the longstanding restrictions imposed by the KBA have fostered a perception that satellite imagery of these territories remains constrained. The Endangered Archaeology in the Middle East and North Africa (EAMENA) project at the University of Oxford has actively advocated for the amendment's reform to promote more equitable access to high-resolution imagery, thereby facilitating the monitoring of endangered archaeological sites in Palestine (Whitebloom). However, research in this field continues to be constrained by the legacy of the KBA, which, despite its partial relaxation in 2020, still affects access to high-resolution satellite imagery in Israel and Palestine. A recent initiative in Gaza highlights the crucial role of remote sensing in supporting teams on the ground amid the Israeli military operations that followed the Hamas attack on Israel in October 2023 ~~(Michael Fradley, Andrew Petersen and Finlayson).~~

Political decisions and government regulations on satellite imagery access can significantly impact the availability of high-resolution, up-to-date imagery in different parts of the world. In March 2025, the U.S. government suspended Ukraine's access to satellite imagery from Maxar Technologies' Global Enhanced GEOINT Delivery program, which provided commercial satellite data. This move was part of a broader halt in intelligence sharing aimed at pressuring Kyiv into peace talks with Russia (Reuters).

Remote sensing is a valuable tool for identifying archaeological and heritage sites; however, it is subject to various biases and constraints that impact its reliability in establishing cultural periods and archaeological certainty. A primary challenge lies in the difficulty of assigning precise chronologies to sites detected through satellite imagery, as such data often lack the stratigraphic and material context essential for accurate dating. As Flohr, Bradbury, and ten Harkel highlight in their study on Lebanon, a considerable number of heritage sites recorded in the EAMENA database are classified under an "unknown" cultural period due to the absence of supporting ground surveys (Flohr, Bradbury and Ten Harkel 320). This limitation results in the disproportionate representation of certain periods, particularly those with large architectural features that are more easily discernible in satellite images, while earlier or less monumental phases may go unrecorded. Additionally, the lack of field verification in some regions raises concerns about the accuracy of site identification. Landscape transformations, such as urban expansion, vegetation growth, and environmental changes further obscure archaeological features, exacerbating disparities in site documentation. These challenges underscore the importance of integrating remote sensing with ground-based surveys and historical records to mitigate biases and enhance the precision of archaeological interpretations. However, access to certain areas remains restricted due to conflict, political instability, geographical barriers, and other logistical constraints, further complicating efforts to obtain comprehensive and reliable heritage data.

In the MENA region, state authorities frequently regulate archaeological and heritage research through permit systems. Remote sensing, however, enables researchers to circumvent these bureaucratic constraints, raising ethical dilemmas regarding its legitimacy. Such concerns include the relationship between heritage sites and local communities, potential breaches of privacy, and the risk of exposing sensitive site locations to looting. These considerations underscore the need for responsible and ethically grounded approaches to the use of remote sensing in heritage studies, incorporating a humanitarian perspective and a 'do no harm' approach (Fisher et al.).

Heritage Recording

The destruction resulting from political instability, protests, and conflicts across parts of MENA, particularly following the events of 2010–2011 and the subsequent crises and conflicts in Syria and Iraq, has led to a surge in digital documentation initiatives aimed at recording damage and threats to the region's cultural heritage. The significance of documenting cultural heritage had already been well established within modern heritage conservation frameworks and charters, such as the Venice Charter of 1964 (ICOMOS "The Venice Charter"), and the 1996 Sofia Principles (ICOMOS "Principles for the Recording of Monuments, Groups of Buildings and Sites"). These frameworks acknowledge that cultural heritage is perpetually at risk and emphasise that documentation serves as a fundamental means of attributing meaning, understanding, and recognition to its values. The Sofia Principles specifically highlight the necessity of recording heritage when it is under threat from human or natural external forces, as well as during or following accidental or unforeseen disturbances that result in damage.

In 2007, RecorDIM (Recording and Documentation Information Management), a five-year international initiative (2002–2007) supported by the Getty Conservation Institute (GCI), published international standards for heritage documentation. Notably, experts participating in the Task Group of RecorDIM represented mostly institutions based in the Global North countries, with the highest representation from the UK, Germany, Canada, USA, and Italy. Other Global North countries were also present, while a few experts came from the Global South, including South Africa, Egypt, and Venezuela. This initiative recognised documentation as a fundamental activity in heritage asset management and sought to establish a unified framework to address thematic, technical, and data standardisation barriers. Such barriers often render documentation produced by individual projects or institutions incompatible and unusable by others (RecorDIM Task Group 16). The initiative ultimately led to a Getty publication outlining guiding principles on recording, documentation, and information management for the conservation of heritage places (Letellier, Schmid and LeBlanc 35).

The events following 2010 and 2011, alongside the rise of ISIS/Da'esh and the deliberate, targeted destruction of historical and cultural heritage in Iraq and Syria, led to the establishment of large-scale documentation projects. Advancements in technology and the increasing availability of high-resolution satellite imagery played a pivotal role in the development and expansion of similar large-scale documentation projects in other regions. Moreover, the rise of social media and its application in raising awareness and drawing attention to threats facing archaeological sites during conflicts and crises provided an additional valuable resource for information collection and heritage documentation.

Projects such as the Cultural Heritage Initiatives of the American Society of Overseas Research (ASOR) (Danti, Branting and Penacho) and the EAMENA project—a collaborative initiative between Oxford, Durham, and Leicester Universities in the UK, funded by the Arcadia Fund (Bewley R et al.)—have played a crucial role in documenting at-risk heritage sites across the MENA region. Similarly, the Syrian Heritage Archive, a joint initiative of the Museum for Islamic Art/Berlin State Museums and the German Archaeological Institute, has extensively focused on heritage documentation (Pütt). These projects employ a range of methodologies, including the analysis of satellite imagery, archival photographs, historical maps, media reports, and field documentation, to record and assess cultural heritage sites under threat.

In the realm of data management and storage, these projects typically employ advanced, state-of-the-art data management technologies and database systems. A prominent example is the open-source, web-based Arches software platform, initially developed and launched in 2013 by the GCI and the World Monuments Fund (WMF). Over the past decade, Arches has emerged as a foundational data management platform for numerous large-scale documentation initiatives, including EAMENA, Maritime Endangered Archaeology (MarEA), and ASOR CHI (Danti, Branting and Penacho 5).

Significantly, with the support of the Arcadia Fund, Arches has been adopted by a range of subsequent cultural heritage and archaeological documentation projects, expanding its geographic coverage across diverse regions of the Global South—including Mongolia, Central Asia, the Indus River Basin, and parts of Africa. The platform's development can be traced back to its predecessor, the Middle Eastern Geodatabase for Antiquities (MEGA)–Jordan, which was implemented by GCI and WMF in 2010 (Myers et al.). At the time, this initiative positioned Jordan at the forefront of archaeological data management in the Middle East, setting a precedent for digital heritage documentation in the region. Arches is a freely available, open-source data management platform designed for flexibility and customizability, allowing organisations worldwide to configure and extend it according to their specific needs while promoting interoperability and sustainable data practices,[1] and allows

user-defined semantic graphs (Fisher 60).

Nevertheless, the development and upkeep of advanced graph databases like Arches remain significantly impacted by the IT infrastructure and resources accessible to communities in the Global South. As a result, heritage organisations and antiquities departments in these regions have largely depended on the support of international institutions and documentation initiatives based in the Global North to establish and sustain their Arches implementations.

Documentation and the application of digital technologies have extended beyond the research and recording of destroyed sites on a large landscape scale. Numerous projects have utilised archival data to facilitate 3D reconstructions and the digital representation of endangered cultural heritage across various platforms. From holograms of the Buddha statues in the Bamiyan Valley of Afghanistan, destroyed by the Taliban (Delman), to an incalculable number of 3D projects reconstructing devastated archaeological sites in Syria and Iraq, digital technologies have played a pivotal role. ~~In particular, the classical site of Palmyra, which was destroyed by ISIS, has been the focus of extensive initiatives, employing digital technologies in diverse forms, including 3D printing, virtual reconstruction, and interactive platforms designed for public engagement.~~ In particular, the classical site of Palmyra, which was destroyed by ISIS, has been the focus of extensive initiatives, employing digital technologies in diverse forms, including 3D printing—such as the Palmyra Arch by the Institute for Digital Archaeology (IDA)—virtual reconstruction and 3D models by ICONEM in France[2], The Arc/k Project[3], and the Institute for the History of Material Culture of the Russian Academy of Sciences[4], as well as interactive platforms aimed at public engagement (Dieb, Alsalloum and Webb).

These projects, such as Palmyra 3D print and reconstruction, sparked some questions about context and benefit of these technologies in the context of conflict and contested cultural heritage. The IDA's 3D-printed replica of Palmyra's Arch of Triumph, displayed in London's Trafalgar Square, New York, and Dubai after the original was destroyed by ISIS in 2015, has become a focal point for ethical debate. Scholars have criticised the reconstruction for offering a depoliticised and overly celebratory narrative that ignores the complex realities of violence in Syria, including the Assad regime's contribution to destruction and the death of Syrian archaeologist Khaled al-Asaad (Khunti 2; Munawar 35). By bypassing the trauma experienced by local communities, the IDA project risks turning heritage into a spectacle divorced from its social and historical contexts (Khunti; Munawar). Digital heritage projects must be rooted in ethical frameworks that ensure local participation, context sensitivity, and transparent authorship—principles that were lacking in this case (Rouhani). As Stobiecka observes, the deployment of digital reconstructions in prominent Western locations transforms them into media events that serve institutional prestige rather than communal remembrance, reinforcing hierarchies of knowledge and representation (Stobiecka). ~~The arch's copyright protection~~ and the limited accessibility of its digital data exemplify digital colonialism, excluding Syrians from meaningful engagement with their own heritage (Khunti). Concerns have also been raised about the inauthenticity of the arch's material and scale, which reflect a visual rather than archaeological fidelity, contributing to a kind of "Disneyfication" of cultural heritage (Khunti 6; Munawar 42), or as Finlayson has noted, such practices risk promoting the notion that once archaeology is destroyed—regardless of the perpetrator—it can be authentically reconstructed without loss (Hopkins). Munawar warns against the hasty reconstruction of cultural sites during ongoing conflict, arguing that such actions can instrumentalise heritage for political ends, entrench power asymmetries, and erase local memory rather than support post-conflict healing (Munawar 43-44). Azzouz, a Syrian scholar, has observed that the growing international 'heritage industry' focused on the protection, documentation, and reconstruction of Syrian heritage has often transformed the pain and trauma of Syrian people into 'heritage projects'. These initiatives tend to prioritise the recovery of monumental sites and iconic landmarks, while marginalising the lived experiences, memories, and needs of the communities who inhabit or once inhabited these spaces (Azzouz).

Digital heritage must be approached not merely as technological replication but as a socially embedded practice. These projects must engage with questions of authenticity, accountability, and community agency to avoid repeating extractive dynamics under the guise of preservation.

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[1] https://www.archesproject.org/what-is-arches/

[2] https://app.iconem.com/#/3d/project/public/a67fd3c1-d923-46bb-86dc-e18394b0a5e9/scene/fbc5ae55-fc7d-4114-ac05-5dae7efb1e83

[3] https://the-arckives.org/

[4] https://palmyra-3d.online/en#3dmodel

Forensic Heritage

Cultural heritage is now being recognised as a human rights concern, with its intentional destruction classified as a war crime under the jurisdiction of the International Criminal Court (ICC) (Bennoune). Accordingly, the systematic collection of evidence and documentation of such acts is essential for legal proceedings and the pursuit of justice.

As Klosterkamp and Jeffrey observe, the "increasingly judicialised nature of international relations" places considerable emphasis on evidentiary practices in the prosecution of war crimes, as seen in contemporary conflicts such as the Russian invasion of Ukraine (Klosterkamp and Jeffrey). Such documentation not only facilitates the prosecution of war crimes specifically targeting protected cultural heritage, but may also serve as supporting evidence for broader international crimes. The deliberate destruction of cultural and religious sites and symbols can be indicative of genocidal intent, as it may reflect an effort to eradicate the identity of a targeted group. Additionally, damage to cultural heritage may demonstrate that civilian populations were intentionally targeted, thereby contributing to charges of crimes against humanity (Office of the Prosecutor).

The ICC actively supports the integration of advanced technologies in the collection of evidence. Tools such as digital recording, 3D imaging, satellite photography, 360-degree presentation software, and the geolocation of visual materials are increasingly employed in this context (Office of the Prosecutor 40). The proliferation of smartphones and social media platforms has also emerged as a valuable source of real-time data, offering critical documentation of potential war crimes.

In Ukraine, the real-time acquisition of digital evidence by organisations such as Mnemonic underscores the growing utility of open-source information in documenting violations, including the destruction of cultural heritage[5].

A forensic heritage approach must synthesise diverse and specialised methods of data collection and documentation to support judicial accountability, post-conflict recovery, and the broader understanding of contemporary human rights violations. As Daniels, Wegener, and Chang discuss, such systematic documentation by heritage professionals is particularly vital in contexts where national law enforcement capacities are constrained in the aftermath of conflict (Daniels, Wegener and Chang). Their proposed methodology includes activities such as on-site surveys, extensive photography, sketching, and the meticulous identification, collection, recording, and preservation of evidence (Daniels, Wegener and Chang 134-35).

However, there are considerable geopolitical obstacles to evidence collection. Klosterkamp and Jeffrey highlight the increasingly blurred lines between civilian and military actors, which complicates legal classifications of both targets and perpetrators. More critically, physical access to conflict zones remains a major impediment. In the case of Ukraine, the absence of secure conditions hampers the ability of investigators to gather eyewitness accounts and to conduct on-site documentation of violations (Klosterkamp and Jeffrey).

The process of evidence collection must be conducted with due sensitivity to local customs, cultural practices, and religious traditions. This includes engaging with, and incorporating the perspectives of, affected communities, especially women, minority groups, and cultural rights advocates, wherever feasible. The ICC's policy on cultural heritage underscores the necessity of working in collaboration with local experts and communities who possess contextual knowledge of the heritage in question (Office of the Prosecutor 37).

While many large-scale documentation projects primarily rely on remote sensing and limited fieldwork for data collection and monitoring—focusing predominantly on tangible heritage sites while maintaining a degree of detachment from local and living communities in at-risk areas—more recent initiatives have sought deeper emotional and cognitive engagement with these communities. Such projects aim to foster cultural heritage protection and enhance understanding of the atrocities faced by populations in conflict zones. The *Nobody's Listening* virtual reality (VR) exhibition exemplifies this approach by integrating art, technology, and advocacy to both memorialise and educate about the Yazidi genocide perpetrated by ISIS/Da'esh. Through immersive storytelling, the exhibition actively involves audiences in the difficult heritage of the Yazidi people, raising awareness about the genocide and the deliberate destruction of their cultural heritage (Rozhen Kamal Mohammed-Amin, Akrivi Katifori and Economou).

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[5] https://mnemonic.org and https://ukrainianarchive.org/en/investigations

Discussion: Critical Reflections on Risks and Digital Heritage Ethics

Ulrich Beck's concept of Risk Society describes how modern society has transitioned from focusing on material progress to managing the risks created by industrialisation and globalisation (Beck *Risk Society : Towards a New Modernity;* Beck *World Risk Society*). Unlike earlier societies concerned with overcoming material poverty, Beck argues that contemporary society is defined by the production and management of risks, many of which are unintended consequences of technological and industrial advancements. These risks, such as climate change, nuclear disasters, pandemics, terrorism, and financial crises, are often invisible, global in scope, and require expert knowledge to understand.

Beck's theory also introduces the idea of reflexive modernity, where society must constantly reassess and respond to the hazards it creates (Rasborg 85; Kovačević and Kovačević 10). He emphasises that these risks transcend national borders and social classes but are unevenly distributed, often affecting the less privileged disproportionately. Furthermore, he warns against the misuse of risk management by powerful entities, such as multinational corporations and wealthy states, for control and profit rather than environmental justice.

The risks of Risk Society include ecological destruction, social inequalities, economic instability, and manufactured uncertainties due to technological dependence.

This reflection on risks and endangerment has deeply influenced the cultural heritage sector as well, where the notion of vulnerability is a key driver of the modern and contemporary conservation movement. This is evident in UNESCO conventions, such as the 1972 World Heritage Convention, which states: *"Noting that the cultural heritage and the natural heritage are increasingly threatened with destruction, not only by the traditional causes of decay but also by changing social and economic conditions, which aggravate the situation with even more formidable phenomena of damage or destruction."(UNESCO "Convention Concerning the Protection of the World Cultural and Natural Heritage")* The 1954 Hague Convention addresses the threats posed by armed conflict to all forms of tangible cultural heritage (UNESCO "Convention for the Protection of Cultural Property in the Event of Armed Conflict").

Combined with growing concerns about the impacts of climate change on cultural heritage, inventorying, documentation, monitoring, impact assessments, and risk assessments have become increasingly significant in international cultural heritage conservation practices (UNESCO World Heritage Centre).

Over the past decades, a paradigm shift in heritage management and conservation approaches has been identified by organisations such as the International Council on Monuments and Sites (ICOMOS), an advisory body to UNESCO's World Heritage programme. This shift includes the recognition of heritage sites with little material culture to preserve, the acceptance of facsimile reconstructions of lost heritage sites, and the use of archaeological restoration and reconstruction to enhance site interpretation and improve public appeal and accessibility (Araoz 47). Moving away from the traditional emphasis on preserving materials, form, and space as the primary vessels of heritage value, digital recording and 3D technology have introduced the idea that degraded physical sites and assets can be reborn in digital form (Greenop and Landorf). This has given rise to the notion that documenting and archiving equate to saving, further entrenching expert-led approaches and strategies (Rico 125). Documentation and digital recording of ruins are no longer merely means of safeguarding memory as intangible, immaterial vessels for recalling the past; rather, they have gradually become heritage itself—a substitute for what is lost or deemed inaccessible. Recorded ruins are datafied—mummified in the sense that they are perceived as immortal, fixed, and frozen. Yet, they can also be interactive, immersive, augmented, and stored in digital clouds.

The mantra surrounding digitally reconstructed cultural heritage—often framed in terms such as "rebirth," "return," or "resurrection"—suggests that these projects offer more than just visualisations of lost or damaged sites. They carry documentary, scientific, aesthetic, social, political, and even economic value. Yet, these reconstructions raise critical questions about authorship, ownership, and control. Who governs this new digital heritage, and who stands to benefit from its multifaceted worth? Frequently, the communities historically and culturally tied to these sites are not the ones curating or profiting from their digital afterlives. Once embedded in the physical landscape and in the rhythms of local cultural and economic life, these places, though digitally accessible, can become remote—abstracted from their original context and community meaning. In this detachment, the reconstructed heritage risks becoming a simulacrum: widely shared but no longer rooted in the lived realities that gave it depth.

The collection and management of data—facilitated by digital technologies, newly acquired satellite imagery, and declassified satellite photographs from previous decades—have significantly accelerated and expanded, rendering nearly every location on the planet accessible for digital documentation, provided the necessary digital infrastructure and data analysis capacities are in place. While effective risk management and the implementation of mitigation and preventive measures for cultural landscapes and heritage sites require scientific risk assessment, hazard classification, the development of disaster risk scenarios, and vulnerability analysis of heritage features, this process is not without ethical, social, and cultural concerns, nor is it immune to potential political misuse.

In many parts of the world, particularly in the Global South, cultural heritage and archaeology are deeply entangled with colonial legacies, foreign interventions, espionage, and military activities (Meskell). Moreover, many of the methods and techniques employed in the collection of archaeological and heritage data—such as remote sensing, mapping, and aerial photography—are indebted to military and intelligence technologies (Pollock). Beyond the ethical questions surrounding methodological approaches and their potential risks to site protection, remote assessment and documentation—while often effective in overcoming geographical barriers and responding rapidly to threats—carry the risk of long-term disengagement by external 'experts' from the local context and its communities. The landscapes and so-called 'ruins' targeted by remote research are rarely inert or abandoned; they frequently encompass contemporary settlements, ongoing land use (Pollock 221), and the lived heritage of present-day communities, whose experiences and narratives are too often overlooked in distant documentation efforts.

Open Data

While the open access movement offers undeniable advantages—especially when aligned with the FAIR Principles of Findability, Accessibility, Interoperability, and Reuse[6]—archaeology faces particular challenges in balancing openness with responsibility. Making site data freely available can significantly aid research, education, and cross-border collaboration, but it also increases the risk of exploitation. In particular, the exposure of exact site coordinates can facilitate looting, illicit trafficking, or unauthorised excavations (Parcak), especially in regions already grappling with governance or security issues. In conflict zones or politically sensitive areas, the publication of condition assessments and management data can also be politicised—used to delegitimise current custodianship, undermine national narratives, or justify interventions under the guise of heritage protection. For instance, in 2024, the Israeli government approved a draft law expanding the Israel Antiquities Authority's jurisdiction to include archaeological sites in the occupied West Bank, justifying the move by claiming that Palestinians are damaging these sites and lack the means to preserve them (Geranpayeh). Moreover, some antiquities departments—particularly in the Middle East—remain wary of open data frameworks, preferring to retain control over access for reasons ranging from national sovereignty and intellectual property to the practicalities of site protection. There are also concerns about the digital divide: open data platforms often assume stable internet access, technical infrastructure, and the capacity to engage with digital tools—resources not equally distributed across global archaeological communities. Additionally, once data is released without restriction, it is difficult to monitor or control its interpretation, especially when it is decontextualised or used to support biased or revisionist agendas. Finally, questions around consent, community ownership, and ethical stewardship remain unresolved, particularly when dealing with Indigenous or local knowledge systems. These factors highlight the need for a more nuanced, context-sensitive approach to open access in archaeology—one that promotes transparency and collaboration, while safeguarding heritage from misuse.

Given that cultural heritage is increasingly recognised as a human rights concern under international humanitarian law (IHL), and that its deliberate destruction may serve as an indicator of other serious international crimes, the role of forensic heritage in providing evidentiary material for prosecutions has become significantly more prominent. Consequently, the documentation of heritage destruction and heritage-related crimes is not only of growing legal and judicial importance, but also at risk of becoming overly instrumentalised. In this context, questions concerning who collects and analyses such evidence, and by what means, become ever more critical.

Tensions may arise between the legal imperative for meticulous documentation of damaged cultural heritage and the aspirations of affected communities for rapid reconstruction, rehabilitation, and the alleviation

[6] https://www.go-fair.org/fair-principles/ (accessed 26 March 2025)

of post-conflict trauma. Hasty reconstruction efforts may inadvertently compromise or destroy potential evidence, while prolonged delays in recovery processes risk deepening psychological and social distress.

Moreover, the collection of testimonial evidence must be approached with sensitivity. Consideration must be given to the privacy and personal circumstances of victims and witnesses. Gathering testimony related to the destruction of cultural heritage—often deeply enmeshed with individual and collective identities—can be re-traumatising, underscoring the need for trauma-informed approaches in all aspects of forensic heritage practice, heritage documentation, and reporting on heritage destruction. Digital open-source research and documentation methods—built on publicly accessible online information—have been increasingly adopted by researchers and institutions working in the field of cultural heritage. The Berkeley Protocol on Digital Open Source Investigations (OHCHR and Human Rights Center at the University of California) outlines key principles to ensure the credibility and integrity of such work. These principles are grouped into three categories: professional standards relating to the competencies required of investigators; methodological guidelines concerning the processes and techniques of investigation; and ethical commitments that govern the responsible conduct of research.

Although there have been valuable efforts to use digital technologies to raise awareness about the intangible aspects of heritage affected by conflict and genocide, such initiatives remain relatively limited. Most attention still focuses on documenting endangered tangible heritage, often overlooking the potential of digital tools to convey stories and evoke emotional engagement. This imbalance is especially significant in post-conflict settings, where intangible heritage—such as oral traditions, rituals, and community knowledge—plays a crucial role in supporting resilience, rebuilding identity, and promoting healing across generations.

The digital recording and preservation of heritage raise important concerns about the long-term sustainability of data repositories. Challenges like uncertain funding, ageing infrastructure, and the risk of digital obsolescence threaten the continued accessibility and usefulness of heritage data. While some digital knowledge transfer does take place between institutions in the Global North and Global South, the rapid pace of technological change often outstrips the capacity of heritage organisations in less-resourced regions. Many such organisations depend on IT infrastructure, software, and cloud services provided by Global North institutions and large technology companies, reinforcing long-standing inequalities and dependencies.

Beyond the digital divide, more complex questions remain around the politics of how data is collected, managed, and shared. These include contested issues of collaboration, authority, and authorship, as well as the uneven distribution of benefits—material, symbolic, and epistemic—arising from digital heritage projects, where *material* refers to financial and technological resources, *symbolic* to institutional prestige and cultural recognition, and *epistemic* to control over how knowledge is created and validated. Addressing these concerns requires more than technical fixes—it demands ongoing ethical reflection and a strong commitment to fairness, transparency, and meaningful community involvement at every stage of digital heritage work.

Conclusion

In an era marked by technological acceleration, environmental uncertainty, and conflict, digital tools have become essential instruments for documenting, protecting, and interpreting cultural heritage. Yet, as this article has shown, these technologies also raise profound ethical, political, and philosophical questions. Digital heritage strategies must move beyond technical solutions to grapple with issues of sovereignty, community agency, and historical injustice. True resilience in heritage protection requires inclusive collaboration, ethical data stewardship, and a conscious effort to avoid reproducing colonial hierarchies in digital form. Only by aligning technological innovation with human rights, justice, and contextual sensitivity can cultural heritage be preserved in ways that honour both past and present communities.

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