



## Levant

The Journal of the Council for British Research in the Levant

ISSN: (Print) (Online) Journal homepage: <https://www.tandfonline.com/loi/ylev20>

# The use of remote sensing and digital tools for cultural heritage management and archaeological research

Andrew Wilson

To cite this article: Andrew Wilson (2021) The use of remote sensing and digital tools for cultural heritage management and archaeological research, *Levant*, 53:3, 384-388, DOI: [10.1080/00758914.2022.2051901](https://doi.org/10.1080/00758914.2022.2051901)

To link to this article: <https://doi.org/10.1080/00758914.2022.2051901>



© 2022 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group



Published online: 30 Mar 2022.



Submit your article to this journal [↗](#)



Article views: 600



View related articles [↗](#)



View Crossmark data [↗](#)

# The use of remote sensing and digital tools for cultural heritage management and archaeological research

**Andrew Wilson**

This conclusion to the Special Issue on *Endangered Archaeology in the Middle East and North Africa: Mapping, Heritage Management and Research* assesses developments in the use of satellite imagery for archaeological research in recent decades, and the potential to use the large EAMENA database, designed for cultural heritage management, for wider questions of archaeological research.

**Keywords** satellite imagery, aerial photography, remote sensing, endangered archaeology

The use of satellite imagery for archaeological purposes has developed considerably since David Kennedy's pioneering article on 'Declassified satellite photographs and archaeology in the Middle East: case studies from Turkey' (Kennedy 1998). We have moved from using monochrome satellite imagery, declassified several decades after it was taken, that has to be laboriously geo-referenced, to a world of high-resolution colour imagery, freely available in already geo-referenced form across the whole of the planet. Ground Sampling Distance or pixel resolutions of 40 cm or less are now available over large areas, making the detail of archaeological sites clearly visible. The modern imagery is accessible on platforms such as Google Earth Pro and Bing Maps which allow one to switch between satellite and map views, and have a large number of place names already marked on them to aid location and navigation across the virtual globe. Imagery from these platforms can also be loaded into GIS software as background layers over which detail can be plotted and annotated.

In addition to the technical improvements in the capability and coverage of satellite photography, and

in the platforms on which to view it, two major political and societal developments of a very different kind have helped drive the use of satellite imagery for archaeological research. The first is the Arab Spring of 2011, which plunged a large region across North Africa and the Middle East into revolution, civil warfare and instability, from which some countries have not yet emerged. In addition to the violence, destruction, loss of life and economic collapse, one of the many side-effects was a cessation or interruption of much archaeological fieldwork, followed by a dramatic contraction in the amount of fieldwork in many countries, especially that by foreign missions, even after some measure of stability was restored in some countries. Some archaeologists working in the region turned instead to desk-based survey using satellite imagery; and it was, of course, in response to the Arab Spring, and in particular the destruction wrought on archaeological sites in Syria, that the EAMENA project was founded, in order to document and record the archaeological heritage by means that did not require the investigator to be in a war zone (Ten Harkel *et al.* 2022). The second development was the COVID-19 pandemic, which from March 2020 put many countries of the world into full or partial lockdown and greatly restricted air

---

Faculty of Classics, School of Archaeology, University of Oxford, Oxford, UK. Email: andrew.wilson@arch.ox.ac.uk

travel; most facets of daily life were severely affected, among them archaeological fieldwork. Once more, some archaeologists unable to do excavation or fieldwork — or even to get to libraries — turned to satellite survey (e.g., Linares Matás and Lim 2021, for a ‘lockdown project’ on the archaeology of Mauritania).

The Endangered Archaeology in the Middle East and North Africa project was born out of a discussion I had in late 2013 with Maja Kominko, then grants officer for the Arcadia Fund, which focuses on endangered heritage and endangered nature, following an awareness-raising event about threats to the archaeology of Syria at St Hugh’s College, Oxford. A formal proposal was put together during 2014 and the project began with Arcadia funding in January 2015, initially as a collaboration between the Universities of Oxford and Leicester, with Durham joining in 2016. Although prompted directly by the Syrian civil war and the deliberate cultural vandalism perpetrated by ISIL/Daesh from 2014 onwards, the project covered a much larger area — Mauritania to Iran — and we quickly discovered that although the most high-profile destruction was war damage, the devastation of archaeological sites wrought by ISIL/Daesh, and looting following the collapse of effective state control in conflict-affected zones, by far the most widespread and significant threats in the aggregate were actually those posed by the normal processes of peacetime development. The inexorable march of progress brings with it urban expansion, agricultural intensification, infrastructure development and large-scale opencast mining. The practice of developer-funded investigation or excavation is not widespread in the Middle East and North Africa, and much archaeological heritage is, in practice, widely destroyed without record. National sites and monuments registers are incomplete. Departments of antiquities often lack resources and political influence. The situation in many countries recalls that of the UK in the 1970s, when the concept of ‘rescue archaeology’ or developer-funded archaeology was new, highly controversial and bitterly resisted by big business interests (e.g., Rahtz 1974). Lessons could still be learned from the rather inglorious track record of western European countries on cultural heritage protection in the decades of rebuilding after WWII, from the 1950s to 1980s. Here, however, the technological advantage of using essentially the same database platform as a sites and monuments record for several countries across the Middle East and North Africa, contrasts positively with the very

fragmented approach, not only within Europe, but within the UK (Ten Harkel *et al.* 2022).

The EAMENA project could not, of course, hope to solve the budgetary or political problems faced by departments of antiquities in the Middle East and North Africa. What it did aim to do was to record sites and to produce a database populated with data that could help departments of antiquities monitor threats to sites (Banks *et al.* 2017; Bewley *et al.* 2016; 2018; EAMENA database; Sheldrick and Zerbini 2017). Subsequent funding, from the UK’s Cultural Protection Fund, enabled us to train staff in departments of antiquities in eight countries (Tunisia, Libya, Egypt, Palestine, Jordan, Lebanon, Iraq and Yemen) in satellite imagery interpretation and the use of the EAMENA database for site identification, as well as for condition and threat assessment (Fisher *et al.* 2021; Hobson 2019). A particularly productive part of that engagement was the opportunity to use feedback from those training sessions to improve the database and make it more responsive, one hopes, to the needs of end users (cf. Mubaideen *et al.* 2022). Further welcome developments have been collaborative research projects undertaken between EAMENA staff and heritage professionals who attended the training sessions (Nikolaus *et al.* 2018), and research projects using EAMENA methodology conducted entirely by former trainees (Mekki 2021; Mubaideen *et al.* 2022).

Since the EAMENA database is designed to record site condition assessments and threats, as well as monitoring site conditions, it is a powerful tool for research on Cultural Heritage Management. The database, though by no means complete, has now reached the size where it can be used to address important issues at national and trans-national levels. What kinds of threats are most prevalent in each country? How much damage is looting doing to sites? Can evidence of looting, from analysis of dated imagery of sites, be correlated with the chronology of sales on e-Bay of antiquities characteristic of the region in which those sites are found? How does damage from looting or warfare compare to, for example, intensification of agriculture, or urban expansion? Are there particular types of site that are most at risk? What is the impact on the archaeological heritage of dam construction schemes? What is the effect of climate change and of coastal erosion/sea-level change?

But in addition to questions of cultural heritage management, as a single database covering a very large region, the Endangered Archaeology in the Middle East and North Africa project’s database is also an extraordinarily rich resource for

archaeological academic research. It contains over 333,000 records on archaeological sites, their condition and threats to them. These include geolocated historic air photos and over a hundred thousand aerial photographs from APAAME (the Aerial Photographic Archive for Archaeology in the Middle East; <http://www.apaame.org/>), across 20 countries from Mauretania to Iran. The quantity of data now entered means that the database has achieved critical mass and the time is ripe to use it for research aimed at broad regional questions with an archaeological focus. It is particularly well suited to questions involving the spatial distribution of classes of sites, of particular periods.

There are, of course, trade-offs between the date and quality of aerial and satellite imagery, which affect its usefulness for archaeological research. More recent imagery is high-resolution and colour, and tends therefore, to reveal more features in the landscape — where that landscape has not already been destroyed. Ground pixel resolutions of 40 cm are common, and some 25 cm imagery is now available and will, doubtless, become more common in the future. By contrast, older declassified satellite imagery, such as that produced by the CORONA missions (1959–72), is greyscale and of lower resolution — but it shows the landscape in the 1960s and 1970s, prior to much of the large-scale urbanization and agricultural intensification of recent decades. By the same token, aerial photography, where available, may be of even earlier date — sometimes from the first half of the 20th century — and shows sites or landscapes in a form even less affected by modern development. There is, in fact, no reason to restrict oneself to just using satellite imagery, and the integration of aerial photographic archives into survey research is essential. It is, however, more difficult to access than the planet-wide blanket coverage of satellite imagery now available on, for example, Google Earth Pro and Bing Maps, being scattered among different physical archives, often with catalogues that are not fully or easily accessible online. Coverage is patchy, and photographs may require scanning, and would usually require geo-referencing. The availability, therefore, of digitized and geo-referenced photographs in the EAMENA database is a helpful step. But there is much more to find and to use, and the paper in this volume by Fradley (2021) is a very useful guide on the development, location and current state of British photo archives of the Middle East. The contribution by Izzo *et al.* (2022) is a very good illustration of how historic aerial photographs — going back as far as German WWI imagery

of 1918 showing features now long destroyed — can, in combination with satellite imagery and existing survey data, be used together to assemble a diachronic picture of settlement and land use in the Jericho Oasis.

For much of the Middle East (and also North Africa), apart from Israel and Palestine, the quality of freely-available satellite imagery became good enough, from 2010 onwards, to identify archaeological sites, and the use of such imagery was immediately incorporated into ongoing survey projects (Winterburn 2021, for sites on the Hejaz railway; cf. also, in Libya, Sterry *et al.* 2011). Image quality for Israel and Palestine was until recently artificially restricted to much lower resolutions, usually, from 2007 onwards, no better than 2 m GSD, because of the Kyl-Bingaman amendment to the 1997 US National Defense Authorization Act, which prevented US satellite imagery suppliers (then dominant in the market) from releasing imagery of Israel and Palestine at a resolution higher than that otherwise commercially available. Very high resolution imagery of these regions, at sub-metre resolution, has actually been commercially available from non-US firms since 2012 (Zerbini and Fradley 2018), something the US has eventually recognized (Whitebloom 2020), with the result that higher resolution imagery of Israel and Palestine is now becoming available. It is to be hoped that this will facilitate research on these areas in a manner comparable to that experienced by the rest of world over ten years ago, following the advent of higher resolution imagery.

The remote sensing approach has, of course, its limitations. As with aerial photography, sites may be identified from satellite imagery, but they can rarely be closely dated from the imagery alone — unless they are sites of a morphological type with a restricted chronological range (e.g., the ‘playing card’ shape of some Roman forts). Dating, and anything more than a basic interpretation of function, generally requires follow-up work on the ground, or ‘ground-truthing’. In some cases, the archaeological data can be augmented by entering information on date, type and function, for sites already known from previous survey or archaeological work. But these deficiencies are, to some extent, compensated for by the sheer quantity of sites recorded through remote sensing, especially in desert and steppe areas. It becomes possible to perform settlement or site analysis on a landscape scale, as shown by Flohr *et al.* (2021) (this volume), where the comparison of sites across different parts of Lebanon reveals the density of archaeological sites in upland areas that have not been so well

explored archaeologically, and which have, traditionally, been thought to be less rich in archaeological remains. The paper by Ten Harkel and Fisher (2021) illustrates how the database can be used to identify — in this case for the Crusader period — types of archaeological site that would benefit from further investigation, and themes that require further research.

The work on the defended landscape of the Hejaz Railway, undertaken by the Great Arab Revolt Project (Winterburn 2021), is a good example of an iterative methodology whose fieldwork, from 2010 onwards, benefited from the availability of high-resolution satellite imagery. The project began with archive work and satellite survey, then fieldwork/ground-truthing of sites along the railway; and then further work on condition assessment and feature interpretation from satellite survey.

The Amman Heritage Houses project uses the EAMENA database in a different way (Mubaideen *et al.* 2022). Rather than use satellite imagery to *identify* sites, it uses the database to locate accurately on the satellite imagery houses already known to be of heritage value, to map their spatial extent, to record details acquired through archival work and ground survey, and to identify condition, disturbances and threats (Mubaideen *et al.* 2022). This paper provides a reaction to and dialogue with the database design, since it was not written by EAMENA project staff, but rather by Jordanian users of the database who are heritage professionals trained in the CPF-funded work. Their input will help shape the database as a tool for future heritage management.

Although the EAMENA database is designed with cultural heritage management in mind, and is optimized for that purpose, it is also a tool with great potential for wider archaeological research. It holds a large dataset of geolocated records of archaeological sites, with information on site classification and period, and provides a portal for accessing geolocated aerial photographs as well as satellite imagery. It covers a vast area and incorporates a combination of sites known from previous research and survey, as well as sites newly discovered from satellite photographs. It provides researchers with a starting dataset, for any area within the Middle East and North Africa, which can be exported and then mapped and analysed in a GIS program over any baseline imagery the user wishes.

## Acknowledgements

I thank all those, too numerous to name here, who have worked on and with the EAMENA project

since 2015. I am deeply grateful to Arcadia, a charitable fund of Lisbet Rausing and Peter Baldwin, for generously funding the EAMENA project, and to the UK's Cultural Protection Fund for funding the training programmes from 2017–2021.

## References

- APAAME (Aerial Photographic Archive for Archaeology in the Middle East): <http://www.apaame.org/>.
- Banks, R., Fradley, M., Schiettecatte, J. and Zerbini, A. 2017. An integrated approach to surveying the archaeological landscapes of Yemen. In: Starkey, J. (ed.), *Proceedings of the Seminar for Arabian Studies*: 9–23. Oxford: Archaeopress.
- Bewley, R., Bradbury, J. and Zerbini, A. 2018. Endangered archaeology in the Middle East and North Africa. *Bulletin of the British Foundation for the Study of Arabia* 23: 60–62.
- Bewley, R. H., Wilson, A. I., Kennedy, D., Mattingly, D., Banks, R., Bishop, M., Bradbury, J., Cunliffe, E., Fradley, M., Jennings, R., Mason, R., Rayne, L., Sterry, M., Sheldrick, N. and Zerbini, A. 2016. Endangered archaeology in the Middle East and North Africa: introducing the EAMENA project. In: Campana, S., Scopigno, R., Carpentiero, G. and Cirillo, M. (eds), *CAA2015. Keep the Revolution Going: Proceedings of the 43rd Annual Conference on Computer Applications and Quantitative Methods in Archaeology*: 919–32. Oxford: Archaeopress.
- EAMENA database. Available at: <<https://database.eamena.org/en/>>.
- Fisher, M., Fradley, M., Flohr, P., Rouhani, B. and Simi, F. 2021. Ethical considerations for remote sensing and open data in relation to the endangered archaeology in the Middle East and North Africa project. *Archaeological Prospection* [e-journal] 2021: 1–4. Available at: <<https://doi.org/10.1002/arp.1816>> [Accessed February 2022].
- Flohr, P., Bradbury, J. and Ten Harkel, L. 2021. Tracing the patterns: fields, villages, and burial places in Lebanon. *Levant* 53(3). doi.org/10.1080/00758914.2021.1968114
- Fradley, M. 2021. British inter-war aerial photogrammetric mapping in the MENA region: archives, access and research potential. *Levant* 53(3). doi.org/10.1080/00758914.2021.1992879
- Hobson, M. S. 2019. EAMENA training in the use of satellite remote sensing and digital technologies in heritage management: Libya and Tunisia workshops 2017–2019. *Libyan Studies* 50: 63–71.
- Izzo, P., Fradley, M. and Zerbini, A. 2022. Snapshots from the past: discoveries and destruction in the Jericho Oasis. *Levant* 53(3) doi.org/10.1080/00758914.2021.2015891
- Kennedy, D. L. 1998. Declassified satellite photographs and archaeology in the Middle East: case studies from Turkey. *Antiquity* 72 (277): 553–61.
- Linares Matás, G. J. and Lim, J. S. 2021. Monumental funerary landscapes of Dhar Tagant (south-eastern Mauritania): towards ethical satellite remote sensing in the West African Sahel. *Archaeological Prospection* 28: 357–78.
- Mekki, H. 2021. Documentation et gestion du patrimoine archéologique de la chaîne montagneuse tuniso-libyenne via l'utilisation des nouvelles technologies: résultats préliminaires. *Libyan Studies* 52: 71–86.
- Mubaideen, S., Salameen, D. and Al Momani, R. 2022. Using the EAMENA database to document modern heritage: the Amman Heritage Houses, Jordan, case study. *Levant* 53(3). doi.org/10.1080/00758914.2021.2019412
- Nikolaus, J., Mugnai, N., Rayne, L., Zerbini, A., Mattingly, D., Walker, S., Abdrbba, M., Ahmed al-Haddad, M., Buzaian, A. and Emrage, A. 2018. Training, partnerships, and new methodologies for protecting Libya's cultural heritage. *Quaderni di archeologia della Libya* 21: 351–58.
- Rahtz, P. (ed.) 1974. *Rescue Archaeology*. London: Penguin.
- Sheldrick, N. and Zerbini, A. 2017. A heritage inventory for documenting endangered archaeology in the Middle East and North Africa. *ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences* IV-2: 237–41.
- Sterry, M., Mattingly, D., Ahmed, M., Savage, T., White, K. and Wilson, A. I. 2011. DMP XIII: reconnaissance survey of archaeological sites in the Murzuq area. *Libyan Studies* 42: 103–16.



- Ten Harkel, L. and Fisher, M. T. 2021. The EAMENA database and its potential impact on research and heritage management: a case study of Crusader heritage in Lebanon. *Levant* 53(3). doi.org/10.1080/00758914.2021.1988474
- Ten Harkel, L., Fradley, M., Flohr, P., Vafadari, A. and Neogi, S. 2022. Documenting heritage in the 21st century: the EAMENA project and its potential for 'big data' research in Levantine archaeology. *Levant* 53(3). doi.org/10.1080/00758914.2021.2037890
- Whitebloom, S. 2020. *Oxford Archaeologists Win Access to Restricted Satellite Images of Israel and the Palestinian Territories* [Online]. Available at: <<https://www.ox.ac.uk/news/arts-blog/oxford-archaeologist%20s-win-access-restricted-satellite-images-israel-and-palestinian>> [Accessed 15 September 2020].
- Winterburn, J. B. 2021. The late Ottoman defended landscapes along the Hijaz railway in southern Jordan. *Levant* 53(3). doi.org/10.1080/00758914.2021.1988247
- Zerbini, A. and Fradley, M. 2018. Higher resolution satellite imagery of Israel and Palestine: re-assessing the Kyl-Bingaman Amendment. *Space Policy* 44–45: 14–28.