



# Building an Integrated Database of North-Eastern African Archaeological and Heritage Sites for Mapping Complex Social Landscapes

DATA PAPER

DAVID LAGUNA-PALMA 

MAURIZIO TOSCANO 

CARLOS RODRÍGUEZ-RELLÁN 

\*Author affiliations can be found in the back matter of this article

 ubiquity press

## ABSTRACT

This dataset contains archaeological and heritage sites of the Marmarica region (NE-Libya/NW-Egypt), ranging from the Late Bronze to the Roman times. It has been developed in the framework of the PERAIA project, which aims to analyse the long-term history and interaction patterns along the harsh environments of north-eastern Africa. The records contain accurate geographic location of sites, including place names, typology, chronology, and metadata of documented remains, along with information regarding the environmental and ecological context. Additionally, the dataset accounts for the specificities of the region's varying environmental conditions and their potential impact on archaeological heritage. All this information associated with each archaeological site was collected from published field data surveys, maps, archaeological reports, and it was subsequently cross-checked with historical aerial photographs and satellite imagery to detect, and to register known and unknown sites within the study area. Regarding the potential reuse of all this data, the dataset is deposited on the project website and linked to Zenodo.

## CORRESPONDING AUTHOR:

**David Laguna-Palma**

Department of Prehistory and Archaeology, University of Granada, Spain

[dlaguna@ugr.es](mailto:dlaguna@ugr.es)

## KEYWORDS:

Mapping; cartographic analysis; GIS; endangered heritage; Marmarica; Open Data

## TO CITE THIS ARTICLE:

Laguna-Palma D, Toscano M, Rodríguez-Rellán C 2023 Building an Integrated Database of North-Eastern African Archaeological and Heritage Sites for Mapping Complex Social Landscapes. *Journal of Open Archaeology Data*, 11: 5, pp. 1–10. DOI: <https://doi.org/10.5334/joad.99>

## (1) OVERVIEW

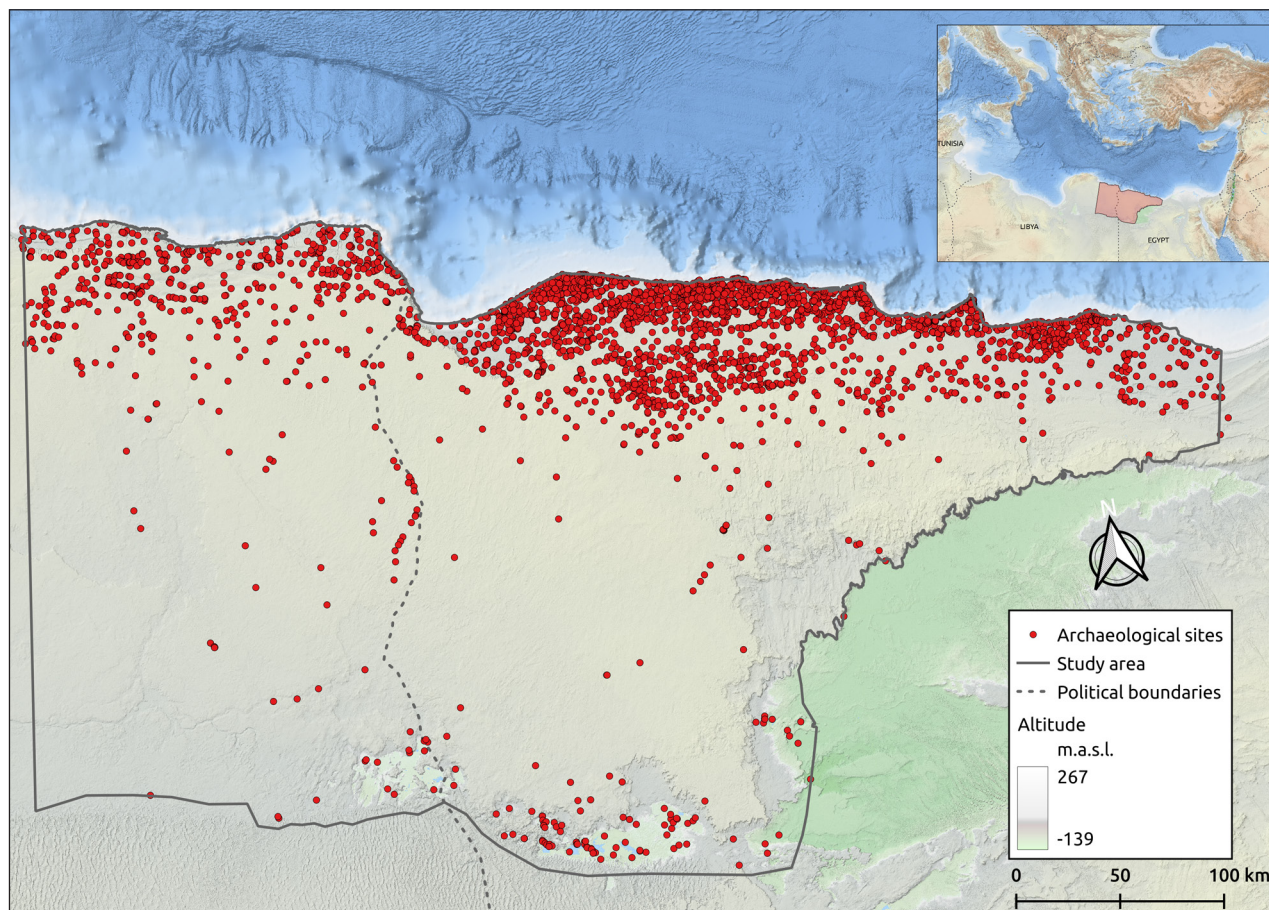
### CONTEXT

Marmarica is a region located in north-eastern Mediterranean Africa, covering areas of present-day Libya and Egypt. Although Marmarica is not a well-defined geographical entity, its limits can be set at the Libyan Sea (Mediterranean Sea), to the North; the margins of the Libyan desert, to the South, and the borders with Cyrenaica (Jebel Akhdar, the “Green Mountain”), to the West. In its Eastern part the boundaries are much less clear, so we used the limits of the Qattara depression to define the study area [9, 10] (Figure 1). From a bioclimatic point of view, Marmarica is mainly characterized by its semi-arid and arid conditions. Meanwhile, its orography varies from stepped gullies in the North, to the great plains sloping down to the south occupying much of the region. At a more detailed scale, the presence of numerous dry riverbeds with potential seasonal flooding -known as wadis-, especially in the coastal zone, and a few oases in the South (mainly al-Jaghub in Libya and Siwa in Egypt) should be highlighted [10, 14].

From a historical and archaeological point of view, the special relevance of this region lies in the fact that it became a transit point between two key areas: the Nile Valley and Cyrenaica. Alongside this East-West mobility, multiple North-South connections have been documented

between the coastal settlements and the inland oases [12]. In view of these circumstances, it is fundamental to consider the mobility patterns along these semi-arid and arid lands and their contribution to the development of settlement and livelihood strategies. Water scarcity was a factor that had a clear impact on the socio-spatial organisation of settlement, agriculture, and pastoral activities of ancient societies, but it would undoubtedly also have affected the way these communities would have moved through the landscape [5]. Nevertheless, its frontier character and environmental conditions might contribute to defining Marmarica as “marginal”. Notwithstanding, Rieger [9] has pointed out the “importance and value of studying marginal habitats, spaces, and socio-economic practices”, especially when some approaches “have been proven to be too simplistic and static”. This is precisely the case of Marmarica, an archaeological understudied region, mainly seen through textual and iconographic sources produced by the neighbouring groups.

To infer human mobility in such a context, it is common to locate settlements, watering places, and archaeological remains scattered across the landscape that serve as proxies to be integrated into GIS platforms to represent interrelationships with other geographical and environmental data. This procedure has been conducted by tying together various strands of evidence, from satellite imagery, historical resources, and environmental



**Figure 1** Map of the Marmarica region displaying the sites documented during the project.

data. Our aim has been to establish a comprehensive open-access dataset of archaeological sites to provide a deeper archaeological and historical understanding of North African heritage (Figure 2); and, at the same time, to trace the network representation of human mobility and interaction patterns in harsh environments along the vast region of Marmarica.

### SPATIAL COVERAGE

WGS 84/UTM zone 35N [projected] [EPSG:32635]

Description: North-eastern Libya; North-western Egypt.

Northern boundary: 3608798 m

Southern boundary: 3164641 m

Eastern boundary: 711754 m

Western boundary: 95617 m

### TEMPORAL COVERAGE

Late Bronze Age to the Roman period of present-day Egypt and Libya (ca. 1400 BC – 600 AD).

The temporal framework developed for this research is based on the chronology suggested on the Digital Egypt for Universities website, a learning and teaching resource developed by the University College London (UCL) [3]. The complete set of temporalities was established as follows: sites are defined into temporal brackets of human occupation predominantly identified by pottery

sherds, soil sedimentation analysis or architectural features identified during field surveys or published archaeological reports. The information contained in the field “Temporalities” of Table 1 corresponds to the chronology assigned for each site in the database.

TEMPORALITIES	CULTURAL PERIOD	DATE
Late Bronze Age	New Kingdom	15th – 11th BC
Early Iron Age	Third Intermediate period	11th – 7th BC
Archaic (Iron Age)		
Classical	Late period	7th – 4rd BC
Hellenistic	Ptolemaic period	4rd – 1st BC
Roman	Roman period	1st BC – 3rd AD
Late Roman	Late Roman period	3rd – 7th AD

Table 1 Chronological scheme.

## (2) METHODS

### STEPS

The development of the data model was a fundamental preliminary step. The design was based on a solid, yet modular structure for the spatial database, with the aim of storing and managing all the data associated with

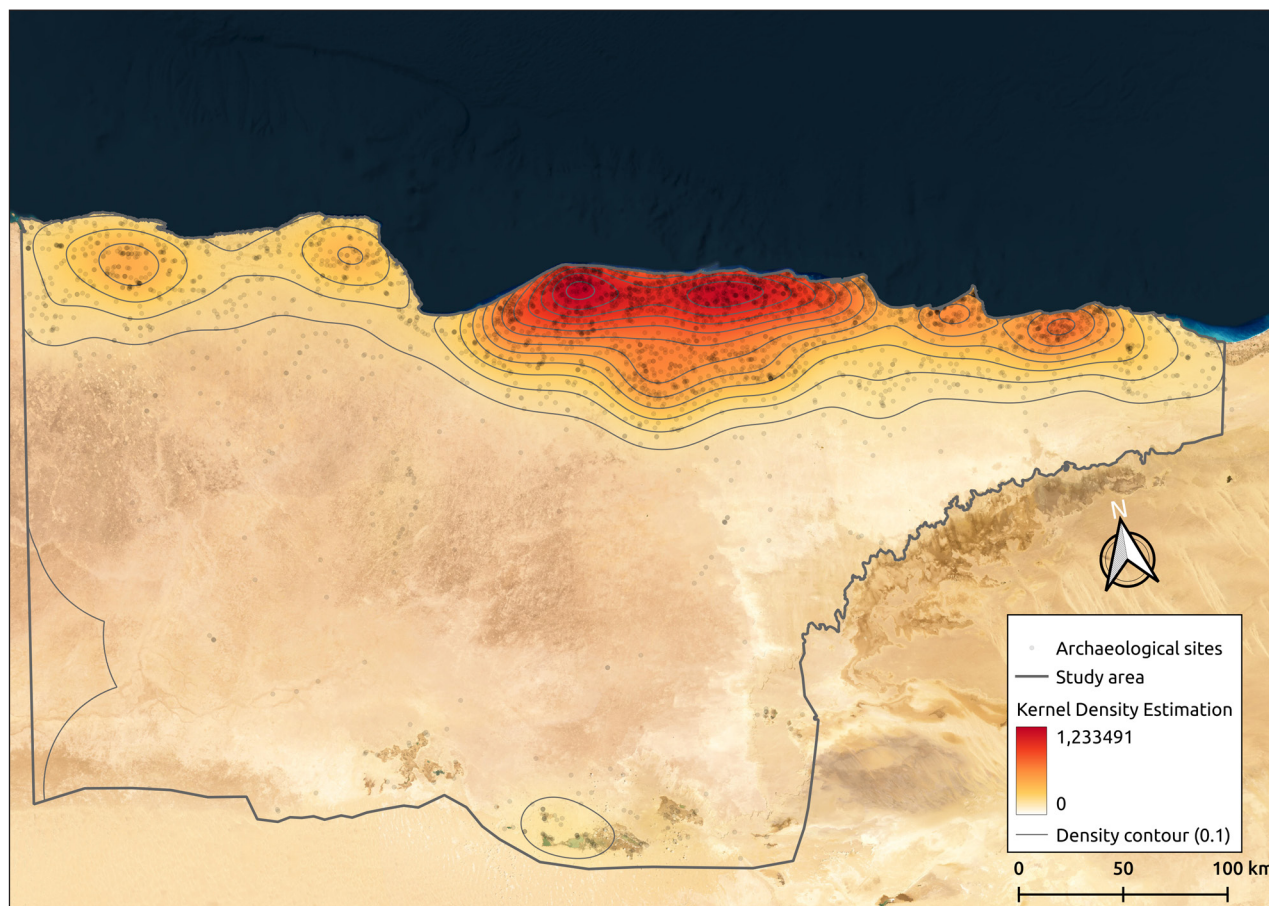


Figure 2 Kernel density shows a high cluster of archaeological and heritage sites mostly along the coast and inland oases.

each site (Table 2). The goal was to develop a model adaptable to the research questions of the project and, at the same time, extend its inferential capacity considering ontologies and controlled vocabularies shared with other projects working with Open Data (Figure 3) ([1, 4, 17] among others).

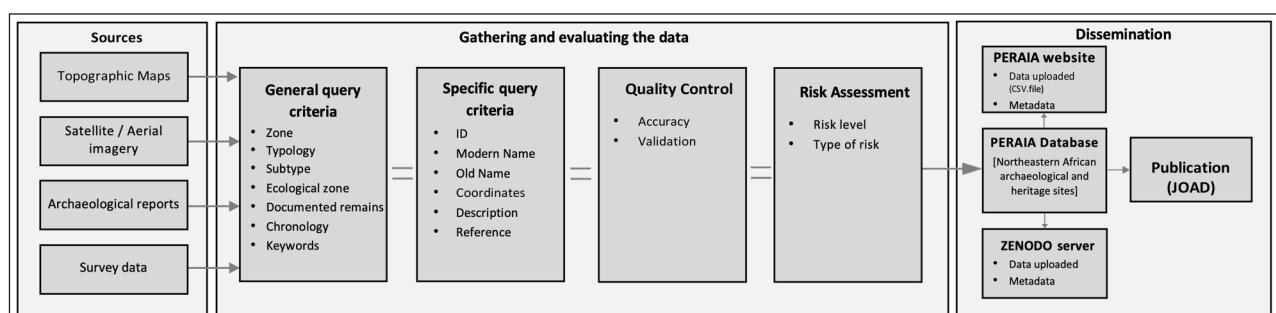
VARIABLE	TYPE	EXAMPLE
ID	string	PE_00002
Zone	numeric	2
Modern_Name	string	Bates's Island
Old_Name	string	Unknown
Coord_x	numeric	27.266849
Coord_y	numeric	31.361078
Accuracy	string	High
Validation	numeric	4
Type	string	Settlement
Subtype	string	Harbour
Eco_Zone	string	Coastal zone and northern tableland
Risk_Level	string	High
Cod_Risk	string	2, 3, 4
Remains	dichotomous	Yes
Chronology	string	Late Bronze Age, Early Iron Age, Archaic, Classical, Hellenistic, Roman, Late Roman
Keywords	string	Marmarica coast, Marsa Matruh, Shells, Cannanite amphora, Cypriot pottery, Trade, Ships
Description	string	Island settlement. Crete, which lies ca. 420 km northwest of Matruh, was perhaps the final point west for eastern Mediterranean traders
Biblio_ref	string	(White, D. 1986: 51–84)

**Table 2** Database record structure.

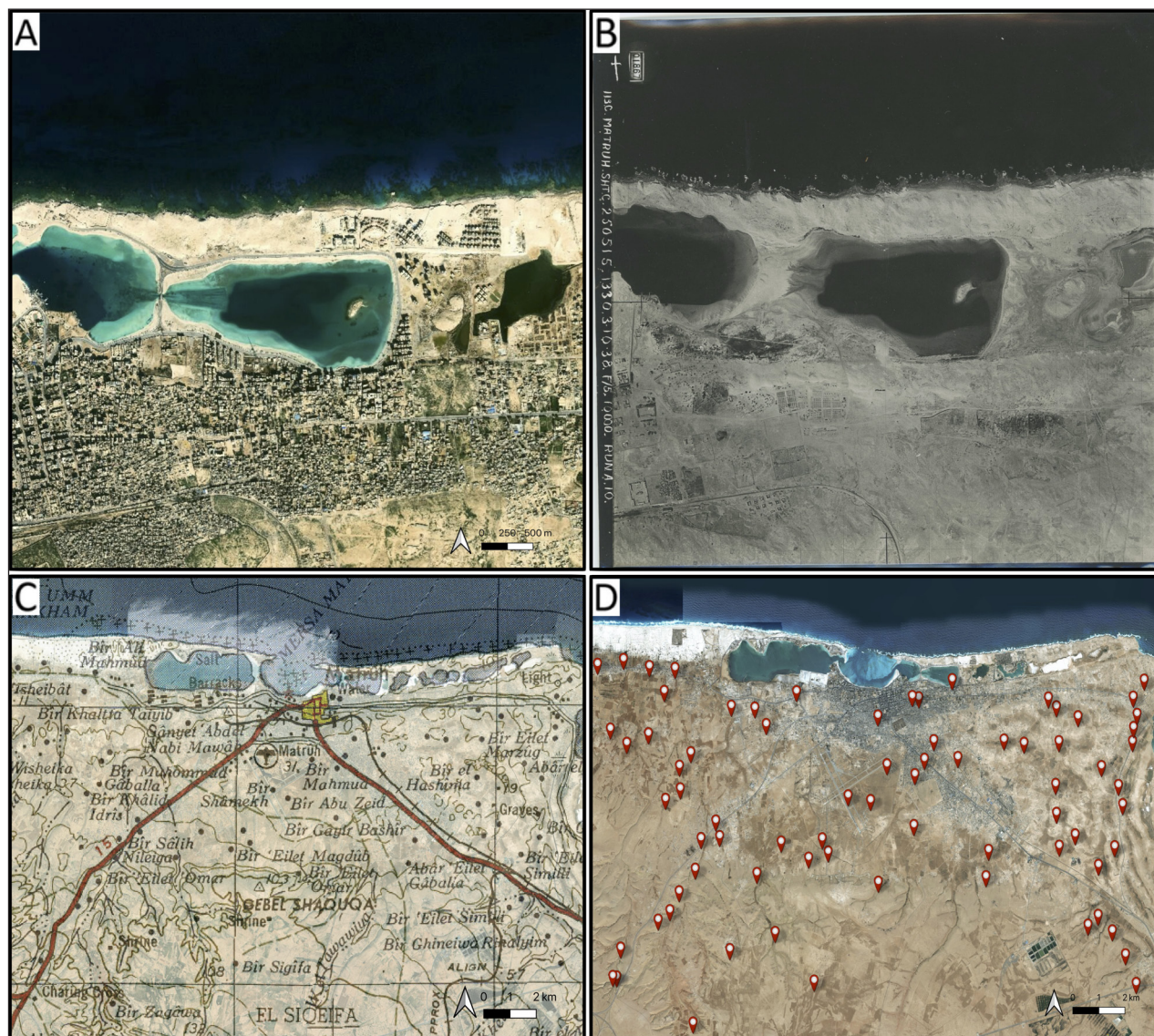
The current situation of the data available for the study region prompted the use of different sources to collate and obtain more information on archaeologically underrepresented areas. To this end, we carried out an aerial survey through photo-interpretation aimed at the identification of known and unknown archaeological and heritage sites in the study area, using satellite imagery and historical aerial photographs, combined with data from field surveys and georeferenced topographic maps<sup>1</sup> (Figure 4). This last set of maps contains relevant information about the region, such as topographical features, water places, settlements, or traditional paths. Interpreting satellite imagery has made it possible to map and to record archaeological and heritage sites across large areas and places where access would not otherwise have been possible [7, 8, 11]. This procedure had two main outcomes: first, it led to a better understanding of the spatial organisation of the territory and the location of features in the landscape; second, it allowed for a digitally mapping and recording of the ancient archaeological and heritage sites, along with geographical and environmental data inside the study area (i.e., how sites interrelate and form complex social landscapes).

### SAMPLING STRATEGY

All data were collected in ArcGIS 10.5. The GIS platform enabled us to georeference the imagery and historical sources in order to identify and register each archaeological site in its geographical location within the study area. In addition, the information from available published surveys and archaeological reports completes the dataset. In this sense, several aspects regarding the long-term human occupation of Marmarica need to be addressed. Evidence for water harvesting and management of historical agropastoral production ranging from the second millennium BC onwards can be used to trace the historical human activity in the region [6, 9, 10, 12, 13, 14, 15]. To this end, our recording has not only been focused on historical settlements and burial places but also on productive areas and watering places (cisterns). These last two locations arguably act as junction nodes; by extension, these sources can be used for the reconstruction of mobility patterns within the region and their connections to other surrounding areas.



**Figure 3** Conceptual model of data collection, validation, and dissemination process.



**Figure 4** Digitisation process of the Mersa Matruh area (NW-Egypt) based on the cross-checking of different sources. **(A)** Satellite imagery showing changes to its coastline and present-day urban expansion; **(B)** Historical aerial photograph from 1938 taken by the Royal Air Force (RAF) (© UCL Institute of Archaeology); **(C)** Topographic map from 1955, US Army Map Service (P502, Sheet NH 35-3 Matruh); **(D)** Spatial distribution of digitised sites by the project covering the entire area (Basemap: © ESRI).

Each site recorded in the database is identified with an ID, name, place categories, coordinates, and chronology. Some of these core elements are present in other gazetteers, and for interoperability reasons, we have followed their same semantic structure. Likewise, these elements are complemented with fields specific to this project, such as zonification number, ecological zone, documented remains, keywords, description, and associated references. Furthermore, we have integrated a validation scale based on the geolocation and available information of sites, and –complementarily– a risk assessment of potential risks threat (Figure 3). As a result, a total of 3352 sites were recorded, with a chronology ranging from Late Bronze to Roman times. Thus, 2717 of these sites correspond to Eastern Marmarica (NW-Egypt), and 635 sites to Western Marmarica (NE-Libya).

## QUALITY CONTROL

We are aware of the uncertainties caused by the nature of the archaeological record. Even data obtained by direct measurements conducted during field surveys (and, therefore, considered to be absolute) are accompanied by some level of uncertainty. Although the importance of this issue is widely recognised [2], we still need to advance in the development of processes and methods to reduce such uncertainties.

To this end, the project has developed a scale for validating the collected data, which was applied during the identification and mapping of archaeological and heritage sites (Figure 5). This scale is relevant for two reasons. First, the variable “Accuracy” refers to two observational measurements: i) each digitized site is categorized according to the degree of observed evidence (i.e., if the anomaly corresponding to the site is detected

VALIDATION SCALE	
ACCURACY	
Closeness degree based on evidence	Description
High	Anomaly detected [precise and accurate]
Intermediate	Anomaly detected [not precise, but accurate]
Low	No anomaly [neither precise, not accurate]
VALIDATION	
Level of confidence (numeric value)	Description
4	Contrasted anomaly [various sources and verified on the field]
3	Contrasted anomaly [all positive evaluations, except on the field]
2	Not contrasted anomaly [cartographic data and satellite imagery]
1	No anomaly [digitisation based on sources]

**Figure 5** Validation scale with fields of accurate of digitized sites and level of confidence of sources.

or not in the imagery); ii) the degree of closeness to the exact location of the site (i.e., the difference between the real geographic position where the archaeological site is located and the place where we placed the digitised site). To obtain a close approximation to the real geographic position of the sites, the model takes into account the precision provided by the sources (e.g., if we have more than one source indicating the location of a site, or if the source provides us with the coordinates). Second, it refers to “Validation”, which is a qualitative variable based on the level of confidence placed in the type of source from which we have obtained the information. It is used to contrast and also collect the associated information for each of the sites that make up this dataset (Figures 6 and 7). We state that this procedure ensures research transparency as much as recognizes the uncertainty surrounding the data.

## RISK ASSESSMENT

The anthropic and environmental processes pose unique challenges for the preservation of archaeological heritage in north-eastern Africa. Vast parts of this region are defined by landscape changes caused by heightened regional development. Such risk is mainly due to contemporary socio-economic processes, such as urban expansion and agricultural intensification, or environmental processes as coastline changes, accelerated by global warming and natural erosion. As a result, we are facing a fast-paced disappearance of heritage sites in the region.

We take a position in line with the approach of other projects, such as EAMENA,<sup>2</sup> documenting the potential risk of destruction to which these historical sites are exposed [16]. This dataset also contains a model that evaluates the impact of the potential risks on this archaeological heritage. Furthermore, we provide a framework to assess the potential vulnerabilities of archaeological sites within the Marmarica region.

## CONSTRAINTS

Each site of interest is represented only as a point in space and no account is taken of the extent or size of the original extension. This simplified geometry has two advantages: it can be applied consistently to all sites, regardless of the information available about their original extent; it is best suited to the spatial architecture required for the reconstruction of the network representation.

## (3) DATASET DESCRIPTION

### OBJECT NAME

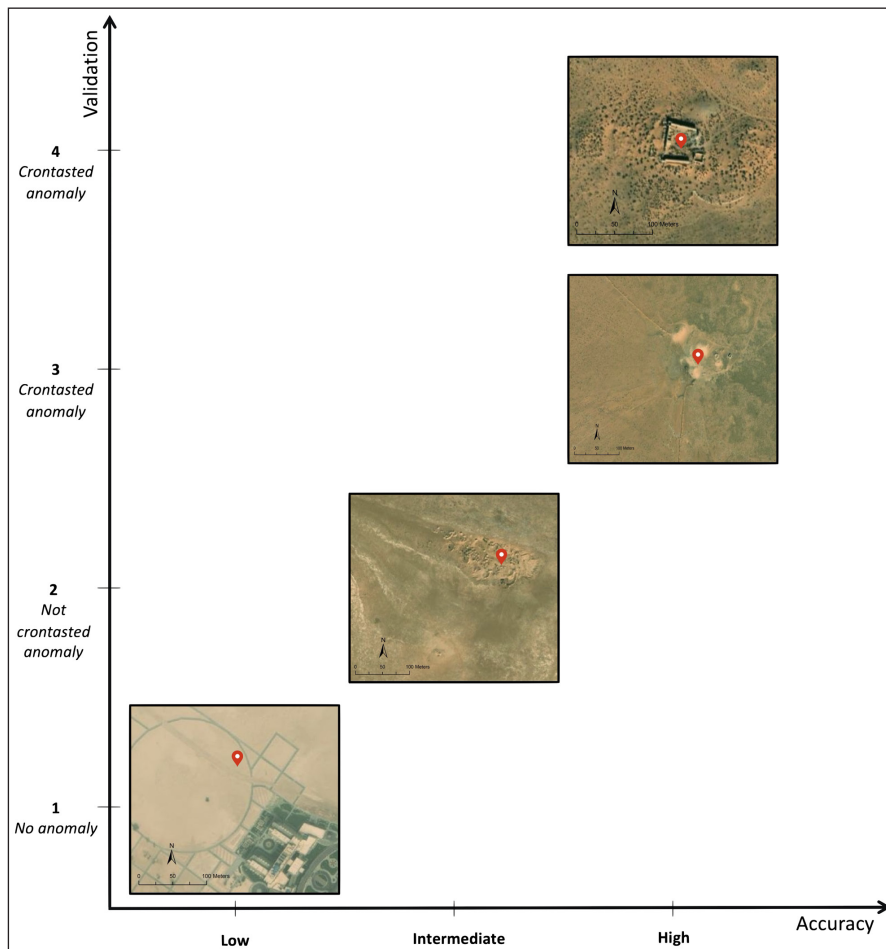
Marmarica\_sites

### DATA TYPE

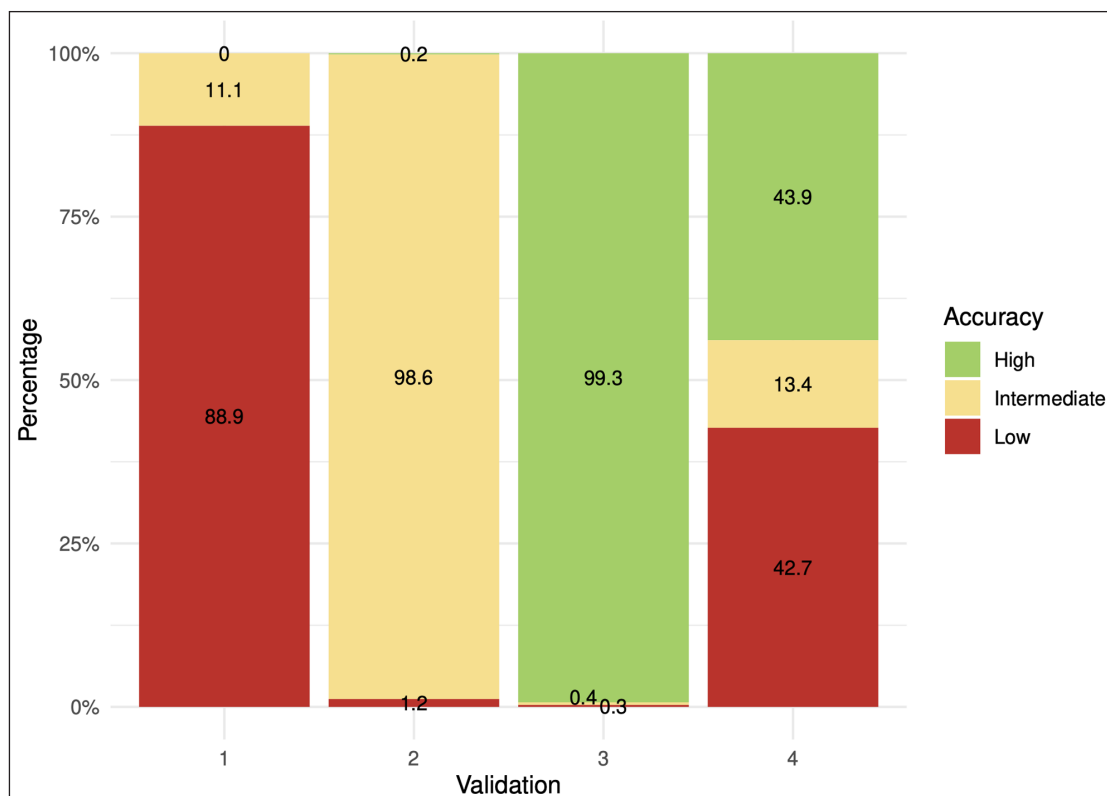
Primary Data.

### FORMAT NAMES AND VERSIONS

.csv, .txt, .xlsx, .tiff



**Figure 6** Examples of archaeological sites according to their closeness degree based on observed evidence, and the level of confidence provided by the sources.



**Figure 7** Chart displaying the relationship between accuracy and validation of the documented sites.

## CREATION DATES

01/01/2021 – 01/05/2022

## DATASET CREATORS

All data has been created by David Laguna-Palma.

## LANGUAGE

English

## LICENSE

CC BY 4.0, Creative Common License.

## REPOSITORY LOCATION

Zenodo last version repository (<https://doi.org/10.5281/zenodo.7678852>).

PERAIA website (<https://peraia.ugr.es/gazetteer/>).

## PUBLICATION DATE

19/12/2022

## (4) REUSE POTENTIAL

The data has been stored in the project's gazetteer, which already contains more than 3000 sites with archaeological interest. It should be noted that the gazetteer's data does not only contain information relevant to our project, but it is designed to be connected to other archaeological platforms and portals that work with Open Data. To this end, the complete database has been uploaded to Zenodo, an open repository developed in the framework of the European Union programme, which allows uploading the dataset and associated

metadata in a versionable format, as well as obtaining an alphanumeric identifier code (DOI) that allows the data to be linked and cited when utilised by other users. Our intention is that both the scientific community and local administrations, as well as any interested user, can access, review, and use the data provided.

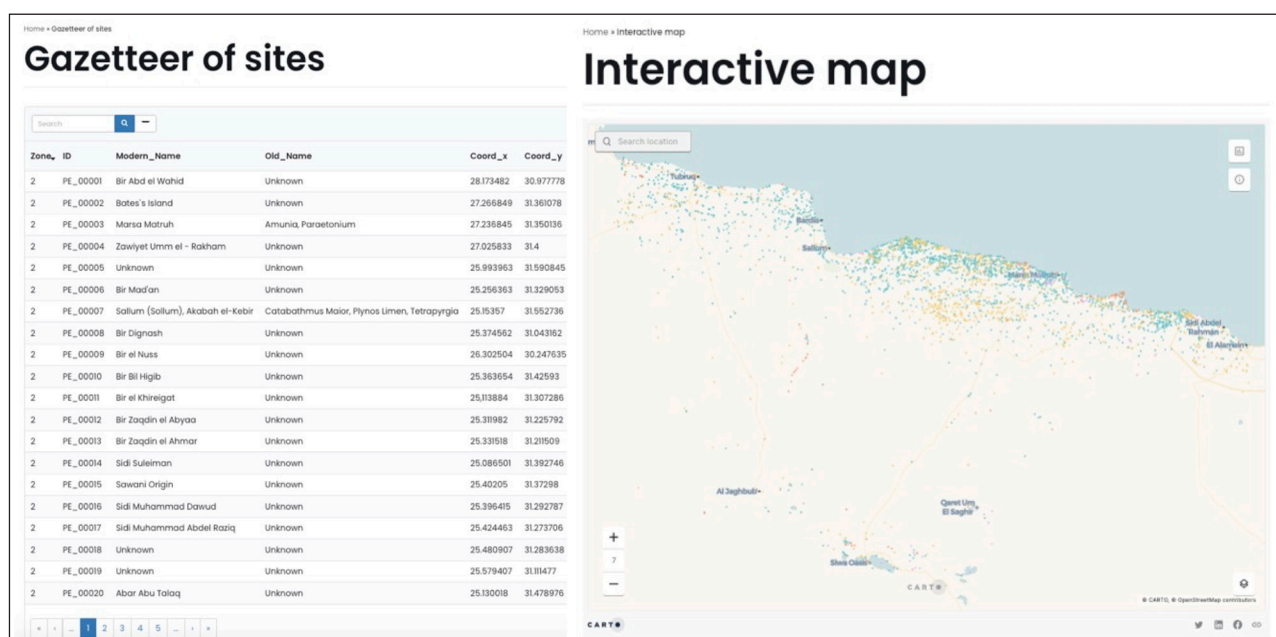
In addition, the database of sites is embedded in the PERAIA website (<https://peraia.ugr.es/>), which is hosted by the University of Granada (Spain). The website service facilitates general and specific queries depending on the search criteria by providing selection tools. Ancillary to the potential reuse of all these data, the interface also enables the downloading of the entire database as a CSV file. Moreover, the web service integrates an interactive map, developed using Carto technology, where users can visualise the sites in their geographic location, and the types of sites are represented in different colors (Figure 8). Thus, any researcher, project, or institution can access the complete database and associated information of the more than 3000 archaeological sites that currently make up the gazetteer.

## NOTES

- 1 Mainly the P502 series from US Army Map Service (1955) at a scale of 1:250,000.
- 2 EAMENA database. Available at: <https://database.eamena.org>.

## ACKNOWLEDGEMENTS

The project is a joint effort between academics from different universities and countries. For this reason, we



**Figure 8** PERAIA web service providing access to the database for direct query and downloading in CSV format, and visualisation of the interactive map.



would like to thank Pau de Soto from the Autonomous University of Barcelona, Borja Legarra Herrero from the Institute of Archaeology, University College London, and Tom Brughmans from the Centre for Urban Network Evolutions (UrbNet) at the University of Aarhus for their collaboration and support in this project.


## FUNDING INFORMATION


This project has been funded by the Spanish Ministry of Universities (FPU17/06503), and the Vice-Rectorate for Research and Knowledge Transfer of the University of Granada (Ref: PPJIB2020.18).


## COMPETING INTERESTS

The authors have no competing interests to declare.

## AUTHOR AFFILIATIONS

**David Laguna-Palma**  [orcid.org/0000-0001-8425-9324](https://orcid.org/0000-0001-8425-9324)  
Department of Prehistory and Archaeology, University of Granada, Spain

**Maurizio Toscano**  [orcid.org/0000-0001-5418-3859](https://orcid.org/0000-0001-5418-3859)  
Spanish Foundation for Science and Technology (FECYT).  
Ministry of Science and Innovation, Spain

**Carlos Rodríguez-Rellán**  [orcid.org/0000-0001-5884-6592](https://orcid.org/0000-0001-5884-6592)  
Department of Prehistory and Archaeology, University of Granada, Spain

## REFERENCES

- Andreou GM, Nikolaus J, Westley K, el Safadi C, Blue L, Smith A, Breen, C.** Big Data in Maritime Archaeology: Challenges and Prospects from the Middle East and North Africa. *J. Field Archaeol.* 2022; 47: 131–148. DOI: <https://doi.org/10.1080/00934690.2022.2028082>
- García-Álvarez D, Van Delden H, Camacho Olmedo MT, Paegelow, M.** Uncertainty Challenge in Geospatial Analysis: An Approximation from the Land Use Cover Change Modelling Perspective. In: Koutsopoulos K, de Miguel González R, Donert K (Eds.), *Geospatial Challenges in the 21st Century, Key Challenges in Geography*. Cham: Springer International Publishing. 2019. 289–314. DOI: [https://doi.org/10.1007/978-3-030-04750-4\\_15](https://doi.org/10.1007/978-3-030-04750-4_15)
- Grajetzki G, Quirke S.** 2000. <https://www.ucl.ac.uk/museums-static/digitalegypt/chronology/index.html> accessed 16/02/2023.
- Manière L, Crépy M, Redon B.** Geospatial Data from the “Building a Model to Reconstruct the Hellenistic and Roman Road Networks of the Eastern Desert of Egypt, a Semi-Empirical Approach Based on Modern Travelers’ Itineraries”. *J. Open Archaeol. Data.* 2020; 8: 7. DOI: <https://doi.org/10.5334/joad.71>
- Nielsen N.** Cereal cultivation and nomad-sedentary interactions at the Late Bronze Age settlement of Zawiyet Umm el-Rakham. *Antiquity.* 2017; 91: 1561–1573. DOI: <https://doi.org/10.15184/aqy.2017.174>
- Ray N, Nikolaus J.** Changing Urban Environments and the Impact on Coastal Cultural Heritage at Marsa Matruh, Egypt. *J. Mari. Arch.* 2022; 17: 445–464. DOI: <https://doi.org/10.1007/s11457-022-09337-0>
- Rayne L, Gatto MC, Abdulaati L, Al-Haddad M, Sterry M, Sheldrick N, Mattingly D.** Detecting Change at Archaeological Sites in North Africa Using Open-Source Satellite Imagery. *Remote Sens.* 2020; 12: 3694. DOI: <https://doi.org/10.3390/rs12223694>
- Rayne L, Bradbury J, Mattingly D, Philip G, Bewley R, Wilson A.** From Above and on the Ground: Geospatial Methods for Recording Endangered Archaeology in the Middle East and North Africa. *Geosciences.* 2017; 7: 100. DOI: <https://doi.org/10.3390/geosciences7040100>
- Rieger AK.** “Un-Central’ Landscapes of NE-Africa and W-Asia Landscape Archaeology as a Tool for Socio-Economic History in Arid Landscapes. *Land.* 2019; 8(1). DOI: <https://doi.org/10.3390/land8010001>
- Rieger AK.** The Various Ways of Being Mobile: Habitual Knowledge, Life-Strategies and the Ancient Route Networks on the Eastern Marmarica-Plateau (Northern Libyan Desert). *Open Archaeol.* 2017; 3: 49–68. DOI: <https://doi.org/10.1515/opar-2017-0003>
- Roberts RC, Jabbar JA, Jones H, Orengo HA, Madella M, Petrie CA.** Paper and pixels: historic maps as a multifaceted resource. 2021; 3: 250. DOI: <https://doi.org/10.5194/ica-abs-3-250-2021>
- Snape S.** Walls, wells and wandering merchants: Egyptian control of Marmarica in the late bronze age. In Eyre CJ (Ed.), *Proceedings of the Seventh International Congress of Egyptologists*. Leuven: Peeters Publishers. 1998. 1081–1084.
- Vetter T, Rieger AK.** Water harvesting as a key for understanding adapted ancient livelihoods in an arid environment – Approaches to dryland archaeology in the Eastern Marmarica (NW-Egypt). *J. Arid. Environ.* 2019; 171: 103940. DOI: <https://doi.org/10.1016/j.jaridenv.2019.02.009>
- Vetter T, Rieger A-K, Nicolay A.** Disconnected runoff contributing areas: Evidence provided by ancient watershed management systems in arid north-eastern Marmarica (NW-Egypt). *Geomorphology.* 2014; 212: 41–57. DOI: <https://doi.org/10.1016/j.geomorph.2013.10.002>
- Vetter T, Rieger, AK, Nicolay A.** Ancient rainwater harvesting systems in the north-eastern Marmarica (north-western Egypt). *Libyan Studies.* 2009; 40: 9–23. DOI: <https://doi.org/10.1017/S0263718900004489>
- Wilson A.** The use of remote sensing and digital tools for cultural heritage management and archaeological research. *Levant.* 2022; 39.
- Zerbini A.** Developing a Heritage Database for the Middle East and North Africa. *J. Field Archaeol.* 2018; 43: S9–S18. DOI: <https://doi.org/10.1080/00934690.2018.1514722>

---

**TO CITE THIS ARTICLE:**

Laguna-Palma D, Toscano M, Rodríguez-Rellán C 2023 Building an Integrated Database of North-Eastern African Archaeological and Heritage Sites for Mapping Complex Social Landscapes. *Journal of Open Archaeology Data*, 11: 5, pp. 1–10. DOI: <https://doi.org/10.5334/joad.99>

**Published:** 25 April 2023

**COPYRIGHT:**

© 2023 The Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution 4.0 International License (CC-BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited. See <http://creativecommons.org/licenses/by/4.0/>.

*Journal of Open Archaeology Data* is a peer-reviewed open access journal published by Ubiquity Press.

