

BOIRA Survey (BOIRA Campo): a mobile application for georeferenced and structured archaeological photographic recording

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Abstract

Photography is one of the most frequent and, at the same time, least structured forms of archaeological recording. During survey, excavation and the documentation of sites for archaeological inventories, field staff take hundreds of images whose later usefulness depends on information that is usually written down separately or reconstructed after the event: position, orientation, scale, stratigraphic unit and context. BOIRA Survey (BOIRA Campo in Spanish) is a progressive web application developed at the Sanisera Archaeology Institute to capture that information at the moment of exposure. Each photograph is linked to its site, sector, grid square, stratigraphic unit and context, together with UTM coordinates, elevation, bearing, tilt and positional accuracy. The application automatically recognises excavation scales, optionally supports GNSS receivers of any brand and total-station points, keeps the original image untouched, and generates reports, catalogues, inventories and GIS layers in open formats. It works offline and in nine languages. The accompanying Zenodo record includes the user manual, the step-by-step tutorial, the technical verification report for version 13.0 and presentation flyers.

Keywords: archaeology, field photography, georeferencing, photographic scale, GNSS, excavation recording, archaeological survey, archaeological inventory, FAIR data.

1. Introduction: an everyday task that deserves a method

Few tasks are as constant in archaeology as taking photographs. Every surface find is photographed during survey, every stratigraphic unit and structure during excavation, and every site when it is documented for an archaeological inventory or heritage record. Photography has long been an essential part of field and laboratory recording, and its documentary value depends on controlling the scale, orientation and context of each shot (Dorrell, 1994). Yet it is a routine gesture, repeated dozens of times a day, and precisely for that reason it often falls outside the most rigorous recording protocols.

The problem lies not in taking the photograph but in what happens afterwards. An archaeological photograph is only a useful document if four questions can be answered unambiguously: where it was taken, which way the camera was facing, at what scale the object appears and to which context it belongs. In practice, that information is scattered across the field notebook, the photo board placed next to the object, the memory of the person who took it and the file name. By the end of a season the result is a set of images that is hard to sort, search and integrate into the excavation archive or a GIS, and staff spend hours reconstructing references that existed at the moment of exposure.

Recent research has shown that designing the digital recording workflow before fieldwork begins improves the accuracy and efficiency of recording, to the point of reformulating the classic maxim

"excavation is destruction" as "excavation is digitization" (Roosevelt et al., 2015). The adoption of mobile devices in fieldwork, from tablets at Pompeii to drones in the Andes, has been widely documented (Averett et al., 2016). This transformation is accompanied by the requirement that research data be findable, accessible, interoperable and reusable, according to the FAIR principles (Wilkinson et al., 2016), which in European archaeology have driven infrastructures such as ARIADNE (Meghini et al., 2017). At the regulatory level, the Valletta Convention commits signatory states to identify their archaeological heritage and maintain an inventory of it (Council of Europe, 1992), a task in which georeferenced photographic documentation is a basic component.

This concern with structuring the archaeological record is not new in the author's work. The B.O.I.R.A. system (Base Organizativa de Información del Registro Arqueológico, "Organisational Database for Archaeological Record Information") was conceived in the early 1990s at the Universitat Autònoma de Barcelona as a database model for survey and excavation recording (Contreras Rodrigo, 1993). It applied structured software engineering methods —Yourdon's analysis and Chen's entity-relationship model— to the volume of information generated by every archaeological research team (Contreras Rodrigo, 1995a, 1995b). The same line of work has since extended to the application of geographic information systems to underwater archaeology (Contreras Rodrigo & Fernández Sánchez, 2022), landscape survey (Valente et al., 2023) and palaeoenvironmental reconstruction (Fernández-Sánchez et al., 2025). BOIRA Survey takes up that approach with current mobile technology and brings it to the point where the data originate: the moment the photograph is taken.

BOIRA Survey arises from that specific need: that images be **referenced and structured from the outset**, in an order that makes them easy to consult and use, so that staff do not have to reconstruct them later.

2. Background

The development of BOIRA Survey started from an analysis of the tools available for field recording. They fall into three groups.

Field cameras with data stamping. Applications such as Solocator (Solocator, 2025) and Theodolite (Hunter Research and Technology, n.d.) overlay position, direction, altitude and date on the photograph. Solocator also allows a project name and description to be assigned, displays coordinates in decimal degrees, UTM or MGRS, can refine and lock the GPS position near buildings, and exports photo data as KML, KMZ or CSV. Theodolite adds a two-axis inclinometer, project notes on the image, a triangulation calculator and CSV and KML export, and writes the data into the file metadata. These tools are effective and immediate, but general-purpose: they do not know the structure of the archaeological record (site, sector, grid square, stratigraphic unit, context), they do not compute the metric scale of the image and, in the case of stamping, the data become part of the photograph itself.

Integrated archaeological recording systems. FAIMS Mobile, developed since 2012 by an Australian digital infrastructure project, is an open-source platform that generates customised Android applications for recording structured data, text, geometry and multimedia offline, with synchronisation between devices through a server (Ross et al., 2013). Its deployment in the Perachora Peninsula survey (Greece) showed that an offline mobile system can produce consistent data and reduce post-processing, although its modules had to be adapted and tested before the

season (Sobotkova et al., 2021). iDig, developed since 2012 by Bruce Hartzler for the excavations of the Athenian Agora, is an iPad application for recording and visualising excavation data in the field (Uildriks, 2016). Both represent a decisive step towards born-digital recording, but they are complete systems that require prior configuration, specific hardware or a server, and in which photography is just one element of a general database.

GIS field-capture platforms. Tools such as ArcGIS Survey123 and ArcGIS Field Maps (Esri, 2022) or QField (OPENGIS.ch, n.d.), the latter for QGIS projects, allow forms to be designed and photographs to be attached to geographic features. They are highly versatile, but require the GIS project or form to be prepared in advance and, in the case of commercial platforms, an account and a licence; the photograph remains an attachment, without documented scale or orientation.

BOIRA Survey is not intended to replace any of these tools, but to occupy the space between them: the immediacy of a field camera combined with the structure of an archaeological record and the metrics of documentary photography. Its aim is to enrich the digital and technological landscape that supports archaeologists with a specific, lightweight tool without barriers to entry.

3. Objectives

1. Record, at the moment of exposure, the archaeological context, position, orientation and accuracy of each photograph.
2. Obtain the metric scale of the image from the scales that archaeologists already place in the scene.
3. Keep the original photograph unaltered and generate a separate documented copy.
4. Organise images by series, places, dates and contexts, and make them locatable on a map.
5. Produce, without intermediate steps, the documents and layers required by reports, inventories and GIS, in open formats that support data interoperability and reuse.
6. Work on any phone, offline, without an account and free of charge.

4. System description and workflow

BOIRA Survey is a progressive web application: it is installed from the browser on Android and iOS phones and, once installed, works offline. Data are stored in the device's own local database.

4.1. Project set-up

Before going into the field, the site, its code and the season are defined, and the coordinate preferences are set: the UTM zone and the magnetic declination, which corrects the compass bearing to refer it to true north and whose local value can be obtained from the World Magnetic Model (Chulliat et al., 2025). Users also choose the photo numbering scheme (continuous, daily, by stratigraphic unit or by context), team-specific attributes, usual scales and the institutional logos for the documented copy. If a GNSS receiver is available, it is connected at this stage; the application guides the connection step by step regardless of brand or model.

4.2. The viewfinder

The viewfinder brings together, over the camera image, the information needed to frame and document the shot: the active series, GPS and network status, a central crosshair, the camera tilt

indicator, a bearing strip with the north line, the compass rose, real-time coordinates and accuracy, a framing grid of variable density, zoom, and a light and colour panel for correcting exposure and colour temperature in difficult conditions (low-angle sunlight, shade). These elements help to obtain level, well-oriented vertical and frontal shots, and are recorded with each photograph (Fig. 1).



Figure 1. The BOIRA Survey viewfinder: active series, GPS status, crosshair, tilt, bearing strip with the north line, compass rose, and real-time coordinates and accuracy.

4.3. The record form

After the shot, the photograph's record form opens, inheriting the project and series data: site, sector, grid square, stratigraphic unit, context and type of view. The description can be dictated by voice and voice notes can be added. Position, bearing, tilt, elevation, accuracy and time are fixed at the moment of exposure, not when the record is saved (Fig. 2).

General

Shot record

× Discard

✓ Save

Photo code

SAN-0001

The app proposes the code according to the series chosen in «Settings»; you can type the one you prefer.

Site

Sanisera

Season

2026

Sector

Basílica

Square

B-3

SU

1023

Photo type

Start of SU

Reference scale in the photo

17/10/2026

Figure 2. Record form of a photograph with its archaeological context data.

4.4. Working on a saved photograph

Photographs can be browsed in a gallery sorted by place or date, or on a map (Fig. 3). From the detail view of each image (Fig. 5), users can:

- **correct the position** on the map or on orthophotography when the signal was poor;
- **enter measured coordinates** from a total station or GNSS, which are kept alongside those of the phone;
- **calibrate the scale** (Fig. 4): the application detects the excavation scale in the image and proposes its length; the user confirms it or corrects it by marking its ends under magnification;
- **annotate the image** with drawings and text, always on the documented copy;
- **generate the documented copy**, with graduated margins, record data, compass rose, scale and up to three institutional logos.

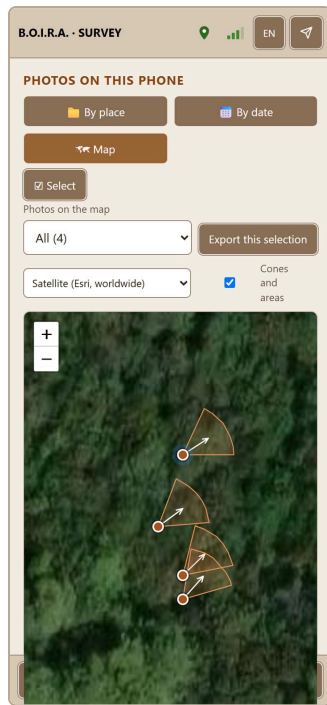


Figure 3. Gallery of photographs located on the map.

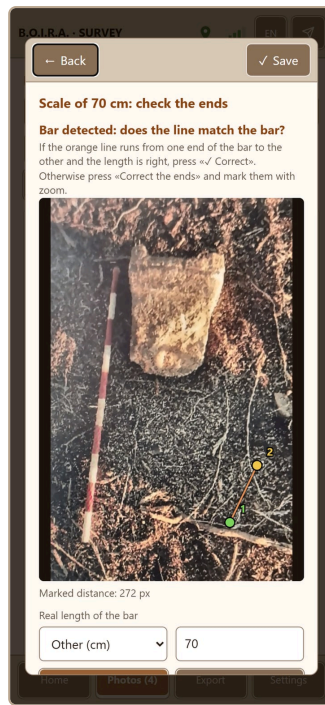


Figure 4. Scale calibration: the application detects the ranging pole and proposes its length for the user to confirm.



Figure 5. Detail of a saved photograph, with its data and correction tools.

4.5. Outputs

The application directly generates the photographic report, the record catalogue and the single-photo sheet in PDF; the inventory in Excel; and layers in GeoJSON, KML/KMZ, GPX, CSV and JSON for any GIS, Google Earth and Google Maps (Fig. 6). The use of open, documented formats makes it easier to integrate the data into archives and repositories, in line with the FAIR principles (Wilkinson et al., 2016). Optionally, each photograph and its record can be copied automatically to the user's own Google Drive, with access limited to the files the application creates.

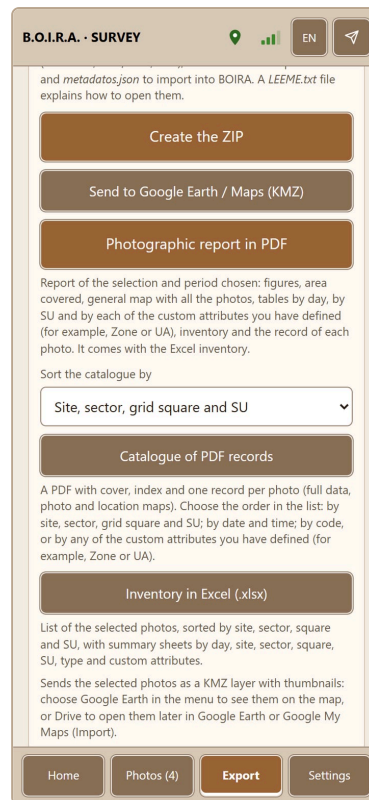


Figure 6. Export screen: PDF reports, Excel inventory and GIS layers.

5. Accuracy and quality control

Positioning. With the phone's GPS, typical accuracy is at the metre level, and the application records for each shot the estimated accuracy reported by the device. With an external GNSS receiver in RTK mode, positioning reaches centimetre-level accuracy. The application reads the GGA (position and fix quality) and GST (error estimates) sentences of the NMEA 0183 standard (National Marine Electronics Association, n.d.) and validates each value before accepting it.

Projection. The conversion of geographic coordinates to UTM (WGS84) and the inverse transformation are computed on the device. Results were checked against the PROJ reference library (PROJ contributors, 2026), with differences below 1 mm.

Orientation. The bearing comes from the phone's compass and is corrected with the configured magnetic declination (Chulliat et al., 2025). The viewfinder also shows the tilt, which makes it possible to document whether a shot is vertical, frontal or oblique.

Scale. Scale is obtained from objects of known length present in the scene, following the usual practice of archaeological photography (Dorrell, 1994): chequered scales from 2 to 20 cm, long scales, ranging poles and bars of 0.5, 1 and 2 m, and each team's own scales. Automatic detection is always subject to the user's confirmation, and the resulting measure is expressed as a pixel-to-centimetre ratio.

Integrity. The original image is never modified; all visible information goes on a separate copy. Each record is considered saved only when the database confirms the write, and the time is fixed at the shutter.

6. Field trials

The application has been tested mainly at the Roman site of Sanisera, in the port of Sanitja (Es Mercadal, Menorca), where the Sanisera Archaeology Institute carries out its excavation programme. Trials took place under real working conditions: strong and low-angle sunlight, shade, irregular mobile coverage and continuous recording of stratigraphic units and finds. Figure 7 shows the kind of document the application is designed to produce: a find photographed next to a reference ranging pole, from which its scale can be computed.

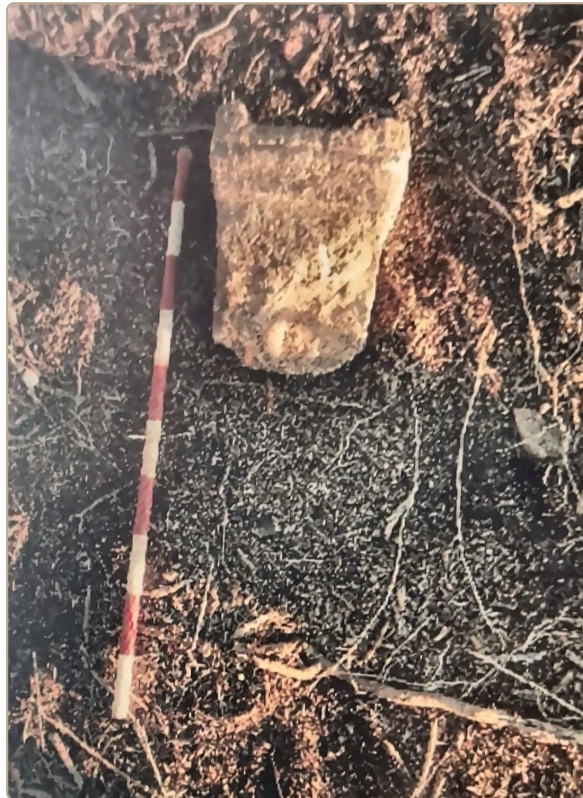


Figure 7. Votive altar discovered at Sanisera during the 2026 season, photographed next to a ranging pole. © Sanisera Archaeology Institute.

7. Verification

Version 13.0 underwent independent reviews of geodetic accuracy, export formats, data persistence, accessibility, according to the contrast criteria of the WCAG 2.1 guidelines (Kirkpatrick et al., 2018), and security. The results are documented in the verification report included in the Zenodo record.

8. Discussion and contributions

Compared with general-purpose field cameras, BOIRA Survey incorporates the structure of the archaeological record, the metric scale of the image and the separation between original and documented copy. Compared with integrated recording systems (Ross et al., 2013; Uildriks, 2016) and GIS platforms, it offers immediate entry, without server configuration, account or licence, centred on photography as a document. Its scope covers survey, excavation and the documentation of sites for archaeological inventories and heritage records.

Among its limitations, the accuracy of position and bearing obtained with the phone depends on each device's sensors and on environmental conditions, and scale detection requires scales to be visible and unobstructed. For work requiring survey-grade accuracy, the application supports GNSS receivers and coordinates measured with a total station.

Development will continue with new versions aimed at extending interoperability with archaeological data management systems.

9. Open science, the European framework and contribution to the community

BOIRA Survey is conceived as a non-profit contribution of the Sanisera Archaeology Institute to the archaeological community. The application is free of charge, contains no advertising, requires no account and collects no user data: photographs and records remain on each user's device, and users decide whether to export them or copy them to their own cloud storage. It works in nine languages, which facilitates its use in international projects and in teams with staff from different backgrounds.

The application's documentation —user manual, step-by-step tutorial in nine languages, technical verification report and this article— is deposited in Zenodo, the open science repository operated by CERN and created in 2013 together with the European Commission within the OpenAIRE initiative (CERN, n.d.). The deposit assigns it a permanent DOI, guarantees its long-term preservation and makes it citable and discoverable in scholarly information services.

The project is aligned with European open science policies: the FAIR data principles (Wilkinson et al., 2016), the objectives of the European Open Science Cloud (EOSC) promoted by the European Commission (European Commission, n.d.), the integration of archaeological data promoted by the ARIADNE infrastructure (Meghini et al., 2017), and the obligation to identify and inventory the archaeological heritage established by the Valletta Convention (Council of Europe, 1992). Its outputs in open formats (GeoJSON, KML, GPX, CSV, JSON) allow the photographic record to be integrated into repositories, excavation archives and geographic information systems without depending on commercial software.

BOIRA Survey is the first published module of BOIRA, the archaeological record management system whose origins go back to 1993 and whose new version is under development. The aim is for BOIRA to become a digital tool at the service of the European archaeological community; to that end, it is intended to apply to European calls supporting software and digital infrastructures that can ensure its sustainability, maintenance and expansion.

10. Availability

The application is available free of charge at <https://boira-campo.pages.dev>. It is closed source and works in nine languages: English, Spanish, French, Portuguese, Catalan, Arabic, Chinese, Korean and Hindi. The documentation and this article can be consulted and cited through their Zenodo record: <https://doi.org/10.5281/zenodo.23440404>

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