Journal of open archaeology data

Geoarchaeology and PalaeoDEMs Modelling to Assess the Archaeological Potential of Ravenna and Its Hinterland

DATA PAPER

MICHELE ABBALLE

ubiquity press

ABSTRACT

This paper presents a collection of nine datasets developed as part of a PhD research project in Archaeology to investigate landscape transformations in the hinterland of Ravenna. The collection includes both primary and processed data, comprising the most extensive geoarchaeological dataset for the region, the first digital catalogue of medieval sites, palaeogeographical reconstructions of rivers and wetlands evolution, and palaeotopographical diachronic reconstructions in the form of palaeoDEMs. These datasets provide a valuable resource for researchers studying the long-term environmental and human landscape dynamics of the area and can support local desktop-based assessments in development-led archaeology. As one of the first open-access data collections of its kind, this work not only facilitates research on the hinterland of Ravenna but also offers opportunities for comparative studies with other regions across Italy and beyond.

CORRESPONDING AUTHOR:
Michele Abballe

Postdoctoral Research Fellow, Department of Humanities, Ca' Foscari University of Venice, Dorsoduro 3484/D, Calle Contarini, 30123, Venezia (VE), Italy

michele.abballe@unive.it

KEYWORDS:
landscape archaeology; geoarchaeology; archaeological sites; reclaimed landscapes; landscape evolution; landscape modelling; palaeoDEM; palaeoDEM modelling; archaeological potential

TO CITE THIS ARTICLE:
Abballe M 2025 Geoarchaeology and PalaeoDEMs Modelling to Assess the Archaeological Potential of Ravenna and Its Hinterland. *Journal of Open Archaeology Data,* 13: 7, pp. 1–15. DOI: https://doi.org/10.5334/joad.148

(1) OVERVIEW

CONTEXT

The collection of datasets was created as part of the author's doctoral research to shed light on the transformations that have occurred in the hinterland of Ravenna (Figure 1), in northeastern Italy, through a combination of digital and field geoarchaeological approaches [1]. The study region has undergone significant geomorphological changes, typical of alluvial plains, including river avulsion, floodplain aggradation, coastal progradation, and subsidence [2]. These natural processes have been exacerbated by human activities, particularly extensive land reclamation over recent centuries, which has led to the near disappearance of wetlands [3]. However, evidence of past hydromorphic conditions is still discernible in the geological record, showing that post-Roman waterlogging events affected multiple areas of the hinterland of Ravenna, such as Lugo, Cotignola, Massa Lombarda, and Villafranca di Forlì [4–6], similar to other areas of the Po Valley. Thus, reclamation efforts, which began in the medieval period (certainly by the 13th century CE), became more systematic in the Modern Era and culminated in the completion of the extensive Cassa di Colmata del Lamone project north of Ravenna in 1962 CE [3].

Before these widespread reclamation efforts, the landscape was characterised by an interplay of low-lying areas bordered by elevated ridges of fluvial or dune origin. In these depressions, low-energy sedimentation prevailed, depositing primarily silts and clays, often interspersed with organic-rich layers or peat horizons: these features provide valuable evidence of past water stagnation [7]. Where sediment supply was minimal, prolonged soil development occasionally led to the formation of distinct soil horizons in formerly well-drained floodplain deposits [8]. Fluvial aggradation processes have often buried these ancient soils and associated archaeological sites, with sediment thickness varying considerably across the region. While most sites are identified through surface artefact surveys, a significant portion lies several meters deep, with the deepest recorded site being the Neolithic village at Fornace Gattelli in Lugo (RA), which is buried beneath 14 meters of sediment [9].

Despite the geomorphological context posing significant methodological challenges for archaeological investigations, the area boasts a long history of research that has led to the mapping of hundreds of sites, spanning from the Neolithic period onward. However, much of this information was previously dispersed across publications focused on specific contexts or included in individual

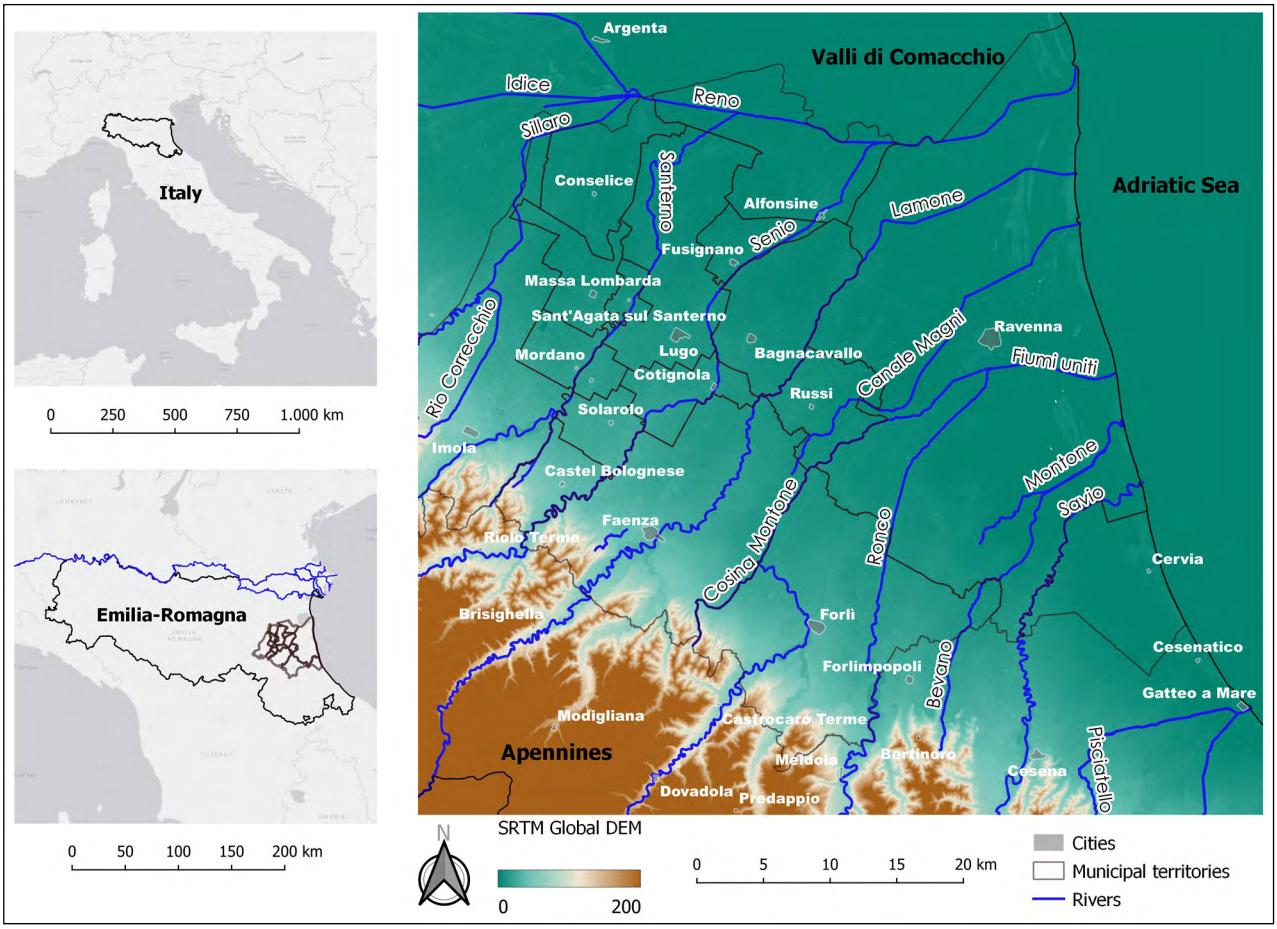

Figure 1 Map of the hinterland of Ravenna, showing municipal territories, main towns and rivers, with the SRTM Global DEM as the basemap. The two insets on the left, created using Esri World Light Gray Base as the basemap, illustrate the location of the Emilia-Romagna region within the Italian Peninsula (top) and the study area within the same region in relation to the Po River (bottom).

municipalities' archaeological maps, without ever being consolidated into a single ready-to-use database. For the first time, a dataset for an area that extends to 1989 km^2 across 17 municipalities in the hinterland of Ravenna has been created. Yet, this collection of datasets is more than just a compilation of archaeological data. It also traces the evolution of the landscape over the past three millennia, reconstructing changes in river courses, the gradual disappearance of inland and coastal wetlands, and the progressive topographic rise of the floodplain caused by fluvial aggradation.

SPATIAL COVERAGE

Description: The research area is located in the Emilia-Romagna region of northern Italy, bounded by the Reno River to the north, the Sillaro River to the west, the Adriatic Sea to the east, and the foothills of the Apennines to the south. It encompasses a total of 17 municipalities located within the plain: 15 in the province of Ravenna (RA), namely Alfonsine, Bagnacavallo, Bagnara di Romagna, Castel Bolognese, Cervia, Conselice, Cotignola, Faenza, Fusignano, Lugo, Massa Lombarda, Ravenna, Russi, Sant'Agata sul Santerno, Solarolo; Imola and Mordano in the province of Bologna (BO); Forlì in the province of Forlì-Cesena (FC). The geographic coordinate system used for the whole collection of datasets is ETRS89/UTM zone 32 N.

The limits of the study area, expressed in WGS1984, are as follows:

Northern boundary: 44.597701470
Southern boundary: 44.181308776
Eastern boundary: 12.383982038
Western boundary: 11.624452850

TEMPORAL COVERAGE

Palaeolithic (~10000 BCE) – Contemporary Age (~2000 CE)

The collection of datasets covers a temporal range from the Palaeolithic (~10,000 BCE) to the Contemporary Age (~2000 CE). No a priori selection of archaeological sites was made, and all available sites have been included. Sites with continuous habitation, particularly those occupied from the medieval period onward, have been specifically incorporated into the dataset.

(2) METHODS

The raw geoarchaeological data in this collection were obtained from published sources, including archaeological literature, municipal and supramunicipal maps, and the regional geological database, as well as archival reports, each with the typical specifications and limitations associated with geoarchaeological and geological data (Figure 2). Historical data were extracted from published literature, elevation data were sourced from the regional geodatabase. Additional data have been collected via targeted geoarchaeological fieldwork. The approaches for data collection, processing, and interpretation will be explained in the relevant subsection.

STEPS

Geoarchaeological data

All known archaeological sites have been systematically compiled by integrating data from published literature on legacy excavations and artefact surveys, as well as from local archaeological maps, which document known sites at both municipal and supramunicipal levels. This dataset was further enriched with information from unpublished archive reports, primarily derived from trial trenches and rescue excavations conducted during development-led archaeology over the past two decades. Additional contributions come from archaeological survey projects conducted in the last twenty years by the University of Bologna across various areas of the hinterland of Ravenna [5, 10–14]. In addition, hundreds of stratigraphic logs were incorporated into the geoarchaeological dataset, playing a crucial role in identifying palaeosols as relative stratigraphic markers, along with poorly drained floodplain and wetland deposits. These geoarchaeological data primarily derive from recent research conducted between 2018 and 2020 [15] predominantly utilising hand augering [5], with limited use of other coring methods. Additional geological stratigraphies were sourced from various materials, including published literature, cores carried out during the *CARtografia Geologica* – CARG national geological mapping project in Italy, records from the Geological, Seismic, and Soil Survey Service of the Emilia-Romagna region, and archival data generously shared by private geologists. Elevation above sea level was calculated for all geoarchaeological entries by extracting Z values from the LocalDEM+ (see section LocalDEMs), ensuring consistency across the entire dataset.

All geoarchaeological data have been assigned a chronological attribute, with values ranging from the Palaeolithic to the Contemporary Age (Table 1), based on available absolute dates, archaeological evidence, or lateral stratigraphic correlations. In addition to specific chronological periods (e.g., Roman period), intermediate stages have been used for stratigraphic data when relative chronologies can be inferred but without precise dating. For instance, a general "post-Roman" value is applied to alluvial deposits covering a Roman-era site when the exact time of deposition (e.g., Early or Late Middle Ages) is uncertain. Furthermore, given the diverse sources and types of data compiled, each chronological attribute has also been assigned a reliability rating (Table 2) based on the type and precision of the source. Absolute chronologies, such as radiocarbon and OSL dates, have received the highest reliability value [5], while excavated sites [4] generally provided more precise dating than

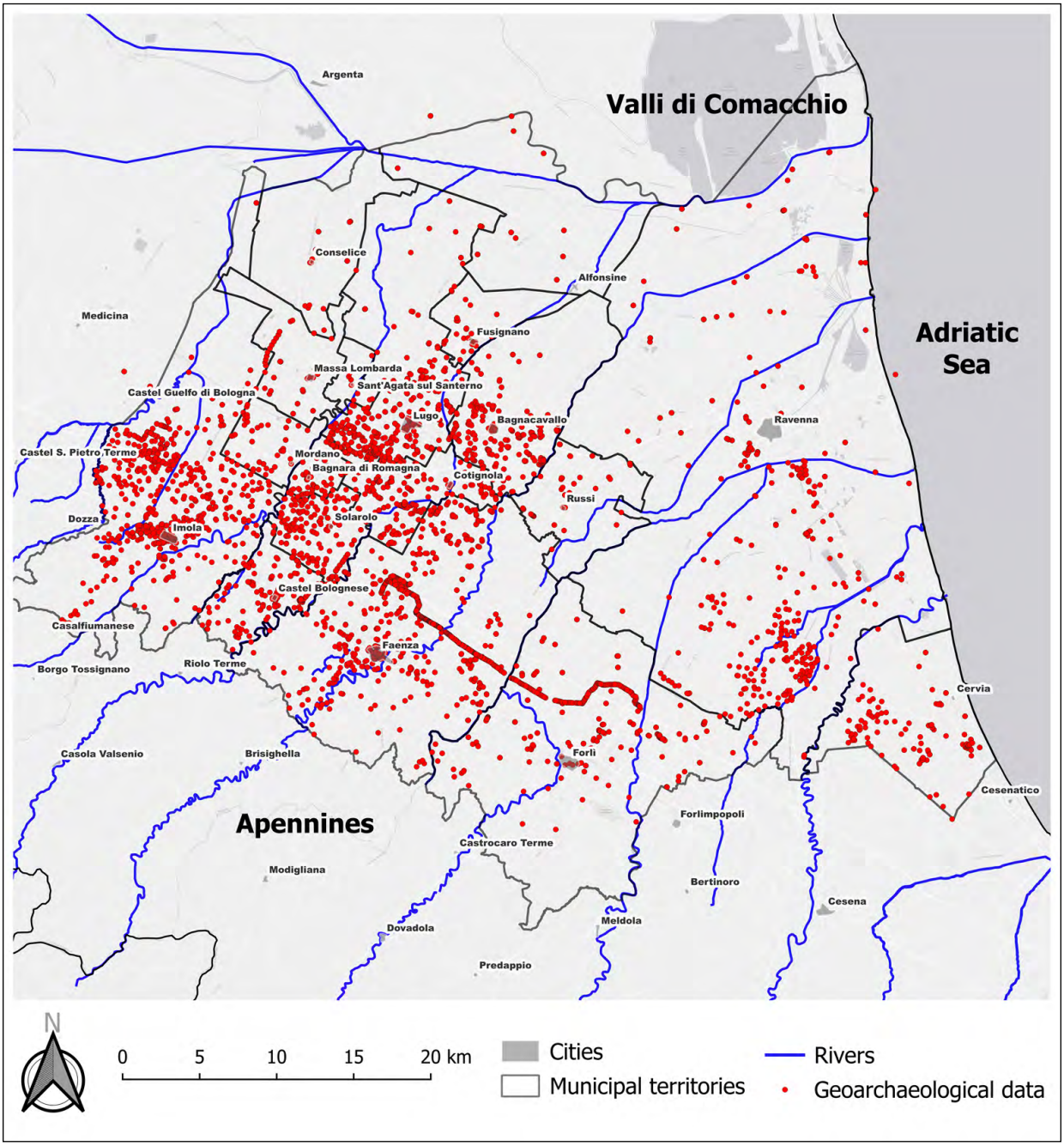

Figure 2 Map of the hinterland of Ravenna, showing municipal territories, main towns and rivers, and geoarchaeological data, with the Esri World Light Gray Base as the basemap.

CHRONOLOGY	RANGE	CHRONOLOGY	RANGE
Contemporary Age	19th–21st CE	Pre-Roman	
Modern Age	16th–18th CE	**Iron Age**	9th–3rd BCE
Post-medieval		Post-Bronze Age	
Late Middle Ages	13th–15th CE	**Bronze Age**	2300–10th BCE
Medieval		Pre-Bronze Age	
Early Middle Ages	7th–12th CE	**Neolithic**	5400–2300 BCE
Post-Roman		Pre-Neolithic	
Late Antiquity	4th–6th CE	**Mesolithic**	6500–5400 BCE
Roman Period	2nd BCE–3rd CE	**Palaeolithic**	pre-6500 BCE

Table 1 Chronological classification used with main periods in bold and intermediate stages.

VALUE	CHRONOLOGY TYPE	METHODS USED
5	Absolute dating	^{14}C and OSL dating
4	Archaeological chronology (certain/well-dated)	Chronology from archaeological excavation
3	Archaeological chronology (uncertain/poorly-dated)	Other archaeological chronologies (e.g., artefact survey, hand augering, and coring)
2	Stratigraphic correlation (certain)	Recognition of dated palaeosols/wetland layers
1	Stratigraphic correlation (uncertain)	Possible correlation with dated palaeosols/wetland layers
0	Unknown	Not enough data to propose a chronology

Table 2 Reliability values given to the chronological classification.

surface surveys and other non-invasive methods [3]. A substantial portion of the assigned chronologies relies on stratigraphic correlations, particularly through the lateral extent of well-recognised palaeosols or wetland layers. These correlations have been classified as either more robust [2] or more hypothetical [1], whereas some data remain uncategorised (0) due to insufficient chronological information.

This dataset is provided in two different formats to ensure ease of use, compatibility with a range of software applications, and reusability: a text file (.csv) and a GIS vector file (.gpkg).

Historical sites

Evidence of medieval sites was collected and digitised, including coordinates when available, from edited medieval written sources and published site catalogues. The focus was specifically on settlement sites, such as villages and castles, as well as religious sites, including parishes, churches, and monasteries. For most medieval sites, exact coordinates are given, which were retrieved from the analysed publications with locations based on place names and historical cartography [16–21].

LocalDEMs

For analyses of the geomorphology of the area, a local digital elevation model (LocalDEM) was created by interpolating manually recorded ground control points (GCP) collected by the Emilia-Romagna region. Starting from the original dataset of ~400.000 points downloaded from the Emilia-Romagna Geoportale, all elevation points not classified as "*isolato al suolo*" (= recorded on bare soil) were removed to filter out these modern disturbances such as artificial fluvial banks, streets, railroads, and the highway. The resulting ~160.000 points dataset was then interpolated using the Inverse Distance Weighting method to create a local elevation model at 10 m resolution devoid of modern interferences (Version v1). The same filtered points dataset has also been interpolated via co-kriging using FABDEM V1–2 [22] as the second correlated variable, via randomly sampling 250.000 locations for additional elevation data from this global DTM. The improved LocalDEM+ shares the same spatial dimension and 10 m pixel resolution, being as well devoid of modern interferences (Version v2).

Geoarchaeological marks

This linear vector dataset results from the systematic study of freely accessible aerial and satellite images, aimed at identifying marks interpretable as evidence of fluvial activity, such as palaeochannels or flood remains (e.g., crevasse splays). During this extensive analysis, numerous archaeological and anthropogenic features (e.g., canals, evidence of cultivation) were also identified. The study was facilitated by the large number of freely accessible digital sources (Table 3), provided in part by the Italian government and private companies. Notably, the advanced digitisation of topographical and geographical data provided by the Emilia-Romagna region through their Moka Content Management System (a GIS accessible online), further supported the analysis.

The systematic examination of available images led to the identification of almost one thousand individual marks, appearing in both bare and vegetated soils. Locally, negative soil marks were detected as discolourations in the ground, often caused by an abundance of sand grains, which result in a lighter colour due to reduced moisture retention and/or the peculiar physical properties of the soil: this effect is particularly evident in palaeochannels, crevasse splays, and dunes. In contrast, positive soil marks tend to appear over archaeological sites due to the higher concentration of organic matter in the soil. Instead, positive crop marks typically form in the presence of negative features like ditches or moats, which retain more moisture than the surrounding soil and promote lush vegetation growth. Negative crop marks, on the other hand, primarily occur in areas with fluvial evidence and dunes, as these locations, due to the abundance of sand grains, often stress plant growth by retaining less moisture [23–29].

The identified marks were vectorised in a GIS environment into a linear file and classified into six

SOURCE	YEAR	TYPE	SENSOR
Istituto Geografico Militare Italiano (IGMI), Volo GAI (Gruppo Aeronautico Italiano)	1954–1955	Aerial	B/W
Ministero dell'Ambiente e della Tutela del Territorio e del Mare (MATTM)	1988–1989 1994–1996 2000 2006–2007 2012	Aerial	B/W (first 2 series) RGB (last 3 series)
Agenzia per le Erogazioni in Agricoltura (AGEA)	2008, 2011	Aerial	RGB
Google Earth Pro	2003 – 2021	Satellite	RGB
Microsoft Bing	2009 – 2020	Satellite	RGB
Esri World Imagery	2011 – 2018	Satellite	RGB
Consorzio Telerilevamento agricoltura (TeA)	2014, 2017	Aerial	RGB
Compagnia Generale Riprese Aeree (CGR)	2018, 2020	Aerial	RGB NIR
PlanetScope	2018 – 2022	Satellite	RGB NIR

Table 3 List of aerial and satellite image sources analysed, including their temporal coverage, collection method, and type of sensor.

categories: archaeological site (certain), archaeological site (uncertain), field systems, fluvial traces, cultivation traces, and modern utilities.

Drone surveys of medieval sites

Drone images were collected for four abandoned fortified medieval sites between July 2020 and August 2022, during the summer period identified as most favourable for the appearance of archaeological marks based on legacy data analysis. The surveys aimed to validate features observed during satellite-based remote surveillance via PlanetScope satellite imagery, document them at higher resolution, and potentially identify new elements [14]. A DJI Mavic Pro 2 drone equipped with a 20-megapixel Hasselblad optical camera was used for this purpose. The sites investigated were:

1. S. Giovanni in Pentecaso, Massa Lombarda (RA), 44.479008, 11.811788;
2. Cavassona, Imola (BO), 44.443366, 11.777063;
3. *Castrum Taularie*, Imola (BO), 44.391166, 11.730569;
4. Montaccio, Imola (BO), 44.386165, 11.655489.

River and wetland evolution

The reconstructed diachronic evolution of rivers and wetlands in the hinterland of Ravenna is presented through two vector files: a linear file for rivers and a polygonal one for wetlands. The process began by digitalising the current state of use in 2022, based on satellite imagery (i.e., river courses and wetland extents), and then proceeded in reverse chronological order for earlier historical periods using a regressive approach. This method starts with the most recent and detailed data and works backwards in time, progressively integrating older sources to extend the reconstruction into earlier periods [for more details, refer to 30–33]. The approach involved copying digitised features from a more recent map (which generally had greater accuracy) and integrating them into earlier maps. The guiding principle was that wetlands gradually decreased in both number and extent over time. In practice, when digitising the state of use for an earlier period (e.g., 1853), water bodies from a more recent map (e.g., 1895) were often expanded, or new ones added, if wetlands shown on the earlier map had disappeared in the later one. The same approach was applied to the reconstruction of rivers and the (paleo) coastlines, enabling the precise mapping of numerous river avulsions and progressive coastal progradation.

For the last four centuries, the primary sources were historical maps, which are abundant for the Modern and Contemporary Ages. Selected maps (Table 4) were georeferenced through the Georeferencer GDAL core tool of QGIS, if not already digitally available in georeferenced format and importable into QGIS via Web Map Service (WMS) protocol. Following the same regressive methodology, evidence from written sources, mainly site locations in the medieval period, and geoarchaeological data, including archaeological sites, palaeosols, wetland layers, known landforms, and identified paleochannels, was used to extend the reconstruction further back in time, reaching as far as the Bronze Age. Of course, the further back the reconstruction extends, the less precise it becomes, so reconstructions for the Early Middle Ages and earlier should be interpreted with caution.

PalaeoDEMs modelling

The dataset comprises palaeoDEMs for the hinterland of Ravenna, generated by interpolating relevant data from the collected geoarchaeological records for four distinct chronological periods: the Bronze Age (~1000

NAME	YEAR	TYPE	SOURCE	GIS ACCESS	RECONSTRUCTED MAP
Romagna olim Flaminia by Giovanni Antonio Magini	1598	Local cartography	Faini & Majoli, 1992, pp. 22–23, fig. 3	Not georeferenceable	1598-early 17th century
Topografia della Romagnola by Andrea Pasolini	First half of the 17th century	Local cartography	Archivio del Comune di Lugo	Not georeferenceable	1598-early 17th century
Geografia del Territorio Bolognese by Camillo Sacenti	1651	Local cartography	Biblioteca Classense	Georeferenced	1651–1694
Territorio di Ravenna by Vincenzo Coronelli	1690	Local cartography	Visualizzare Ravenna website	Georeferenced	1651–1694
Legatione della Romagna by Abbate Filippo Titi	1694	Local cartography	Faini & Majoli, 1992, pp. 36–37, fig. 14	Georeferenced	1651–1694
Bassa Romagna nel Ducato di Ferrara by Luigi Manzieri	1750	Local cartography	Biblioteca Comunale Ariostea di Ferrara	Georeferenced	1750–1764
Pianta del Territorio Ravenna by Francesco Ginanni	1759	Local cartography	Visualizzare Ravenna website	Georeferenced	1750–1764
Carte du païs situé entre Bologne et Ferrare by Joseph Jérôme de Lalande	1761	Local cartography	Giberti, Ferri, & Nanetti, 2005, TerMap20	Georeferenced	1750–1764
Carta delle pinete ravennati by Francesco Ginanni	1764	Local cartography	Visualizzare Ravenna website	Georeferenced	1750–1764
Catasto Austriaco	1853	Regional cartography	Moka-GIS	WMS	1853
IGM Primo Impianto	1895	National cartography	Moka-GIS	WMS	1895
Google Earth	2022	Global satellite basemap	Google Earth Pro	WMS	2022

Table 4 List of cartographic sources used, detailing their dates, spatial coverage, origin, georeferencing status (whether pre-georeferenced via WMS or manually georeferenced for this study), and the chronological period they were used to reconstruct.

BCE), Roman period (~100 CE), Early Middle Ages (~1200 CE), and Late Middle Ages (~1400 CE). The complete workflow for palaeoDEM modelling is illustrated in Figure 3, detailing the analysis and refinement phases used to create an enhanced version of each diachronic model, referred to as palaeoDEM+.

Geoarchaeological data lacking relevant chronological attributes were filtered out from the original dataset. However, to maximise the available data for each model, information from earlier periods was also included, but only for depths of 0.5 m or less, a standard value representing agricultural ploughing depth, but also minimal or null over-flooding in subsequent periods. The altitude of each site and layer was extracted from LocalDEM+. Each DepthPoint vector file, produced for the four periods, was interpolated using Ordinary Kriging with linear trend removal and two variogram components (Gaussian and Linear) to produce four palaeoDEMs.

Since each palaeoDEM potentially contained information on geomorphological landforms, including ancient features now buried, they were processed using the Multi-Scale Relief Model (MSRM) algorithm [34] in Google Earth Engine [35], following a similar approach applied to present-day DEMs to identify fluvial and beach ridges in the region [36]. These morphometric analyses were carried out with minimum and maximum kernel sizes of 12 m and 4000 m and a scaling factor of 2, to highlight slightly elevated areas above the surrounding plain that correspond to (palaeo)landforms. All recognisable landforms were manually digitised into a polygonal vector file for each chronological period, referred to as PalaeoLandforms, taking into consideration relevant geoarchaeological data, as well as palaeochannels identified through remote sensing, and fluvial and beach ridges mapped in the present landscape [36]. To incorporate these geomorphological insights into the model, hundreds of "simulated" points were then generated, each assigned a specific depth value based on nearby data and local geomorphological insights. Specifically, simulated points within reconstructed PalaeoLandforms were used to better represent features known to be continuous, such as (buried) beach ridges, which were not consistently depicted in the palaeoDEMs due to the uneven distribution of geoarchaeological data across them. Additional points outside PalaeoLandforms, particularly in areas where extensive wetlands persisted until relatively recent times, were included to ensure a spatially complete raster fully covering the study area. Altitude values for all simulated points were extracted from LocalDEM+, with the actual elevation resulting by subtracting the assumed depth values from the computed altitude. These points were then merged with the original DepthPoints to create a PalaeoPoints vector file for each chronological period.

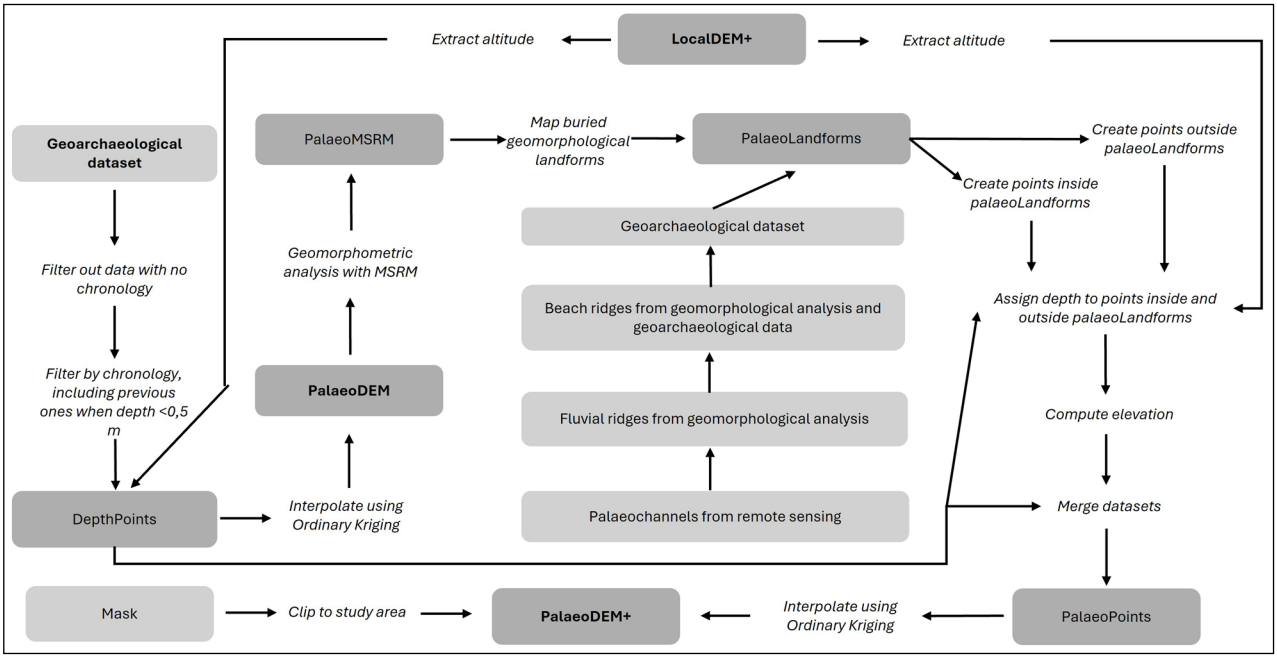

Figure 3 Workflow for large-scale palaeoDEM modelling, analysis and refinement. Input data in light grey coloured boxes, operations in italics, output products in dark grey coloured boxes with main output products in bold.

The PalaeoPoints file was then used for a second interpolation using Ordinary Kriging with linear trend removal and two variogram components (Gaussian and Linear), producing four PalaeoDEM+ models, one for each investigated period: the Bronze Age, Roman period, Early Middle Ages, and Late Middle Ages (Figure 4).

ArchaeoMAPs

The final dataset includes four ArchaeoMAPs that estimate the depth of the palaeosurface with potentially associated sites for the four chronological periods analysed, in relation to the current topography of the hinterland of Ravenna (Figure 5). These rasters were produced by subtracting the current topography, represented by the LocalDEM+ grid file, from each corresponding palaeoDEM+. The calculations were performed using the GDAL raster calculator, rounding all values to two decimal places. The depth of palaeosurfaces was capped at a "maximum" of –0.5 m, which, as previously explained, represents a standard value for agricultural ploughing depth. These four raster maps provide a continuous representation of the hinterland of Ravenna and allow for spatial analysis of the presumed depth of both exposed and buried palaeosurfaces. In practice, individual locations on each map can be interrogated to have an estimation of the supposed depth of a potential archaeological site of a specific time period across the entire study area.

SAMPLING STRATEGY

No specific sampling strategy was employed, with an effort to systematically incorporate all available geo-archaeological evidence. However, the geoarchaeological dataset remains partial for the urban centres of Imola, Faenza, Forlì, and Ravenna. Additionally, data collection may be less exhaustive for the Apennine portions of the municipalities of Imola, Castel Bolognese, Faenza, and Forlì. In the analysis of aerial and satellite imagery, the northern part of the study area was excluded due to recent land reclamation activities, while the abandoned city of Classe, just south of Ravenna, was also omitted as it has already been the subject of a detailed study [37], although some relevant discoveries have been recently made there through remote sensing [38].

QUALITY CONTROL

Significant uncertainties exist regarding the spatial accuracy of the geoarchaeological data due to the highly heterogeneous nature of the sources. Data collected from projects conducted by the University of Bologna generally offer high accuracy, as they were based on access to original spatial data. Similarly, archival records from the Soprintendenza provide good precision when available in digital format (e.g., GIS or CAD formats), as opposed to paper-based archaeological documentation such as maps or sketches. Greater uncertainty surrounds the data provided by the regional authorities, which were supplied in digital format but without information on the original data collection methods. Assessing the accuracy of data derived from archaeological maps and literature is even more challenging, as some were compiled decades ago, making their original precision uncertain. In general, all collected data were digitised and georeferenced in a GIS environment whenever possible, to ensure a limited positioning error that would not compromise the objectives of the research.

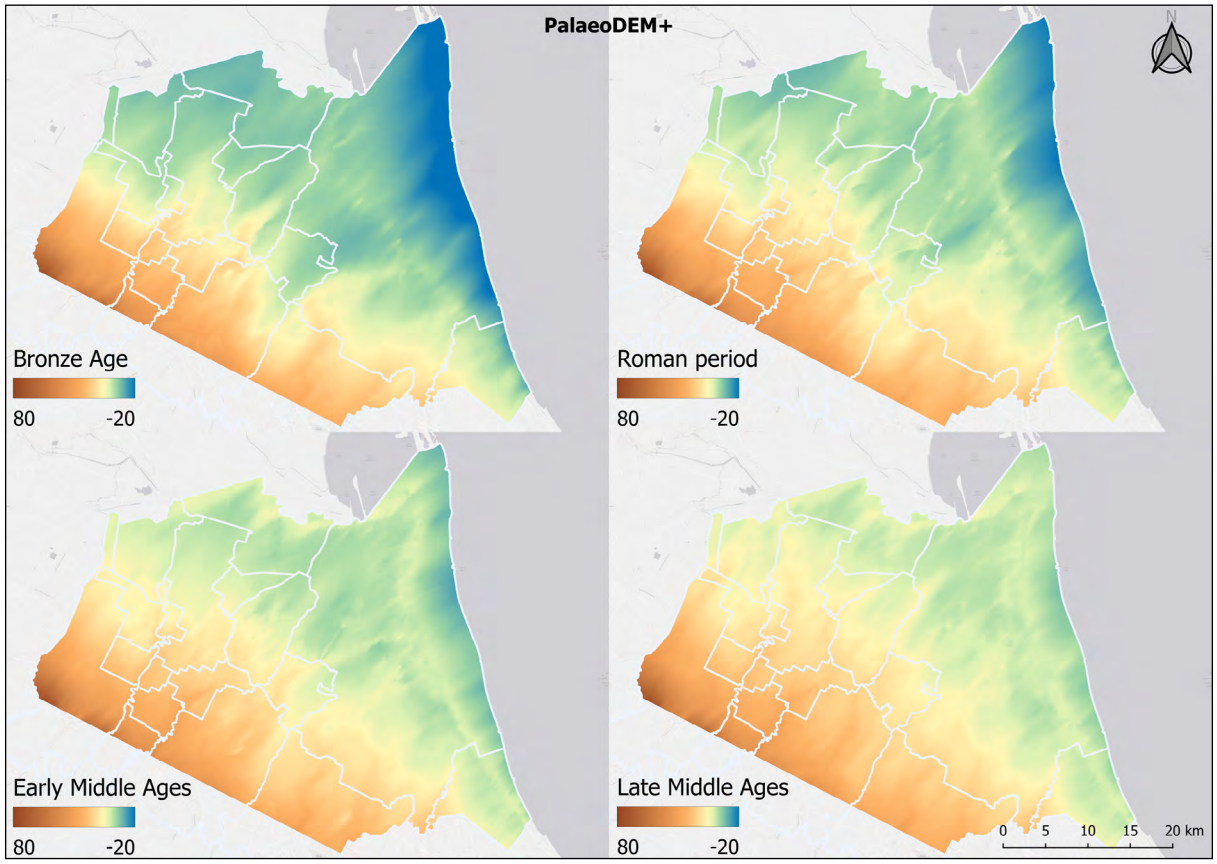

Figure 4 PalaeoDEM+ generated by integrating original geoarchaeological data with "simulated" data for a refined reconstruction of the diachronic evolution of the palaeotopography of the hinterland of Ravenna.

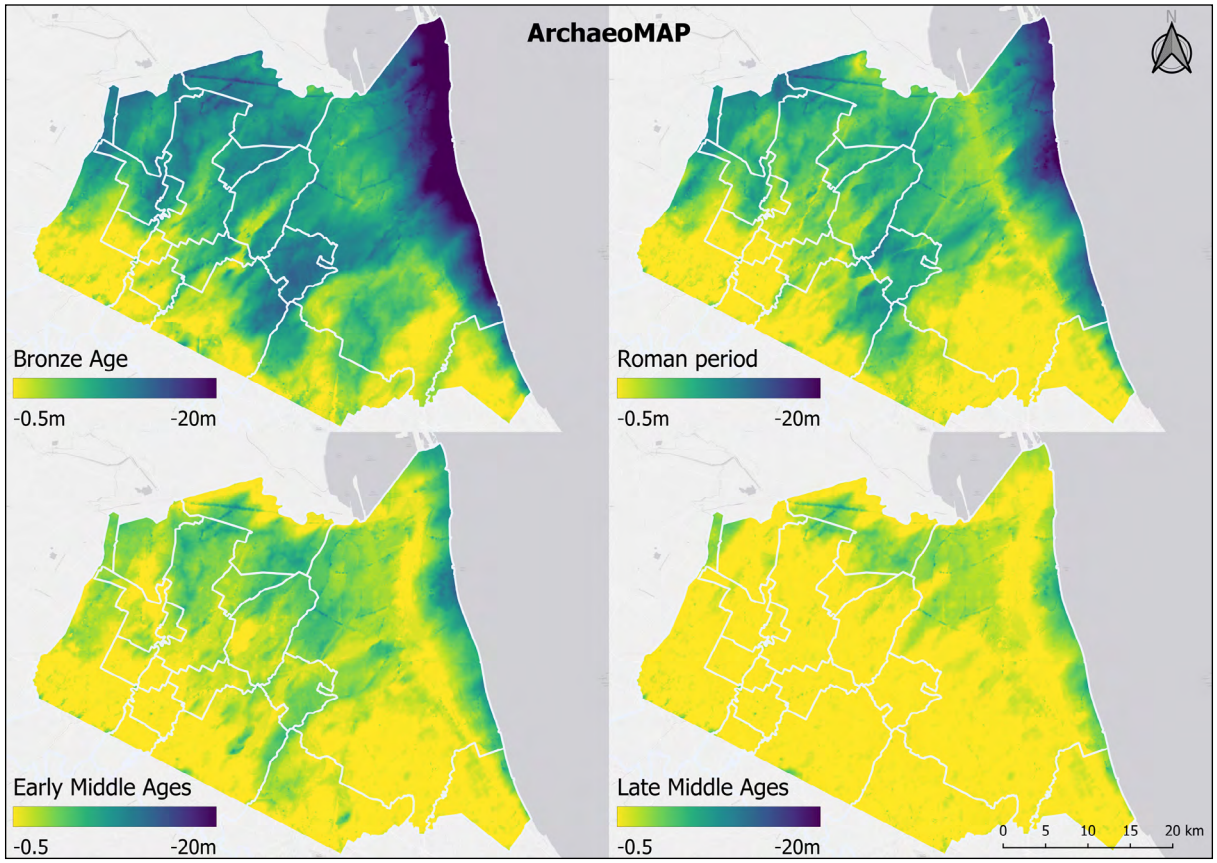

Figure 5 ArchaeoMAPs generated by subtracting the current topography, represented by the LocalDEM+ grid, from each corresponding palaeoDEM+, thereby highlighting the estimated depths of palaeosurfaces and potential archaeological remains of the hinterland of Ravenna for the four chronological periods analysed.

CONSTRAINTS

There are various constraints associated with each type of data collected. In particular, the spatial accuracy of archaeological data varies significantly in a way that is often difficult to assess precisely. Chronologically, the dataset also presents challenges due to the limited presence of stratigraphic sequences dated using absolute dating methods and the prevalence of archaeological survey data, many of which were collected using non-systematic methods in the 20th century. This likely led to a bias favouring the identification of Roman sites over those from earlier or later periods [1]. Regarding medieval sites, a systematic collection of data from primary written sources, even published ones, has not been undertaken. Additionally, post-medieval data are currently lacking, as no systematic cataloguing of relevant sites has been conducted, such as religious buildings that proliferated from the Late Middle Ages onwards. Regarding geoarchaeological marks, this dataset cannot be considered exhaustive, due to intentional exclusions (e.g., the northern portion of the study area and Classe) and the inherently ephemeral nature of crop and soil marks. Furthermore, the reconstruction of river courses and wetland extents over time is relatively simplistic (static) and often based on limited data. This is particularly critical for earlier periods, especially before the Early Middle Ages, requiring cautious interpretation: revising these reconstructions as new data become available is strongly recommended. The same recommendation applies to the PalaeoDEMs, whose accuracy is directly influenced by the quantity and quality of the data used, which is unfortunately limited for such a wide area. The data used to build these models have relatively low spatial coverage and temporal resolution, introducing uncertainties that are difficult to mitigate, particularly in areas with little available evidence, such as former wetland regions. Nevertheless, the approach developed to simulate additional points representing known ridges to their full extent has significantly improved the spatial coverage and predictive accuracy of the original PalaeoDEMs. As a result, the four enhanced PalaeoDEM+ models can be considered successful in reconstructing the diachronic evolution of the palaeotopography of the alluvial plain around Ravenna, which has been affected by significant fluvial aggradation. However, like all models, these should be viewed, and ideally used, with the understanding that they represent an attempt at reconstruction rather than an exact reproduction of past landscapes. Making the underlying data and models openly available will hopefully help ensure that they are not viewed as static or definitive but as evolving resources that can be continuously verified and updated as new data and knowledge become available.

(3) DATASETS DESCRIPTION

DATASETS AND OBJECTS NAME

- Geoarchaeological dataset for the hinterland of Ravenna https://doi.org/10.5281/zenodo.8043319
  - Ravenna_hinterland_geoarchaeological_data.csv = text file with the full geoarchaeological dataset
  - Ravenna_hinterland_geoarchaeological_data.gpkg = vector file with the full geoarchaeological dataset
  - Ravenna_hinterland_archaeological_site.gpkg = vector file with archaeological sites extent
  - Ravenna_hinterland_geoarchaeological_data_metadata.txt = text file with metadata of geoarchaeological dataset
  - Ravenna_hinterland_geoarchaeological_dataset_bibliography.odt = text file with bibliographical references of geoarchaeological dataset
  - Ravenna_hinterland_geoarchaeological_dataset_archaeological_reports.odt = reference file with the list of unpublished archaeological reports collected from SABAP-RA and SABAP-BO
  - Ravenna_hinterland_geoarchaeological_dataset_archaeological_reports.bib = reference file with the list of unpublished archaeological reports collected from SABAP-RA and SABAP-BO
  - Ravenna_hinterland_geoarchaeological_dataset_geological_reports.bib = reference file with the list of raw geological reports from SGSS available online

- Medieval sites in the hinterland of Ravenna https://doi.org/10.5281/zenodo.8043347
  - Ravenna_hinterland_medieval_sites.csv = text file with the medieval sites dataset
  - Ravenna_hinterland_medieval_sites_metadata.txt = text file with metadata of medieval sites dataset
  - Ravenna_hinterland_bibliography.docx = text file with bibliographical references of known medieval sites dataset

- LocalDEM+ of the hinterland of Ravenna https://doi.org/10.5281/zenodo.8043366
  - Ravenna_hinterland_LocalDEM+.tif = DEM raster file at 10 m resolution, free of modern interferences
  - Ravenna_hinterland_LocalDEM+.gpkg = a vector point file containing the elevation data used to model the LocalDEM+

- Remotely sensed geoarchaeological marks in the hinterland of Ravenna https://doi.org/10.5281/zenodo.8043356
  - Ravenna_hinterland_marks.gpkg = vector file with the full geoarchaeological marks dataset

- Ravenna_hinterland_marks_metadata.txt = text file with metadata of geoarchaeological marks dataset

- Deserted medieval fortified settlements in the hinterland of Ravenna seen from drone https://doi.org/10.5281/zenodo.8042145
  - 1. Cavassona (14-07-2020).zip = archive file with drone photos in .jpg format of Cavassona site in Imola shot on the 14th of July 2020
  - 1. *Castrum Taularie* (14-07-2020).zip = archive file with drone photos in .jpg format of *Castrum Taularie* site in Imola shot on the 14th of July 2020
  - 2. *Castrum Taularie* (18-07-2021).zip = archive file with drone photos in .jpg format of *Castrum Taularie* site in Imola shot on the 18th of July 2021
  - 1. S. Giovanni in Pentecaso (27-07-2021).zip = archive file with drone photos in .jpg format of S. Giovanni in Pentecaso site in Massa Lombarda shot on the 27th of July 2021
  - 2. S. Giovanni in Pentecaso (08-08-2022).zip = archive file with drone photos in .jpg format of S. Giovanni in Pentecaso site in Massa Lombarda shot on the 8th of August 2022
  - 1. Montaccio (06-08-2022).zip = archive file with drone photos in .jpg format of Montaccio site in Imola shot on the 6th of August 2022

- Rivers evolution in the hinterland of Ravenna https://doi.org/10.5281/zenodo.8043243
  - Ravenna_hinterland_historical_rivers.gpkg = vector file mapping the reconstructed evolution of the river network
  - Ravenna_hinterland_historical_rivers_metadata.txt = text file with metadata of reconstructed evolution of the river network

- Wetlands evolution in the hinterland of Ravenna https://doi.org/10.5281/zenodo.8043221
  - Ravenna_hinterland_historical_wetlands.gpkg = vector file mapping the reconstructed evolution of the wetlands
  - Ravenna_hinterland_historical_wetlands_metadata.txt = text file with metadata of reconstructed evolution of the wetlands

- PalaeoDEMs of the hinterland of Ravenna https://doi.org/10.5281/zenodo.14534156
  - Ravenna_hinterland_PalaeoDEM_data.gpkg = vector point file containing filtered geoarchaeological data from Geoarchaeological dataset for the hinterland of Ravenna according to four chronological periods
  - Ravenna_hinterland_PalaeoDEM_Bronze.tif = raster file of palaeoDEM for the Bronze Age
  - Ravenna_hinterland_PalaeoDEM_Roman.tif = raster file of palaeoDEM for the Roman period
  - Ravenna_hinterland_PalaeoDEM_Early.tif = raster file of palaeoDEM for the Early Middle Ages
  - Ravenna_hinterland_PalaeoDEM_Late.tif = raster file of palaeoDEM for the Late Middle Ages
  - Ravenna_hinterland_PalaeoDEM_extrafiles.zip = archive folder contening raster files of palaeoDEM uncertainty (SD) of four chronological periods, text files with reports of data analysis and interpolation, and related metadata
  - Ravenna_hinterland_PalaeoDEM_MSRM.zip = archive folder contening raster files of palaeoDEMs processed with the MSRM algorithm [1], text file with GGE [2] scripts, and related metadata
  - Ravenna_hinterland_PalaeoDEM_PalaeoLandforms.gpkg = vector point file containing reconstructed fluvial and coastal landforms for four chronological periods
  - Ravenna_hinterland_PalaeoDEM_PalaeoPoints.gpkg = vector point file containing geoarchaeological data and simulated points inside and outside landforms according to four chronological periods
  - Ravenna_hinterland_PalaeoDEM+_Bronze.tif = raster file of palaeoDEM+ for the Bronze Age
  - Ravenna_hinterland_PalaeoDEM+_Roman.tif = raster file of palaeoDEM+ for the Roman period
  - Ravenna_hinterland_PalaeoDEM+_Early.tif = raster file of palaeoDEM+ for the Early Middle Ages
  - Ravenna_hinterland_PalaeoDEM+_Late.tif = raster file of palaeoDEM+ for the Late Middle Ages
  - Ravenna_hinterland_PalaeoDEM+_extrafiles.zip = archive folder contening raster files of palaeoDEM+ uncertainty (SD) of four chronological periods, text files with reports of data analysis and interpolation, and related metadata
  - Ravenna_hinterland_PalaeoDEM_verification_data.gpkg = vector point file containing additional geoarchaeological data for the evaluation of PalaeoDEM and PalaeoDEM+ for each chronological period

- ArchaeoMAPs of the hinterland of Ravenna https://doi.org/10.5281/zenodo.8043377
  - Ravenna_hinterland_ArchaeoMAP_Bronze.tif = raster file depicting the supposed depth of the Bronze Age palaeosurface and potentially associated archaeological sites
  - Ravenna_hinterland_ArchaeoMAP_Roman.tif = raster file depicting the supposed depth of the Roman period palaeosurface and potentially associated archaeological sites
  - Ravenna_hinterland_ArchaeoMAP_Early.tif = raster file depicting the supposed depth of the Early Middle Ages palaeosurface and potentially associated archaeological sites
  - Ravenna_hinterland_ArchaeoMAP_Late.tif = raster file depicting the supposed depth of the Late Middle Ages palaeosurface and potentially associated archaeological sites

DATA TYPE
Primary data, secondary data, processed data, and interpretation of data.

FORMAT NAMES AND VERSIONS
GPKG, TIF, ZIP, CSV, TXT, DOCX, RTF, ODT, BibTeX.

CREATION DATES
The datasets were created between 2018 and 2023 as part of the PhD project "*Geoarchaeology and palaeoDEMs modelling to assess the archaeological potential of Ravenna and its hinterland*" at Ghent University/University of Verona. They were finalised between 2023 and 2025 as part of a research fellowship supported by ERC grant SSE1K, GA 101044437, DOI 10.3030/101044437.

DATASET CREATOR
Michele Abballe, Data Collector, Ca' Foscari University of Venice (ORCID ID: 0000-0002-0557-1449)

LANGUAGE
English

LICENSE
CC0

REPOSITORY LOCATION
The datasets are available at the following Zenodo community: https://zenodo.org/communities/geoarchaeology-palaeodems-ravenna-hinterland/

PUBLICATION DATE
06/09/2023 – 31/01/2025

(4) REUSE POTENTIAL

The collection of datasets represents the most comprehensive and systematic collection of archaeological and geoarchaeological data for the hinterland of Ravenna, integrating archaeological and geological stratigraphic information reinterpreted within a geoarchaeological framework for the first time. As such, it may serve as a primary resource for studying this region from ~10,000 BCE to the present. The palaeolandscape reconstructions offered by the PaleoDEM+ models have significant potential for further modelling applications, including predictive analyses of settlement patterns, land-use/land-cover reconstructions, and simulations of past flooding processes. More broadly, they are valuable in any application that relies on deriving geographical variables from topography to modelling past landscape processes and phenomena. Instead of relying solely on present-day terrain data, these reconstructions provide a more robust foundation for reconstructing historical landscape dynamics, including but not limited to land use, vegetation cover, flood dynamics, and settlement location preferences.

Beyond academic research, both the raw data and reconstructive models can contribute significantly to Archaeological Resource Management (ARM) locally. In particular, the geoarchaeological dataset can serve as a valuable starting point for desktop-based assessments in preventive archaeology, implementing with more geoarchaeological data the recently released *Geoportale Nazionale per l'Archeologia* [39]. Additionally, the ArchaeoMAPs derived from the PalaeoDEM models represent a substantial improvement over existing archaeological maps, which are often highly schematic and lack detailed palaeotopographic reconstructions. Crucially, they can help estimate the depth of potential buried palaeosurfaces and associated archaeological sites across different periods. When combined with other reconstructed features, such as landforms, palaeochannels, and wetland extents, these models may allow for a more meaningful prediction of site potential at specific depths, based on the expected environmental context (e.g., dryland vs wetland, floodplain vs ridge).

ACKNOWLEDGEMENTS

This PhD project was carried out at the Department of Archaeology, Ghent University, and funded by the Bijzonder Onderzoeksfonds UGent (BOF) under Grant number BOF.FJD.2017.0002.01. This PhD research was carried out within the joint PhD Programme in Arts and Archaeology together with the University of Verona. Additional financial support was awarded by the Fonds Wetenschappelijk Onderzoek (FWO) via three Grants for long stays abroad at the University of Bologna for literature studies, archival research, and fieldwork activities (under Grant numbers V421419N, V430720N, and V409421N).

Archaeological fieldwork was carried out within the RA.LA project, a research project run by the University of Bologna in the hinterland of Ravenna under the direction of Prof. Andrea Augenti. Authorisations for the fieldwork were granted by the Ministero della Cultura – Soprintendenza Archeologia, Belle Arti e Paesaggio per la città metropolitana di Bologna e le province di Modena, Reggio Emilia e Ferrara (no. 14787-A of 10/07/2020) and Soprintendenza Archeologia Belle Arti e Paesaggio per le province di Ravenna, Forlì-Cesena e Rimini (no. 9044-P of 15/07/2020).

Access to unpublished archaeological reports was granted by the Soprintendenza Archeologia, Belle Arti e Paesaggio per la città metropolitana di Bologna e le province di Modena, Reggio Emilia e Ferrara (no. 15184 of 15/07/2020) and Soprintendenza Archeologia Belle Arti e Paesaggio per le province di Ravenna, Forlì-Cesena e Rimini (no. 11164 of 24/08/2018; no. 13838 of 17/10/2018; no. 7271 of 31/05/2019; no. 7498 of 06/06/2019; no. 12098

of 13/09/2019; no. 9231 of 17/07/2020; 13119 of 09/10/2020; no. 16989 of 16/12/2020; no. 2519-P of 12/02/2025).

FUNDING INFORMATION

The PhD project at Ghent University/University of Verona was funded by the Bijzonder Onderzoeksfonds UGent (BOF) under Grant number BOF.FJD.2017.0002.01 and supported by three Grants for long stays abroad by the Fonds Wetenschappelijk Onderzoek (FWO) under Grant numbers V421419N, V430720N, and V409421N. The research fellowship at Ca' Foscari University of Venice is supported by ERC grant SSE1K, GA 101044437, DOI 10.3030/101044437. Views and opinions expressed are however those of the author only and do not necessarily reflect those of the European Union or the European Research Council Executive Agency. Neither the European Union nor the granting authority can be held responsible for them.

COMPETING INTERESTS

The author has no competing interests to declare.

AUTHOR AFFILIATIONS

Michele Abbalie orcid.org/0000-0002-0557-1449
Postdoctoral Research Fellow, Department of Humanities, Ca' Foscari University of Venice, Dorsoduro 3484/D, Calle Contarini, 30123, Venezia (VE), Italy

REFERENCES

1. **Abbalie M.** *A capital between lands and waters: reconstructing the evolution of the alluvial landscape around Ravenna through digital and field geoarchaeology*. unpublished PhD Thesis. Ghent: Ghent University/University of Verona; 2023.
2. **Stefani M.** The Po Delta Region: Depositional Evolution, Climate Change and Human Intervention Through the Last 5000 Years. In: Soldati M, Marchetti M, editors. *Landscapes and Landforms of Italy*. Cham: Springer International Publishing; 2017. pp. 193–202. DOI: https://doi.org/10.1007/978-3-319-26194-2_16
3. **Abbalie M, Bondi M, Cavalazzi M.** Le aree umide e lagunari tra la costa e l'entroterra ravennate: metodi di indagine ed evoluzione del paesaggio dall'età romana al Medioevo. *L'ARCHEOLOGO SUBACQUEO*. 2024;30(76):1–13. DOI: http://doi.org/10.4475/0772_5
4. **Marabini S, Vai GB.** *Carta geologica della pianura tra Imola e Ravenna: guida alla lettura*. Imola: Thèodolite editore; 2020. Available at https://www.socgeol.it/files/download/notizie%20dal%20mondo%20della%20geologia/Guida_alta.pdf.
5. **Abbalie M.** Geoarchaeological mapping of medieval wetlands and their reclamation in the hinterland of Ravenna: two case studies from Massa Lombarda (RA) and Villafranca Di Forlì (FC). *ArcheoLogica Data*. 2022;2:42–62. DOI: http://doi.org/10.13131/unipi/2785-0668/n4tg-xz64
6. **Abbalie M, Cavalazzi M, Fiorotto C.** Integrated Approaches to Understanding Complex Long-Term Reclamation Processes in the Hinterland of Ravenna (Italy). *Journal of Wetland Archaeology*. 2022;22(1–2):112–142. DOI: https://doi.org/10.1080/14732971.2022.2083798
7. **Amorosi A, Bruno L, Cleveland DM, Morelli A, Hong W.** Paleosols and associated channel-belt sand bodies from a continuously subsiding late Quaternary system (Po Basin, Italy): New insights into continental sequence stratigraphy. *GSA Bulletin*. 2017;129(3–4):449–463. DOI: https://doi.org/10.1130/B31575.1
8. **Bruno L, Campo B, Hajdas I, Hong W, Amorosi A.** Timing and mechanisms of sediment accumulation and pedogenesis: Insights from the Po Plain (northern Italy). *Palaeogeography, Palaeoclimatology, Palaeoecology*. 2022;591:110881. DOI: https://doi.org/10.1016/j.palaeo.2022.110881
9. **Cremonini S, Bassetti M.** Contesto morfo-sedimentario Olocenico e processi naturali di formazione del sito. In: Staffè G, Degasperi N. editors. *Il villaggio neolitico di Lugo di Romagna – Fornace Gattelli. Strutture Ambiente Culture*. Origines 34. Firenze: Istituto Italiano di Preistoria e Protostoria; 2019. pp.29–48.
10. **Mancassola N.** Le Forme Del Popolamento Rurale Nel Territorio Decimano Dalla Caduta Dell'Impero Romano All'anno Mille. In: Ficara M, Manzelli V, editors. *Orme nei campi. Archeologia a sud di Ravenna*. Quaderni di archeologia dell'Emilia-Romagna 20. Borgo S. Lorenzo (FI): All'Insegna del Giglio; 2008. pp. 89–104.
11. **Cavalazzi M, Abbalie M, Benato A, De Felicibus M.** Archeologia dei paesaggi in Bassa Romagna. Il progetto Bassa Romandiola (2009–2016). *Archeologia medievale: cultura materiale, insediamenti, territorio*. 2018;XLV:317–334. DOI: https://doi.org/10.1400/270084
12. **Augenti A, Bondi M, Cavalazzi M, Fiorini A, Sericola M.** Archeologia dei paesaggi nel territorio ravennate: il Progetto Cervia. *Archeologia medievale: cultura materiale, insediamenti, territorio*. 2020;XLVII:115–139. DOI: https://doi.org/10.36153/am47.2020.06
13. **Cavalazzi M, Abbalie M, Ferrari A.** Landscape archaeology in the Ravenna hinterland: the survey at Cotignola (RA), 2018. *FOLD&R*. 2022;18:1–20. Available at https://www.fastionline.org/docs/FOLDER-sur-2022-18.pdf.
14. **Abbalie M.** Legacy imagery, continuous satellite monitoring and targeted drone surveys for the study of deserted medieval fortified settlements in the hinterland of Ravenna, Italy. *Archeologia e Calcolatori*. 2023;34(2):225–246. DOI: https://doi.org/10.19282/ac.34.2.2023.12

15. **Abbalie M.** *Geoarchaeological hand augering in the hinterland of Ravenna (2018–2020)* – (Dataset). Pisa: MappaOpenData; 2021. DOI: http://doi.org/10.13131/unipi/xakr-qc30
16. **Mancini W, Vichi F.** *Castelli Rocche e Torri di Romagna*. Bologna: Edizioni ALFA; 1959.
17. **Montevecchi F.** Repertorio dei Castelli, Rocche e Torri. In: Gazzola P, Fontana GF, Berardi D, editors. *Rocche e castelli di Romagna. Vol. I Imola, Faenza e il Ravennate*. Bologna: Alfa; 1970. pp. 139–400.
18. **Montevecchi F.** Repertorio dei Castelli, Rocche e Torri. In: Berardi D, Gazzola P, Fontana GF, editors. *Rocche e castelli di Romagna. Vol. II Cesena e il Forlivese*. Bologna: Alfa; 1970. pp. 107–432.
19. **Mascanzoni L.** *La "Descriptio romandiole" del Card. Anglic: introduzione e testo*. Bologna: La Fotocromo Emiliana; 1985.
20. **Augenti A, Ficara M, Ravaioli E.** *Atlante dei beni archeologici della provincia di Ravenna. Vol. 1: Il paesaggio monumentale nel Medioevo*. Studi e Scavi 35. Bologna: Ante Quem; 2012.
21. **Ravaioli E.** *L'insediamento fortificato in Romagna tra fonti scritte e dati archeologici (VIII–XVI sec.): le province di Forlì-Cesena e Ravenna*. Bologna: Bononia University Press; 2015.
22. **Hawker L, Uhe P, Paulo L, Sosa J, Savage J, Sampson C, Neal J.** A 30 m global map of elevation with forests and buildings removed. *Environmental Research Letters*. 2022;17(2):024016. DOI: https://doi.org/10.1088/1748-9326/ac4d4f
23. **Edis J, Macleod D, Bewley R.** An archaeologist's guide to classification of cropmarks and soilmarks. *Antiquity*. 1989;63(128):112–126. DOI: https://doi.org/10.1017/S0003598X00075621
24. **Lasaponara R, Masini N.** Detection of archaeological crop marks by using satellite QuickBird multispectral imagery. *Journal of Archaeological Science*. 2007;34(2):214–221. DOI: https://doi.org/10.1016/j.jas.2006.04.014
25. **Fowler MJF.** Satellite Imagery and Archaeology. In: Cowley DC, Standring RA, Abicht MJ, editors. *Landscapes through the Lens. Aerial Photographs and Historic Environment*. Oxford: Oxbow Books; 2010. pp. 99–110. DOI: https://doi.org/10.2307/jj.18255587.14
26. **Verhoeven G, Sevara C, Karel W, Ressl C, Doneus M, Briese C.** Undistorting the past: new techniques for orthorectification of archaeological aerial frame imagery. In: Corsi C, Slapšak B, Vermeulen F, editors. *Good practice in archaeological diagnostics: non-invasive survey of complex archaeological sites*. Cham: Springer; 2013. pp. 31–67. DOI: https://doi.org/10.1007/978-3-319-01784-6_3
27. **Ceraudo G.** Aerial Photography in Archaeology. In: Corsi C, Slapšak B, Vermeulen F, editors. *Good practice in archaeological diagnostics: non-invasive survey of complex archaeological sites*. Cham: Springer; 2013. pp. 11–30. DOI: https://doi.org/10.1007/978-3-319-01784-6_2
28. **Musson C.** Flights into the Past. In: Musson C, Palmer R, Campana S, editors. *Flights into the past: aerial photography, photo interpretation and mapping for archaeology*. Occasional Publication of the Aerial Archaeology Research Group 4. Heidelberg: AARG – Arcland; 2013. pp. 11–155.
29. **Czajlik Z, Árvai M, Mészáros J, Nagy B, Rupnik L, Pásztor L.** Cropmarks in Aerial Archaeology: New Lessons from an Old Story. *Remote Sensing*. 2021;13(6):1126. DOI: https://doi.org/10.3390/rs13061126
30. **Tabacco G.** Problemi di insediamento e di popolamento nell'alto medioevo. *Rivista storica italiana*. 1967;79:67–110.
31. **Coste J.** La méthode régressive. In: Noyé G, editors. *Structures de l'habitat et occupation du sol dans les pays méditerranéens*. Collection de l'École Française de Rome 105. Paris: Casa de Velázquez; 1988. pp. 241–246.
32. **Abbé J-L.** Le paysage peut-il être lu à rebours? Le paysage agraire médiéval et la méthode régressive. In: Cursente B, Mousnier M, editors. *Les territoires du médiéviste*. Rennes: Presses universitaires de Rennes: Rennes; 2005. pp. 383–399. DOI: https://doi.org/10.4000/books.pur.8207
33. **Carocci S.** "Metodo regressivo" e possessi collettivi: i "demani" del Mezzogiorno (sec. XII–XVIII). In: Boisseuil D, Chastang P, Feller L, Morsel J, editors. *Écritures de l'espace social*. Paris: Éditions de la Sorbonne; 2010. pp. 541–555. DOI: https://doi.org/10.4000/books.psorbonne.11261
34. **Orengo HA, Petrie CA.** Multi-scale relief model (MSRM): a new algorithm for the visualization of subtle topographic change of variable size in digital elevation models. *Earth Surface Processes and Landforms*. 2018;43(6):1361–1369. DOI: https://doi.org/10.1002/esp.4317
35. **Gorelick N, Hancher M, Dixon M, Ilyushchenko S, Thau D, Moore R.** Google Earth Engine: Planetary-scale geospatial analysis for everyone. *Remote Sensing of Environment*. 2017;202:18–27. DOI: https://doi.org/10.1016/j.rse.2017.06.031
36. **Abbalie M, Cavalazzi M.** Morphometric analysis for geoarchaeological research: from testing different methods to results verification in the Romagna plain. *Archeologia e Calcolatori*. 2021;32(1):117–136. DOI: https://doi.org/10.19282/ac.32.1.2021.07
37. **Boschi F.** *Tracce di una città sepolta. Aerofotografia e geofisica per l'archeologia di Classe e del suo territorio*. Studi e Scavi 34. Bologna: Ante Quem; 2012.
38. **Abbalie M, Cavalazzi M.** Traces around a capital: the hinterland of Ravenna through remote sensing. *GROMA: Documenting Archaeology*. 2023;6(2021):3–26. DOI: https://doi.org/10.32028/Groma-Issue-6-2021-1937
39. **Calandra E.** Il Geoportale Nazionale per l'Archeologia, in *L'archeologia preventiva nel quadro del Recovery Plan*. Atti dei Convegni Lincei 334. Roma: Bardi Edizioni; 2022. pp. 71–77.

TO CITE THIS ARTICLE:
Abballe M 2025 Geoarchaeology and PalaeoDEMs Modelling to Assess the Archaeological Potential of Ravenna and Its Hinterland. *Journal of Open Archaeology Data,* 13: 7, pp. 1–15. DOI: https://doi.org/10.5334/joad.148

Submitted: 13 February 2025 **Accepted:** 22 April 2025 **Published:** 29 April 2025

COPYRIGHT:
© 2025 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.