ARCHEOLOGICA DATA, II, 2022
DOI 10.13131/UNIPI/2785-0668/A2KY-A663

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SAMPLING IN HISTORICAL WETLANDS: A DATASET FOR ADDRESSING LANDSCAPE ARCHAEOLOGY IN BASSA ROMAGNA (RAVENNA HINTERLAND, NORTHERN ITALY)

Abstract: this paper aims to present the dataset collected in 2008-2009, during the preliminary phase of the "Bassa Romandiola" project (University of Bologna), a landscape archaeological project that investigates the hinterland of Ravenna (northeastern Italy); the city is located in the south-eastern Po Valley lowland, near the northern Adriatic coast. The dataset was produced through a review of all the already published materials, such as studies and reports (both historical and archaeological), and maps; it consists of 625 entries, divided into 4 main categories (Environmental features; Infrastructures; Archaeological discoveries; Historical sites). The paper also compares the outcomes of this preliminary research phase with the results of ten years of artefact survey (2009-present). The dataset discussed here brings about a significant advancement in the knowledge of this region. Indeed, previous studies were fragmented, focused on a single historical period, or characterised by a monodisciplinary approach. Finally, this dataset allowed us to define the best sampling strategy for the following artefacts surveys and was fundamental to ensure the success of the project in such a complex environment.

Keywords: Ravenna hinterland, Wetland archaeology, Artefact survey, Sampling strategy.

1. Introduction

The impact of geopedological biases is well-known by landscape archaeologists since the 1960s and 1970s (Vita-Finzi, 1969; Terrenato, 2004, p. 39). However, such biases reach a tipping point in the case of alluvial floodplains (Brown, 1997), where alluvial phenomena cross subsidence and, thus, cause a relevant growth of ground level. These areas have been defined, from an archeological perspective, as clay-landscape with 'difficult' soils (Mills, 2007, pp. 132-134). In addition to this, wetlands may have been present in floodplains and these have been usually reclaimed only recently, mostly for agricultural purposes. Thus, archaeologists that are set to work in this kind of environment have to deal with a landscape that is today very different from the past; this element makes the interpretation and synthesis of the archaeological data more difficult.

The area considered in this paper presents many of the biases just detailed; it is situated in the northern part of the Ravenna hinterland (northeastern Italy), a sub-region that is called *Bassa Romagna* and it includes the south-eastern part of the Po Valley, near the northern Adriatic coast (fig. 1). The historical and archaeological investigations that analysed the Po Valley region have to face the impact of the environmental factors on the evolution of historical socio-ecological systems. Furthermore, the geopedological biases discussed above strongly affect the results of archaeological investigations. Researchers tried to solve this problem by

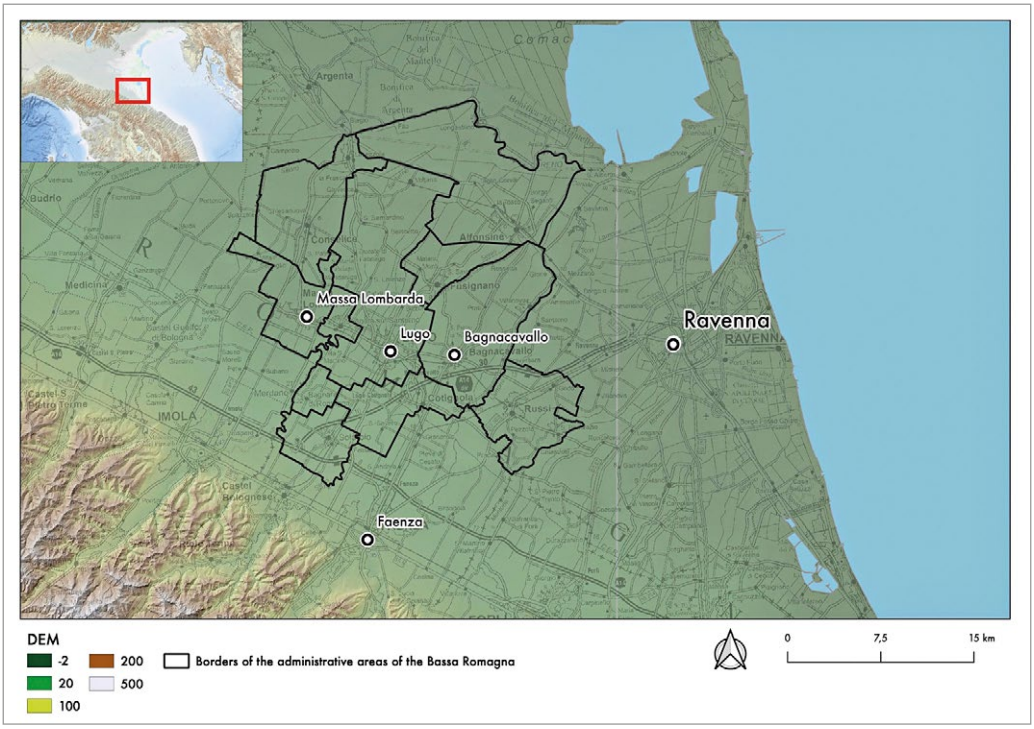

fig. 1. The Bassa Romagna sub-region and the main city centers. Base map: shaded Tinitaly DEM (Istituto Nazionale di Geofisica e Vulcanologia) and Carta Tecnica Regione Emilia-Romagna.

applying multidisciplinary approaches (e.g. geoarchaeology, written sources analysis, remote sensing) to define, in the best way possible, the geopedological and environmental characteristics of the analysed areas (e.g. Balista et al., 1997; Rucco, 2015; Brandolini & Cremaschi, 2018; Bianchini et al., 2019; Rucco et al., 2019; Brandolini & Carrer, 2020; Brandolini, 2020; 2021).

However, while the number of geoarchaeological investigations in this region (and other neighboring ones such as Veneto, see: Arnaud-Fassetta et al., 2003; Corrò & Mozzi, 2017; Mozzi et al., 2020) is growing, there is a lack of current systematic artefact survey projects, which are able to collect new archaeological information and cross it with the environmental and geological data. In particular, regarding the Bassa Romagna sub-region, previous investigations never applied the systematic artefact survey as a method of research; moreover, they were mainly focused on a single historical period (Franceschelli & Marabini, 2007) and they were fragmented, analysing only a portion of this area (Cani, 1980) or the more relevant archaeological and historical sites (Augenti et al., 2012).

With this in mind, this paper aims to present the dataset collected in 2008-2009 during the preliminary phase of the "Bassa Romandiola" project (University of Bologna), a landscape archaeological project that investigates the Bassa Romagna sub-region. The objective of this project is to define the development of the settlement patterns in the area after the end of the Roman period and during the Middle Ages (see below and Castagnetti, 1982; Pasquali, 1984; 1995; Mancassola, 2008a). Secondly, I would like to compare the outcomes of this preliminary research phase with the results of more than ten years of artefact survey (2009-now).

The preliminary phase of the "Bassa Romandiola" project included a review of the previously known archaeological, historical, and geopedological data; the aim of this phase was to collect the existing knowledge on the investigated region and to define a more successful sampling strategy to carry out artefact survey.

2. Context

The "Bassa Romandiola" project began in 2008/09 (Cavalazzi, 2012; De Felicibus, 2017; Cavalazzi et al., 2018; Cavalazzi, 2020; Cavalazzi & Mancassola, 2021) and it investigated the Bassa Romagna sub-region (approx. 525 sq. kms), the north-western portion of the Ravenna hinterland (fig. 1), through a series of intensive artefact surveys. The area is bounded eastwards by the river Lamone, westwards by the rivers Santerno and Sillaro, and northwards by the river Reno and the medieval course of the river Po, the so-called Po of Primaro (Franceschelli & Marabini, 2007). An intense activity of alluvial sedimentation of the Appennine rivers buried the historical ground levels; for instance, the Late Republican/Imperial layers are buried sometimes 10 m deep (Cremonini, 1994). Moreover, the past landscape varied greatly, as it alternated higher lands (e.g. inactive fluvial ridges) and depressed areas (e.g. marshes). These elements give a clear picture of a very unstable territory from the geomorphological point of view, which makes the reconstruction of its development over time complex.

The spatial coverage of the dataset produced is:
Coordinates: ETRS89 / UTM zone 32N (EPSG: 25832):
Datum: European Terrestrial Reference System 1989:
Area: 710 sq. kms;
Northern Boundary: 4944633.870394330471754 1;
Southern boundary: 4906172.8787757735699415;
Eastern boundary: 750590.3472269270569086;
Western boundary: 717543.6236887938575819.
While, the temporal coverage is:
Bronze Age (1600 BCE)-Modern Age (1800 CE).

3. Methodology

The dataset presented here is based on the review of all the published sources, including studies or reports (both historical and archaeological), and maps. All these sources are listed in the Bibliography.pdf file (see paragraph 6). Only unpublished maps have been analysed (see below).

The first phase of my research (2008/09) included the review of the available data and studies to date in order to define the distribution of the historical and archaeological sites in combination with other landforms (e.g. routes, marshes, forests, etc.). The information collected was recorded first in an Access database; secondly, with the aid of ArcGis 9.3 software, I created a dataset composed of several shapefiles, one for every recorded category (landforms or site, see paragraph 6).

In a second phase, the analysis of the historical maps (15th-19th century CE), published or unpublished, allowed me to better define the geographic position and the spatial characteristics of each feature and information previously collected. Historical maps, which were held in the archives of Ravenna (Archivio storico comunale, Archivio di stato), Imola (Archivio diocesano), and Lugo (Archivio comunale), have been digitally reproduced and georeferenced using a spline transformation in ArcGIS. At least four Ground Control Points were used in this process, which enabled me to reference portions of the landforms considered here, such as currently existing canals and land-divisions.

Useful results came mostly from the elaboration of the 17th-19th centuries CE cartography, such as the cadastre "Campione Pasolini" (1638-1642, *Archivio Storico Comunale di Lugo, Mappe*) or the Cadastral Map of Emilia-Romagna Region (1853, WMS produced by the Regione Emilia-Romagna). On the other hand, older sources or less accurate maps were not useful for our purposes, because it was impossible to obtain an accurate result through the georeferencing process (similar problems and approach in a nearby area of the central Po Plain in Brandolini, 2020). This operation allowed me in particular to define the approximate location of historical sites, at least when the ancient toponyms survived in the late and post-medieval cartography.

Finally (third phase), I recorded data about the geopedogical characteristics of the area. This topic was already studied by several scholars, such as, among others, L. Gambi (1949), A. Veggiani (1973; 1995), S. Cremonini (1994), S. Marabini (with C. Franceschelli, 2007; with G. B. Vai, 2020), who produced geomorphological maps, which examine the diachronic development of the hydrographic systems and wetlands. Moreover I analysed the geological technical cartography at our disposal at the time (Preti, 2002). These maps have been digitised and georeferenced in ArcGIS to define the position and extension of the features of this category.

4. Quality control

During the first and second phase described above, the geographical position of the historical and archaeological sites mentioned in our sources (vector type: points) was classified according to three values: "sure", "area", and "not sure". In the first case the data collected allowed me to locate the position of a site or toponym, at least according to the examined sources. In the second case, "area", the position was defined by historical cartography or by the surviving toponym in a radius max. 1 km long; the geographical location of a feature was in this case only probable in the area identified, but not completely sure. Finally, in the "not sure" category, none of the elements found enabled me to determine the geographical position of a given feature. When possible, positions and sites have been checked in the field, in person. For polygonal and line vectors, I listed only two possible values: "sure" and "not sure". Most of the historical sites defined by a polygonal features were not sure, for instance the woods or the marshes mentioned in the written sources, whose limits were defined in most cases crossing written sources with the edited studies (e.g. Pasquali, 1995; Franceschelli & Marabini, 2007). This classification has limits: it was performed according to the conditions listed above and I based it on the hypothesis of previous researchers.

5. Constrains

For the historical sites mentioned in the previous studies or in the written sources, the main problem is to locate precisely their position. To minimize errors, I decided to record information only from the studies which have a high level of reliability and were citing their primary sources. On the other hand, the archaeological sources are characterised by several more relevant limits, namely: i) the discoveries described in the literature were frequently defined with generic and uncertain chronological categories, e.g. "Roman site"; ii) the geographical positions of these discoveries were frequently recorded imprecisely, as well as the depth from the soil surface; iii) the lack of details in describing the archaeological discoveries is sometimes relevant. I decided to register the information as presented in the studies, highlighting their critical aspects, or, when possible, recording more accurate data through cross-referencing sources. These limits were particularly evident in the reconstruction of the development of the hydrographic systems through time (tab. 1). One of the main challenges that scholars faced here was to define and to correctly identify the landform created by rivers, e.g. a palaeochannel (see above). This is due to the great geomorphological variability of this landscape through time. The result is the co-presence in the database of several and parallel different hypotheses, which are formulated through the analysis of different accounts with a similar degree of reliability.

6. Dataset descriptions

The dataset consists of 625 entries, divided into 4 main categories (Environmental features; Infrastructures; Archaeological discoveries; Historical sites, tab. 1-4), recorded in shapefiles and in an Access database, plus the reference file (Bibliography.pdf), namely:

a) Environmental features (tab. 1):

paleochannels.shp	Geomorphological traces of ancient rivers' course (vector type: line)
fluvial_ridges.shp	Landforms created by depositional activity of rivers (polygon)
Roman_wetlands.shp	Limits of marshes and lagoons during the Roman period and Late Antiquity, 2nd c. BCE-7th c. CE (polygon)
early_medieval_wetlands.shp	Limits of marshes and lagoons in Early Middle Ages, 8th-11th c. CE (polygon)
late_medieval_wetlands.shp	Limits of marshes and lagoons in High and Late Middle Ages, 12th-15th c. CE (polygon)
historical_woodlands.shp	Limits of woods in Middle Ages, 8th-15th c. CE (polygon)
channels.shp	Artificial canals (line)
Roman_hydrography.shp	Reconstruction of the hydrographic systems during the Roman period and Late Antiquity, 2nd c. BCE-7th c. CE (line)
early_medieval_hydrography.shp	Reconstruction of the hydrographic systems during the Early Middle Ages, 8th-11th c. CE (line)
late_medieval_hydrography.shp	Reconstruction of the hydrographics systems during the High and Late Middle Ages, 12th-15th c. CE (line)

b) Infrastructures (tab. 2):

Roman_roads.shp	Branches of Roman roads, 2nd c. BCE-7th c. CE (line)
early_medieval_roads.shp	Branches of early medieval roads, 8th-11th c. CE (line)
late_medieval_roads.shp	Branches of high and late medieval roads, 12th-15th c. CE (line)
Roman_centuriation.shp	Land divisions of supposed Roman origin (line)
Bagnacavallo_land_division.shp	Regular Land divisions localized in area of Bagnacavallo city (line)
MassaLombarda_land_division	Regular Land divisions localized in area of Massa Lombarda city (line)

c) Archaeological discoveries (tab. 3):

ancient_sanctuaries.shp	Evidence of Roman and pre-Roman sanctuaries, 2nd c. BCE-7th c. CE (point)
burial_sites.shp	Cemeteries or burials, 2nd c. BCE-18th c. CE (point)
castles.shp	Fortified medieval sites, 8th-15th c. CE (point)
curtes.shp	Directive centres of the manorial system, 8th-10th c. CE (point)
harbors.shp	Medieval harbors, 8th-15th c. CE (point)
kilns.shp	Productive sites with kilns, 2nd c. BCE-18th c. CE (point)
massae.shp	Main center of a compact monastic medieval property, the *massa,* 8th-12/13th c. CE (point)
monastic_convent_buildings.shp	Evidence for monastery or convent buildings, 8th-15th c. CE (point)
plebs.shp	Baptismal medieval churches, 8th-15th c. CE (point)
roads.shp	Traces of Roman and medieval roads, 2nd c. BCE-18th c. CE (point)
roman_farms.shp	Rural productive sites of the Roman period, 2nd c. BCE-7th c. CE (point)
roman_villas.shp	Evidence for Roman villas, 2nd c. BCE-7th c. CE (point)
rural_churches.shp	Rural medieval churches, or *cappellae*, 8th-15th c. CE (point)
single_houses.shp	Isolated medieval houses, 8th-15th c. CE (point)
sporadic_discoveries.shp	Extra-site finds (point)
villae.shp	Medieval not fortified village, 8th-15th c. CE (point)
villages.shp	The pre-Roman village, before 2nd c. BCE; indeed, a Roman *vicus* never was documented in the investigated area (point)

d) Historical sites (tab. 4)[1]**:**

castles.shp	Fortified medieval sites, 8th-15th c. CE (point)
casalia.shp	Medieval rural farms, 8th-15th c. CE (point)
convents.shp	Medieval convents, 13th-17th c. CE (point)
curtes.shp	Lands managed through the manorial system, 8th-10th c. CE (polygon)
harbors.shp	Medieval harbors, 8th-15th c. CE (point)
hospitalia.shp	Medieval hospices, 8th-15th c. CE (point)
massae.shp	Medieval monastic properties, 8th-15th c. CE (polygon)
mills.shp	Medieval mills, 8th-15th c. CE (point)
monasteries.shp	Medieval monasteries, 8th-15th c. CE (point)
monastic_ buildings.shp	Monastic buildings, other than monasteries (e.g. single monastic churches or chapels, mentioned in medieval written sources with the term *obediencae* or *cellae*), 8th-15th c. CE (point)
plebs.shp	Baptismal medieval churches, 8th-15th c. CE (point)
rural_churches.shp	Rural medieval churches, 8th-15th c. CE (point)
sparse_houses.shp	Single sparse medieval houses, 8th-15th c. CE (point)
villae.shp	Not fortified medieval villages, 8th-15th c. CE (point)

e) Database_Romandiola.mdb: an Access database linked to the GIS geodatabase

f) Bibliography.pdf: a list of references mentioned in the Access database

Thus, the dataset was created by organising the information in two separate main file categories: the Access database and the geographical information of each feature, recorded with shapefiles. This dataset was collected by the author between 1/10/2008 and 1/06/2009, recording the information in English (ESRI shapefiles, .shp) and Italian (ESRI shapefile, .shp, and database access .mdb).

7. Discussion

7.1 The dataset, the archaeological research, and heritage preservation

The dataset collected allowed the team of the Bassa Romandiola project (see above) to examine contextually several kinds of information (geopedological, historical written sources, and archaeological data) in order to reconstruct the characteristics of the considered region, the settlement patterns evolution, the pedology and geomorphology of the area, and its environmental history. Previous research (e.g. Cani, 1980; Franceschelli & Marabini, 2007) was carried out by analysing only a part of the Bassa Romagna, or simply by focusing on a single historical period, such as the Roman period. Thus, the dataset was the first systematic synthesis of all the published information for the whole Bassa Romagna sub-region. This synthesis was, and currently is, a crucial resource for further research (e.g. Abballe, same issue), as it allows a better management of the local landscape and archaeological heritage (e.g. Carta Archeologica, 2010).

Furthermore, this dataset was used to define the sampling strategy of the "Bassa Romandiola" artefact survey. As mentioned above, the Bassa Romagna is a very complex region from the geopedological point of view, given its environmental history; however, the data collected allowed us to define a strategy to manage this complexity. According to the environmental and historical characteristics of the area, we adopted different sampling fractions in each

[1] The analysis of historical primary and secondary sources allowed us to collect data dated from the 6th to the 16th/17th century CE.

Landscape Stratum	Geomorphological, archaeological, and historical main characteristics	Sample characteristics
i. High floodplain	Stable floodplain; Roman period sites in surface or buried maximum 3-4 m deep; centuriation mainly conserved	Rectangular transects oriented according to the centuriation (approx. N/W-S/E) and a within-stratum sampling fraction of 50/100
ii. Fluvial ridges in the low floodplain	Stable floodplain; Roman and Bronze periods buried under plough soil; Roman centuriation retraced in the Late Middle Ages or not conserved and replaced by medieval or modern land divisions	Rectangular transects oriented N-S or E-W, which cover the whole fluvial ridges, and a within-stratum sampling fraction of 100/100
iii. Low floodplain	Unstable floodplain, generally marshes dried in Modern and Contemporary periods; Roman and Bronze periods buried from 5 to 10 m deep or more; centuriation mainly absent	Area excluded from the sample

tab. 5. Landscape strata in "Bassa Romandiola" project and sampling strategy (after Cavalazzi, 2020).

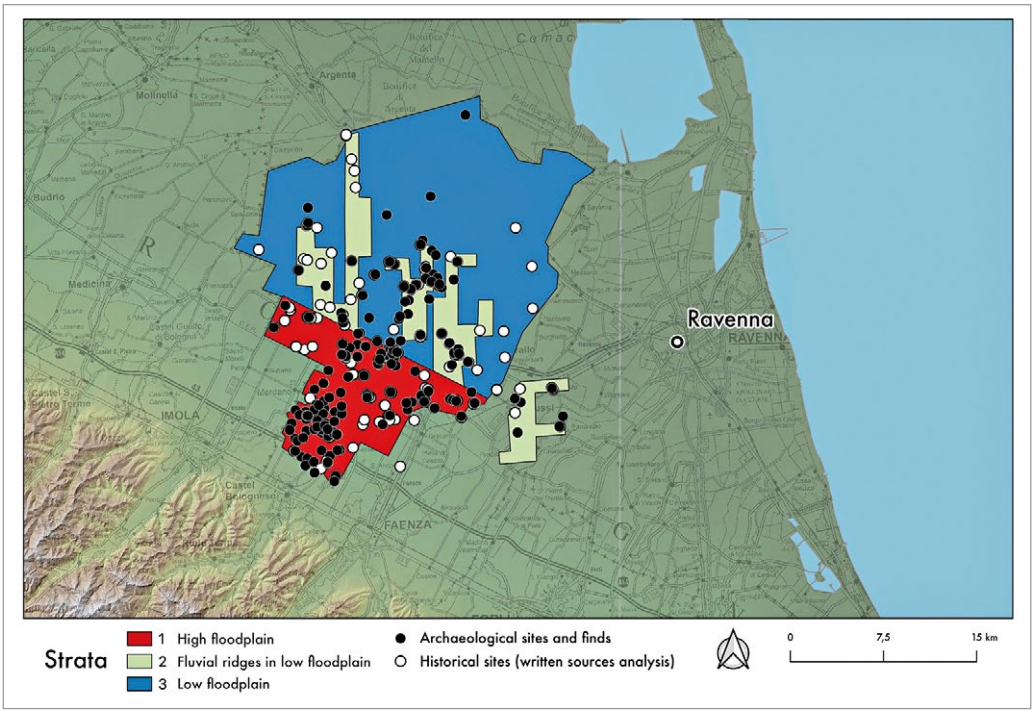

fig. 2. Preliminary database (archaeological and historical sites), landscape strata of the "Bassa Romandiola" project. Base map: shaded Tinitaly DEM (Istituto Nazionale di Geofisica e Vulcanologia) and Carta Tecnica Regione Emilia-Romagna.

stratum identified, with what was defined as a systematic disproportional stratified strategy (tab. 5 and figg. 2-3; Banning, 2020; Cavalazzi, 2020).

This approach enabled me to detect several potential geomorphological windows, where ancient palaeo-soils were exposed on the surface or buried near the surface (tab. 5, "stratum 2"). This stratum was included in our sample, approx. with a sampling fraction of 100/100. At the same time, this approach allowed the spatial definition of the historical wetlands, which

were reclaimed only very recently (mainly from the 16th c., Gambi 1949); these zones were excluded from the sample of the survey. This approach enabled us to contextually examine the resources at our disposal within the scope of this research, and to define a sample of 150 sq. km, the 22% of the Bassa Romagna sub-region (525 sq. km).

7.2 Settlement patterns development around a Byzantine capital city: comparing results of the artefact survey (2009-now) and the preliminary dataset

Until now, the landscape archaeological project "Bassa Romadiola" investigated through intensive artefact surveys approximately the 15% of the territory of the Bassa Romagna (i.e. 78 sq. km, Cavalazzi et al., 2018; Cavalazzi, 2020; Cavalazzi & Mancassola, 2021). In 5 field-campaigns, we detected 78 artefact concentrations (fig. 3); in particular, these concentrations were located inside the above-mentioned geomorphological windows, and dated from the 5th to the 18th century CE. The research gave a first answer to two of the main questions of this project: 1) what happened in this area of the Emilia-Romagna region after the end of the Roman period (i.e. after the 5th century CE); 2) What was the effect of the end of Roman rule on the development of the settlement pattern. To briefly answer these questions, the artefact survey identified a relevant growth in the number of the sites between the 8th-10th centuries CE, or rather the Carolingian and Ottonian periods, sometimes in continuity with late antique sites (5th-7th centuries CE; Cavalazzi, 2020). This growth took place according to two main trends: a dispersed site pattern (as recorded in the area of Zagonara, fig. 4.A) and a clustered pattern (as recorded in the area of Bagnacavallo, fig. 4.B). The clusterisation of the settlements appears to have been a frequent trend in the Ravenna lowland during the Early Middle Ages (8th-11th centuries CE), as already documented in other contexts of the Ravenna hinterland itself or in the area of Cesena (40 km south of Ravenna) (Mancassola, 2008b; Negrelli, 2008; Cavalazzi, 2020).

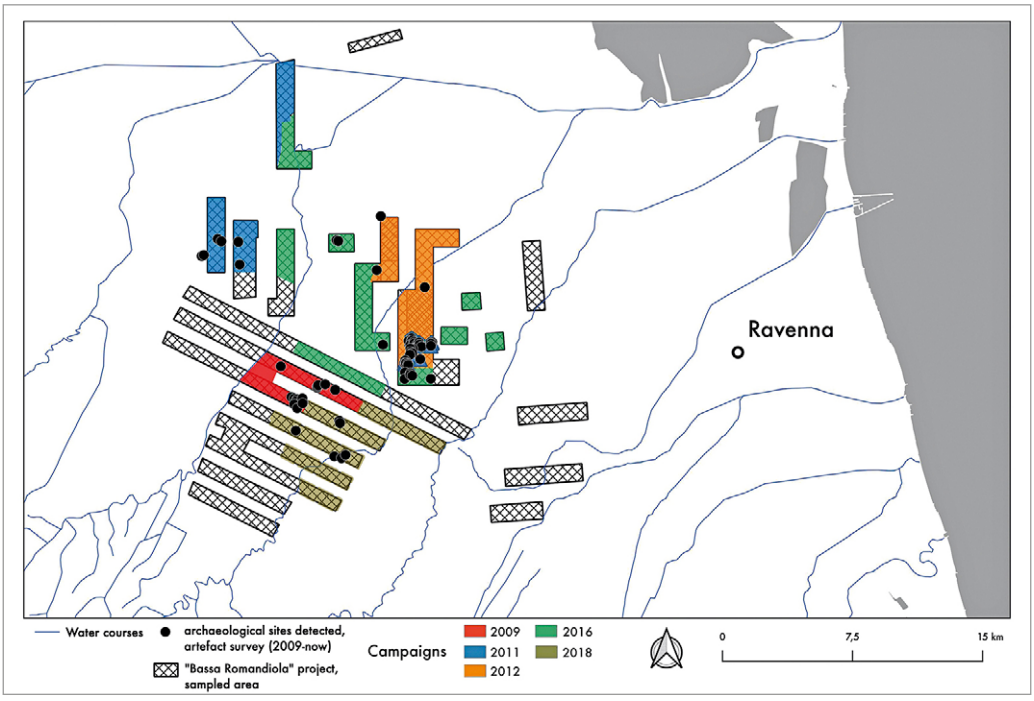

fig. 3. Sampled area of the "Bassa Romandiola" project, transects investigated, and archaeological sites documented with artefact surveys (2009-now).

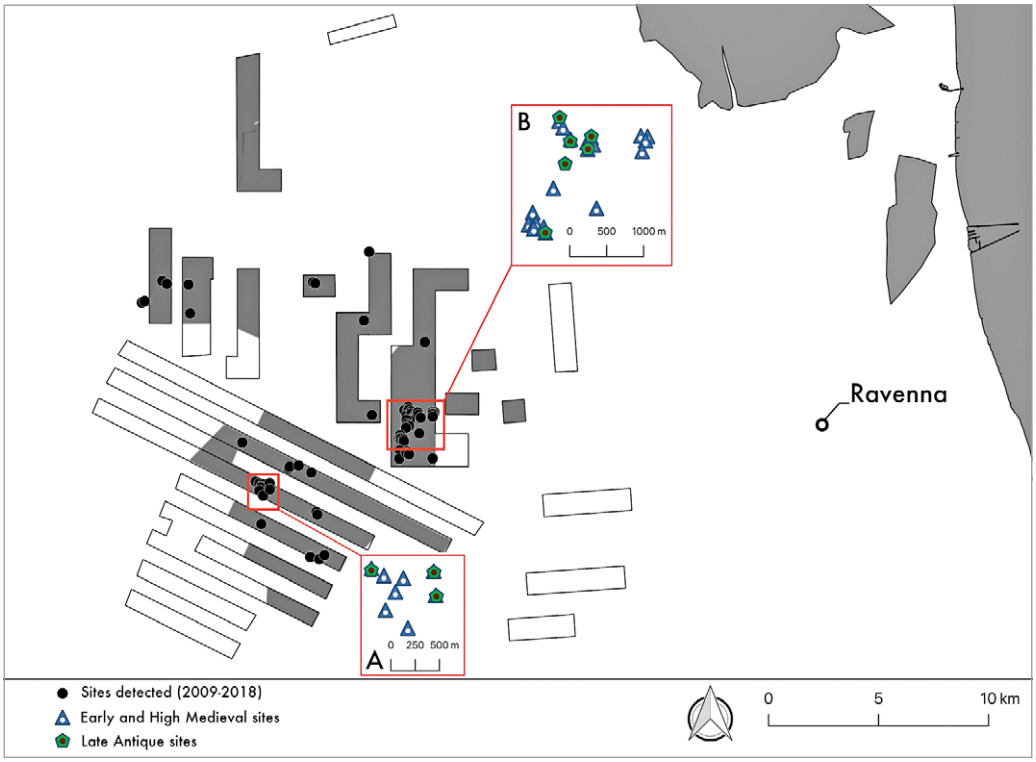

fig. 4. Detected sites in the 5 field-campaigns (2009-now) completed since now. In the panes, the geomorphological windows in the area of Zagonara (pane A) and Bagnacavallo (pane B); after Cavalazzi, 2020.

Systematic fieldwork allowed us to correct and complete the historical scenario depicted before by both historians and archaeologists. First of all, it documented trends in contrast with what the written sources attested and, consequently, with what our preliminary dataset showed. Here is an example: the Bassa Romagna was an area in which an early diffusion of the "mezzadria" (Pasquali, 1995) was documented, appearing already from the 12th century CE; this was a system of landownership where farmers lived in rented parcels. The archaeological sites occupied since the 8th/9th century CE (fig. 4.A-B), were all abandoned in the 12th/13th century. By crossing the archaeological data with the written sources, we discovered that sites were abandoned because of a wide and deep reorganisation of the settlements, which was put in place by the main territorial powers of the period, such as rural counts and urban communes, who clustered their subjects in fortified villages (Cavalazzi et al., 2018; Cavalazzi, 2021). Thus, our archaeological investigations demonstrated that the "mezzadria" contracts in the Bassa Romagna sub-region were not characterised, as often happened, by a sparse settlement pattern; on the contrary, farmers did not live in the parcels rented, but, probably, they resided in larger villages.

Moreover, the preliminary dataset was mainly focused on what researchers studied and the sources documented before the beginning of the project. The attention of these researchers was absorbed by the history of the main sites: e.g. pre-Roman villages, Roman villas, medieval castles, or great fortified villages. The minor sites were rarely included in the primary sources preserved in the area (Pasquali, 1998) and, consequently, this kind of site was excluded from the objects of the previous research. Thus, relevant processes, such as the trends of the settlement patterns evolution after the Roman period or the reorganisation of the rural

settlements in the 12th century CE (see above and Cavalazzi, 2021), were unclear or totally ignored. Our project, therefore, shows the important role played by such sites and the need for a more multifaceted approach in the future.

However, the preliminary dataset, which I am presenting here, allowed us to complete the information collected with the artefact survey. Given the complexity of the geographical context, the systematic analysis of the previous knowledge about the region was the only way to complete the puzzle, and try to fill the gaps caused by these geopedological biases. By crossing the preliminary dataset with the data collected with survey in the geomorphological windows described, we can try to complete the synthesis in several ways, also recurring to some processes in the field of Bayesian inference (Abballe, 2017; Cavalazzi, 2020).

8. Conclusion

The preliminary dataset of the Bassa Romandiola project brought forth a significant advancement in the knowledge of the considered region, the northern part of the Ravenna hinterland, the *Bassa Romagna*. The previous studies were fragmented, focused on a single historical period, or characterised by a monodisciplinary approach. This dataset will help to carry out future research and to better manage the local landscape and heritage. Furthermore, this kind of dataset, in such a geographical area (a lowland with a significant geopedological variability), allowed us to design the most suitable and successful sampling strategy for the artefact survey as well as to better address the fieldwork. Since the preliminary phase of the research, it was clear that a new and creative systematic operative approach was absolutely necessary to improve the knowledge of the history of the local socio-ecological systems and to solve the doubts emerging from the work of previous researchers (see introduction). The systematic survey carried out was an important element to build upon in order to address the research questions; nevertheless it was also clear that we need to complete the interpretative framework with a multidisciplinary and multiscale approach, involving several and complex research paths, including, for instance, an accurate geoarchaeological and archaeobotanical study (Marabini & Vai, 2020; Abballe, 2020; same issue; et al., in press; Abballe & Cavalazzi, in press; Fiorotto et al., 2020). The preliminary dataset presented here was, thus, fundamental for the synthesis of the data collected and the development of further research (Cavalazzi et al., 2018; Cavalazzi, 2020; Cavalazzi & Mancassola, 2021).

Acknowledgments

The collection of the preliminary dataset was funded by a grant of the Centro di Studi sulla Romandiola Nord Occidentale. I want to thank Prof. Paolo Maranzana and Michele Abballe for reading this paper and the precious advices; Prof. Andrea Augenti and Dr. Nicola Mancassola for supervising the preliminary phase of the research; Prof. Mauro Bovoli, Prof. Leardo Mascanzoni, Prof. Gianfranco Pasquali, and the other members of the scientific board of the Centro di Studi sulla Romandiola Nord Occidentale for making possible the beginning of the "Bassa Romandiola" project.

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