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Water management and land-use practices from the Iron-Age to the Roman period in Eastern Iberia

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Abstract

This study investigates water and land usage in the territory of La Carència, an Ibero-Roman city located near Turís (Valencia, Spain) in Eastern Iberia. The outstanding political importance of La Carència during the Iberian Iron-Age period is attested by its large size, the monumental character of its structures and on-site finds. Multidisciplinary and micro-regional landscape work at its territory documented significant differences between the Iberian and the Roman settlement patterns, which are attributed to the distinct agricultural production and water management systems of each period. While Iberian sites are more related to the agricultural exploitation of flat, dry land for which water sources, such as natural springs, were probably used, Roman sites seem to be associated with more productive soils that take advantage of flooding areas and the drainage of water accumulation zones.

Such different agricultural preferences based on large-scale water management are documented for the first time in the Iberian Peninsula and they attest to the great potential of multidisciplinary landscape archaeology to address past land-use practices.

Keywords

Water management; Ancient agriculture; Iberian Roman; GIS; Remote sensing; Eastern Iberia

1. Introduction

The importance of water retrieval, management, transport, distribution and evacuation for the maintenance and development of human societies has been stressed in many studies (e.g. Grove and Rackham, 2003, 351–360; Harrower, 2010, Orengo and Miró, 2013). Water management systems are always associated to different cultural practices with each society perceiving water in accordance with the physical nature of the environment, its cultural resources and its social needs.

Water management systems can be employed for multiple purposes. They do not only include the supply, storage and distribution of water but also such diverse activities like the management of flooding episodes, the development of irrigation systems, the desiccation of wetlands and the exploitation of littoral wetlands. In the Mediterranean, water availability or shortage are key factors for human activity and land use, conditioning the relationship between human communities and their physical environments (Riera et al., 2009). Alluvial Mediterranean floodplains and rivers have been thus always particularly attractive areas for the provision of water resources and productive grazing and arable lands. They are also highly risky environments, subjected to seasonal flash flood events due to the strong seasonality in both precipitation and temperature, characteristic of Mediterranean climatic regimes (Benito et al., 2008). For instance in the case of Eastern Iberian rivers, like the Xúquer, peak discharges

11,000 times higher than mean discharges are recorded during the autumn months (Masachs, 1950).

This paper endeavours to explore the different approaches to natural water resources by the inhabitants of the Ibero-Roman oppidum of la Carència (Valencia, Spain) as they transformed their native Iron-Age cultural practices after the Roman contact and its cultural influence. La Carència is located between the well-known Iberian cities of Kelin, Edeta, Sucro, Saiti and Castellar de la Meca (Fig. 1), its study now completing the geopolitical map of the Valencian area during the Iberian Iron Age (Díes et al., 1997, Bonet and Mata, 2001, Mata et al., 2007).

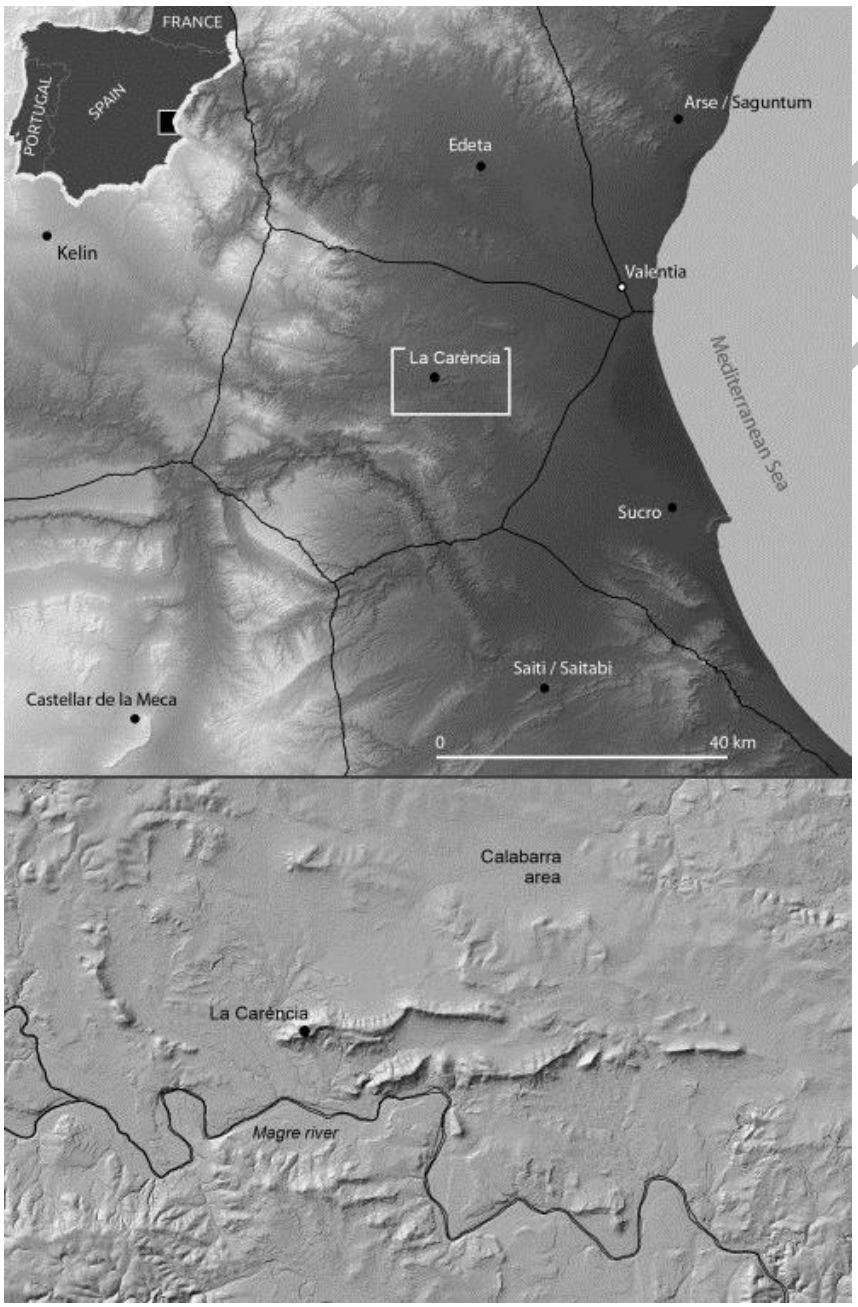

Figure 1. Location of la Carència and other Iberian cities in the central Valencian area with their hypothetical territories delineated by the average walking time between them (cost surface developed from the walking times per slope degree published by Balstrøm

Iberian Iron Age societies were organised around oppida, which were political centres from where land and trade were controlled. These nuclei were generally fortified and located on prominent sites that "facilitated visual control over the surrounding countryside and nearby subordinate sites" (Grau, 2003, 261). Over the last decades, many Iberian city-states and their territories have been excavated and studied within the Valencian region (e.g. Bernabeu et al., 1987, Bonet and Mata, 2001, Bonet et al., 2008, 165–189; Díes et al., 1997, Grau, 2005, Mata et al., 2007). However, multidisciplinary landscape studies are still scarce as the current methodological approaches of the Iberian territorial research focus largely on settlement patterns. In this paper we present the application of a combination of Remote Sensing, GIS-based techniques, archaeomorphology and archaeological survey to address the Iberian-Roman exploitation of the la Carència landscape in relation to water management strategies in an attempt to expand and improve the current toolkit and interpretations. This multidisciplinary approach is essential for a meaningful analysis of the forms and development of water management systems within a landscape. The complementary results by these techniques aid in the formulation of theories on not only how water was managed but also on how the landscape was transited, conceived and exploited throughout time.

The main objectives of this study are to (1) generate hypothesis for the interpretation of the distribution of Iberian and Roman sites in la Carència territory, (2) address differences in water management and land-use practices between indigenous Iberian and Roman communities and (3) evaluate the contribution of a landscape-based multidisciplinary analysis including the use of archaeology, GIS and remote sensing to the study of ancient Mediterranean landscapes and land-use practices.

2. Study area and archaeological context

La Carència oppidum is located at 379 m a.s.l. on the Portell mountain range (Turís), 30 km west from the Mediterranean coast in the Valencian region (Fig. 1). The Portell range has an east-west orientation, it is 4 km long and its karstic relief overlooks the alluvial floodplain of the Magre River, a tributary of the lower course of the Xúquer River. The climate of this Mediterranean region is temperate with hot and dry summers, with mean summer and winter temperatures of 25 °C and 12.5 °C respectively, and an annual average precipitation between 500 and 600 mm characterised by a strong seasonal variability (AEMET, Iberian Climate Atlas). The Magre River, like most Mediterranean rivers, shows a strong seasonality in discharge patterns.

Previous to this project this site was merely the subject of test pit digging and occasional finds (Gil-Mascarell, 1975). From 2001, a research programme, directed by the Valencian Service for Prehistoric Research (SIP), began a thorough archaeological study of the site and its immediate territory from a long-term and micro-regional perspective. Results yielded by this research have helped enhance the heritage value of this site, which, as a result, was listed as a Spanish National Cultural Heritage Site in 2008. Excavation and intensive survey gave evidence of a first occupation phase dating back to the Bronze Age. From then on the site was continuously occupied until the Late Roman period. It covered an area of 8.6 ha and included three walled

perimeters and several towers of which only five have been documented (Albiach et al., 2007, Albiach et al., 2011, 112). Its relative height over its immediate territory of ca. 90 m offers the site a clear visual dominion over its surroundings. Its size, long span and the quality and diversity of the structures and materials discovered within this area – particularly, a collection of one thousand Greek, Roman and Iberian coins – contributed in regarding the oppidum of la Carència as one of the principal Iberian city-states of the Valencian region.

3. Methodology and sources

Intensive survey and subsequent analysis of the collected ceramic finds formed the first phase of the project. This enabled the investigation of long-term occupation patterns around la Carència. The first aim of the campaigns was to locate all those sites included in the different Valencian archaeological site records and complete the site distribution map of the study area by total coverage survey. On a second phase, fieldwork reassessed the results of the earlier prospections by introducing the systematic use of GPS, thus recording not only site locations but also the extension of ceramic dispersion areas. Relative densities of ceramic dispersion areas were also incorporated by total material recovery and on-site ceramic analysis. Ceramic fragments of well-known typologies were employed to ascribe chronologies to the sites. The combined presence of higher ceramic densities with construction material and/or remains of buildings was employed to assess the central area of the sites. All the information obtained during the fieldwork seasons was introduced into the database management system (DBMS) linked to the project's GIS.

GIS-based archaeomorphological research was also carried out following the methodology described by Orengo and Palet (2010). Archaeomorphology, a term employed mainly in French landscape studies, refers to the study of ancient human-made structures preserved as part of the modern landscape, such as roads, field systems, channels and irrigation systems, and urban shape and distribution by means of cartographical documents and aerial photography. In order to conduct archaeomorphological research it was necessary to develop a custom geodatabase. All geographically referred information relevant to the morphology of the study area was incorporated into this geodatabase. It included aerial photographic stereopairs from 1956, 1977 and 1985 but also 1: 5.000 digital orthophotographs from 1996 to 2004 and the high-resolution (0.35 m/px) series acquired in 2010. The inclusion of the aerial photographs as a single orthoimage per period followed an orthorectification process through photogrammetric block triangulation whereby a set of highly accurate ground control points were used. Average RMSE values were always kept below 0.5 m of ground error. Different map types were also included. Simple geographic transformations or reprojections were employed for many of them. However, in the case of pre-twentieth century maps, many control points were needed to rectify and georeference them. Cadastral information and environmental data were obtained via institutional WMS.

ASTER and Landsat multispectral satellite imagery analysis was performed to verify traces of ancient buried roads and other landscape macrostructures. Satellite images were corrected, pansharpened and georeferenced. Along with topographical and geological maps, they were helpful in determining which areas had traces of different types of land use. They were also useful in detecting high moisture content in soils. Despite their lower spectral resolution, the high spatial resolution of aerial photographs allowed the location of small landscape structures and complemented the results obtained by satellite image analysis.

In order to perform topography-based GIS analyses, a LiDAR-derived Digital Terrain Model (DTM) of 1m/cell developed by the Cartographic Institute of Valencia (ICV) was employed. The DTM underwent a process of sink detection and filling to eliminate small depressions that resulted in a depressionless DTM, necessary to carry out hydrologic analyses (Orengo, 2012).

Quarrying and soil apportion activities in the study area have substantially modified the landscape from the 1960s onwards. It is for this reason that a second DTM of 5 m/cell was produced following the same methodology as that employed for the generation of the 1956s orthoimage. This second DTM represented the topography of the area as it was in 1956. A cut and fill analysis between the LiDAR-based DTM and the 1956 DTM was performed to obtain a clear image of those areas that underwent major modifications during the last 55 years. These could be restored by employing the height values procured from the 1956 stereopairs. In this way a DTM suited for most types of topographic analyses was developed.

Hydrological factors have been acknowledged elsewhere (Gillings, 1998, Harrower, 2010, Orengo, 2012) as being of primary importance in the modelling of human settling and movement through the landscape. The fact that a trend towards warmer temperatures and increased water availability during the Roman period had been recorded in the Iberian Peninsula (Riera et al., 2009) converted hydrologic factors into a specific conditioning feature for this case study. Consequently, flow accumulation and direction raster maps were created so as to get information on how water may have moved through the landscape and where it could have been accumulated. Also, information on modern flood occurrences was incorporated: their extension, range and frequency on the study area were supplied via WMS by the Regional Department of Environment, Water, Urban Development and Residential Planning. Finally, a more detailed flood model was developed (for methodological details see Orengo, 2012) in order to define with more precision the areas covered by seasonal flooding episodes, frequent in coastal Mediterranean environments.

The Regional Department of Environment, Water, Urban Development and Residential Planning provided additionally a soil productivity map of the study area. As this map is the result of topographic, geomorphologic and geologic data analyses, little prone to change except for quarrying activities in the area, it offers a good approximation to the potential of agricultural soil capacity in the past. Soils are classified according to five categories, from very high (A) to very low (E).

Cumulative Viewshed Analysis was performed to assess the differences in site distribution and visual dominion between Iberian and Roman sites in the area. The existence of towers or lookouts inside the sites provided by the archaeological data was incorporated in the OFFSETA field on the site database as an increase in height of 5.7 m (4 m for the tower plus 1.7 for the

human viewer). When this information was otherwise not available, the existence of a viewing height of 4 m was assumed. This is a conservative height taking into account the plan size of documented Iberian watchtowers (Olmos, 2011). Regarding the generation of viewsheds from Iberian sites, only those that showed continuous occupation since the Middle Iberian period were employed. Sites founded during the Late Iberian period, which did not display traces of Roman ceramics, were also included. Viewsheds from Roman sites were otherwise restricted to those sites of recent foundation whereas those that showed previous Iberian occupation were discarded. As this paper focusses on those sites displaying Roman settlement dynamics, the newly founded sites were considered as providing more precise information, avoiding possible interferences from Iberian settlement patterns in the analysis. It should be also noted that chronological and cultural site ascription was mainly based on survey-recorded sherd scatters. From a ceramic analysis perspective, the transitional phase between Iberian and Roman periods indicates the simultaneous use of Roman and Iberian ceramic types, which renders the cultural ascription of the sites difficult. Thus, the approach followed intended to overcome these biases.

Finally, a sedimentological trench in the Calabarra area was excavated in order to test some of the hypothesis put forward by the combination of remote sensing and GIS hydrologic analysis and the distribution of sites. The sediment was described onsite and samples were taken for laboratory-based chemical processing for the extraction of biological micro-fossils.

4. Results

Intensive field survey documented seventy-one archaeological sites. On the basis of ceramic evidence they were chronologically attributed to different periods covering the Bronze Age to the Modern period. Fifty-one of those could be linked to Iberian or Roman occupation.

Archaeomorphological analysis of aerial photographs and ancient maps produced a relative chronological stratification of paths within the examined area (Fig. 2). The analysis highlighted a major path (Fig. 2, in red, in the web version) crossing the study area. This path joined the towns of Turís and Montserrat. These were Islamic alquerias[1] previous to the Christian conquest of the area in the 13th century, and therefore, it is possible this path already existed during the Islamic period. A series of tributary paths to this one were also documented (Fig. 2, in yellow, in the web version). These displayed a morphogenic character (Chouquer, 2000): they organise and distribute the landscape's minor paths, field systems and sites and, in fact, many archaeological sites are associated to them (Fig. 2).

[1] Islamic village. The Islamic period in this area of Spain spans from the 8th to the 13th century

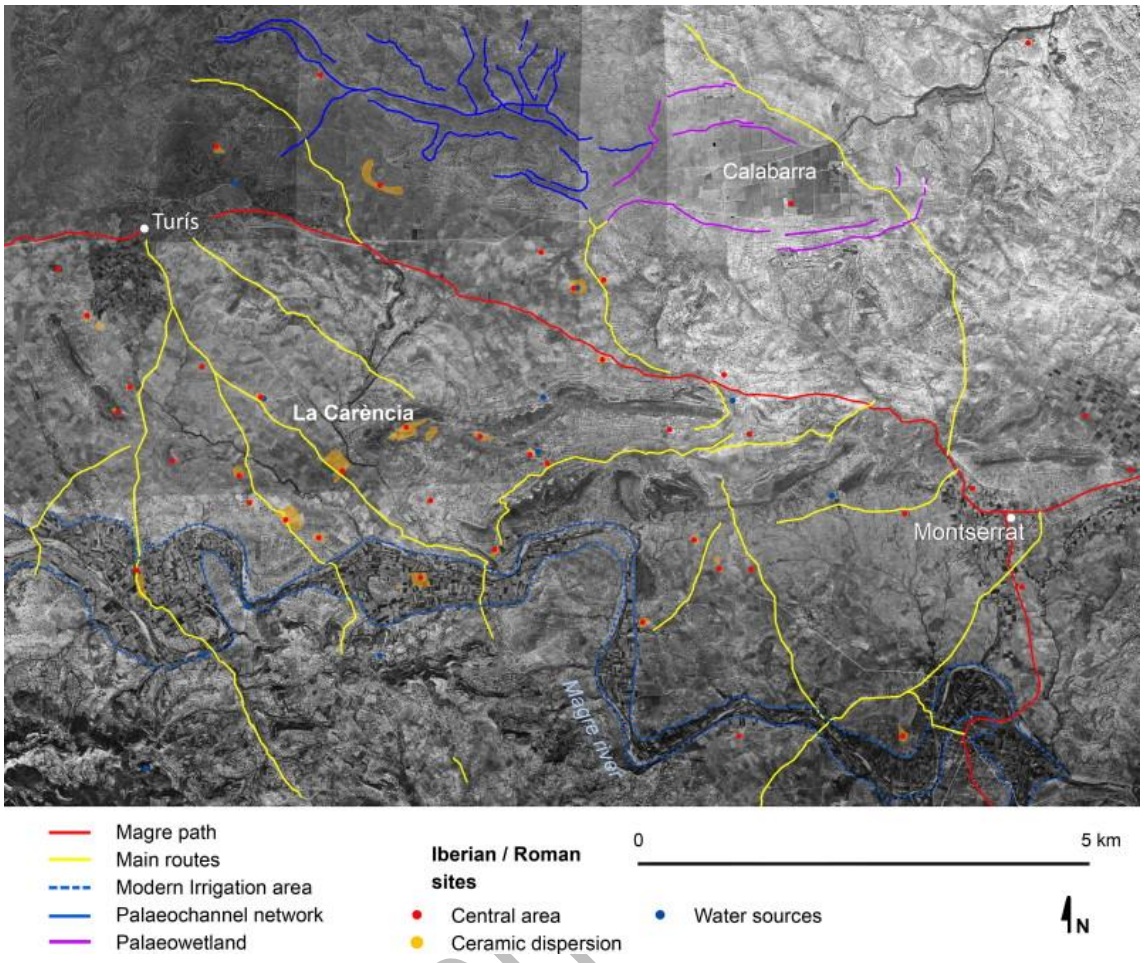

Figure 2. Archaeomorphological analysis of the study area

Archaeomorphological analysis also permitted the identification of irrigated areas (probably developed during the modern period), a series of natural palaeochannels that no longer exist and a possible palaeowetland in the Calabarra sector (Fig. 2). This was further corroborated by multispectral imaging analysis, which revealed traces of buried paths and defined the extent of the palaeochannels' network. Unsupervised classification of a Landsat image helped to define the areas with higher moisture content, which further confirmed the existence of a palaeowetland located in the Calabarra sector, indicated by higher moisture accumulation content (Fig. 3). Finally, wide band aerial photography interpretation allowed the detection of a buried structure in Calabarra, closely resembling a Roman villa (Fig. 3).

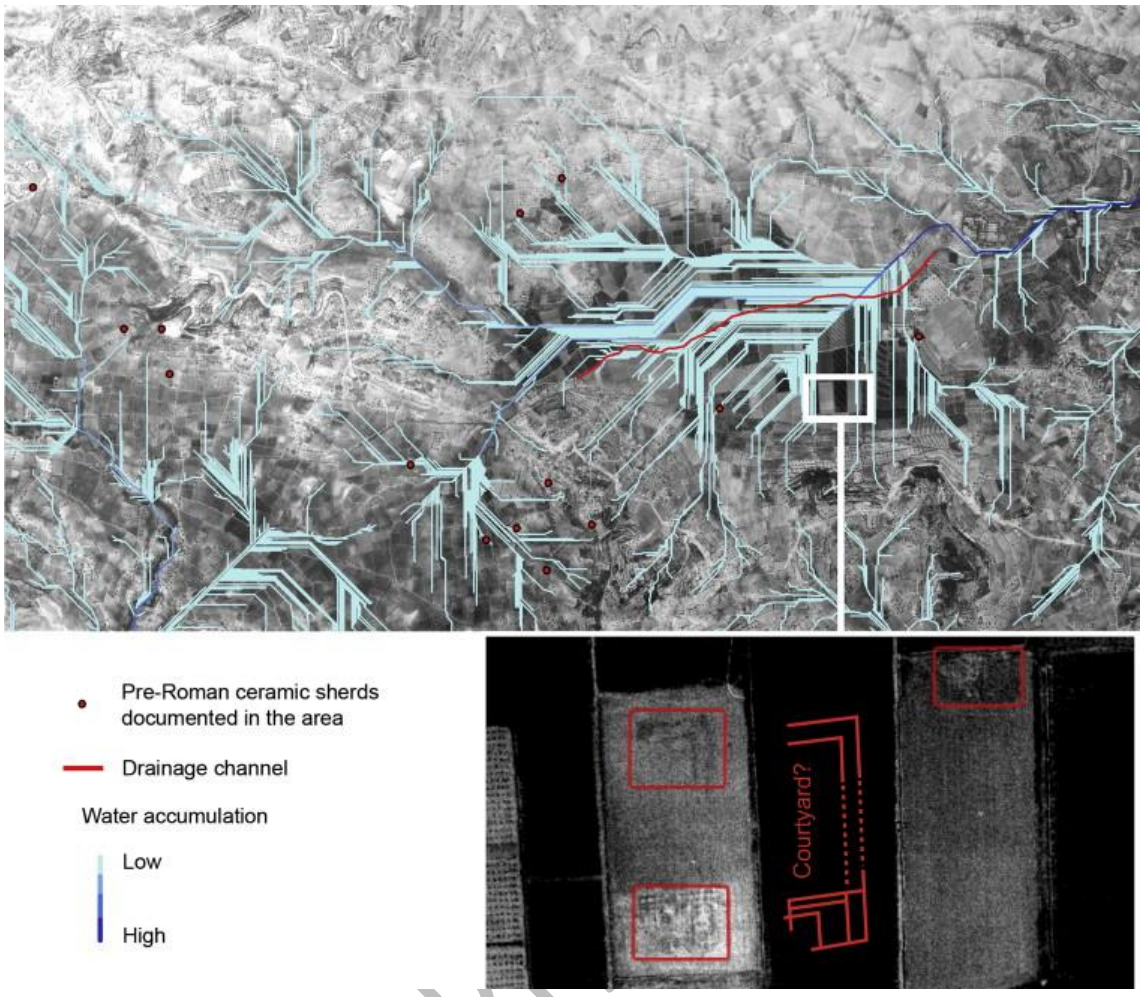

Figure 3. Water accumulation and detail of buried structures at the Calabarra area

Topographic analyses based on the generated depressionless DTM and the modified LiDAR-based DTM included the generation of viewsheds and both hydrological analysis and modelling. Viewshed analysis employing the modified LiDAR-based DTM resulted in the generation of cumulative visual areas form Iberian and Roman sites and from la Carencia's towers. These allowed assessing the visual control area of the oppidum and that of the different clusters of sites during both the Iberian and Roman periods, which, as indicated in Fig. 4, present significant differences. Hydrological modelling employing the depressionless DTM confirmed both the existence of a natural palaeochannel network and a water accumulation area in the Calabarra sector: as shown in Fig. 3, water flow (represented as blue lines, in the web version, of different intensity depending of the quantity of accumulated water) closely follows the palaeochannels detected in the aerial photograph and delineated in Fig. 2. These lines converge in the Calabarra area where water accumulation reaches its maximum values.

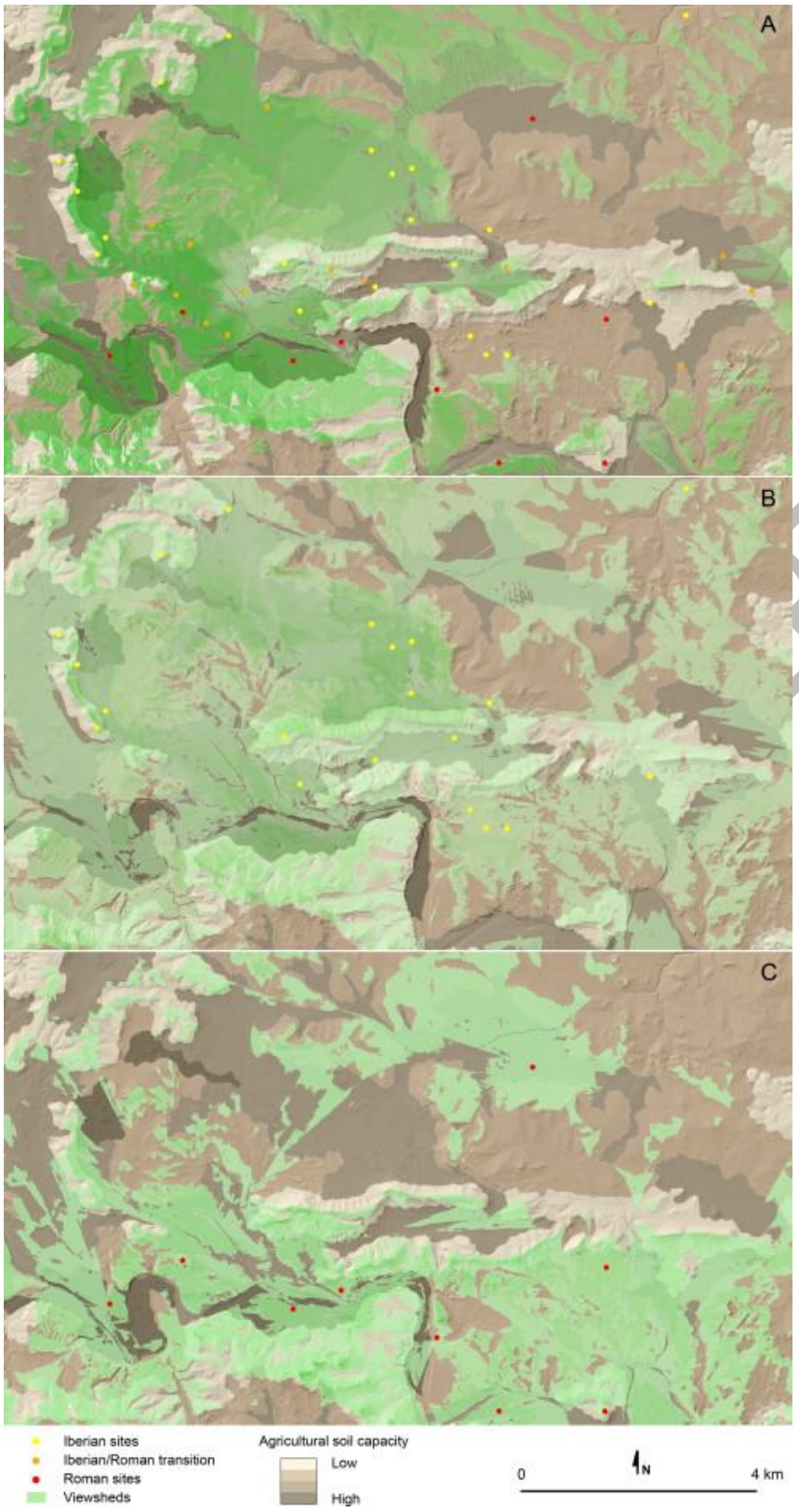

Figure 4. Viewsheds from la Carència and from the selected Iberian and Roman sites overlaid on a soil quality map

Fieldwalking in the Calabarra area lead to the identification of a drainage channel that traversed the lower axis of the palaeowetland (Fig. 3). Its stratigraphic analysis suggested four different construction phases, probably of modern date. A document dating to 1741 (Ardit, 2007, 208) indicates that the area was accumulating water during this period, and therefore, this drain is assumed to be of a later date. The opening of a trench that cut the modern drain allowed for the sedimentary description of a 210-depth stratigraphic record (Fig. 5). This is mainly composed of light orange sands and gravels sitting over an orange-to-yellow tertiary clay marl level and covered by brown–orange chalky muds. However, two hydromorphic strata composed of light brown fine-grained silts are present from 97 to 106 cm and from 150 to 162 cm depth. The uppermost of these probably corresponds to the wetland documented during the 18th century. A ceramic fragment dated to the 14th century found in the profile between the two hydromorphic layers suggests that the lower hydromorphic stratum has a pre-Christian date. The lower hydromorphic level is cut by a wall settled on lime mortar that most probably corresponds to a first phase of the desiccation channel that was buried before the 14th century and superseded by the modern drain. Sediment samples taken from this layer were unsuccessfully tested for the possible presence of pollen.

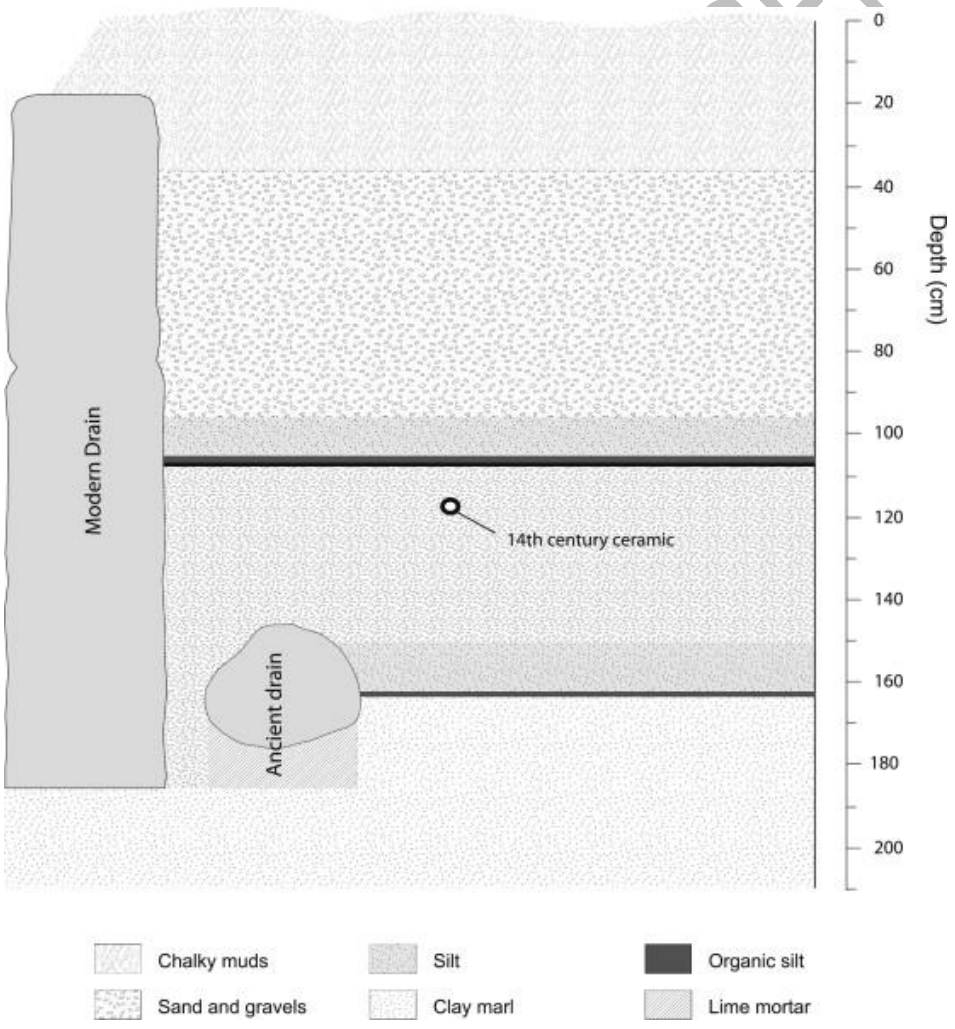

Figure 5. Sedimentological description and drains found at the Calabarra trench

5. Discussion: shifting cultural practices from the Iberian to the Roman period

The archaeological literature on Iron Age Eastern Iberia has traditionally acknowledged a strong tendency towards the settling of flat areas in the Roman period in contrast to the Iberian preference of elevated spots to establish settlements (Bonet and Ribera, 2003, 88). However, the Iberian settlement pattern of la Carència's hinterland is associated with the use of flat areas. The results of viewshed analysis from la Carència also prove an absolute visual dominion of the city over its surrounding sites in that period (Fig. 4). The proximity of the fortified city-state probably rendered selection of easily defensible spots unnecessary, and thus, it seems the most suitable areas for agricultural purposes were accordingly chosen, regardless of their defensive possibilities. The research in fact demonstrated that most sites are located on soils with high and moderate agricultural potential, ideal for dry-land farming. Also, the results of cumulative viewshed analysis from Iberian settlements show a concentration of viewsheds in areas characterised by this type of soil (Fig. 4). This preference for soils well adapted to dry-land farming is consequent with agricultural practices documented in the Iberian culture, where cereals, legumes, but also olive, grape, fig, walnut, hazel and almond are well represented (Mata et al., 2010, 3–36). In la Carència's territory some of the Iberian sites are found in close proximity to springs and other water sources, reinforcing the hypothesis relating these sites to agricultural production. Only the sites located at marginal areas of the city's surroundings, where the viewsheds generated from la Carència were no longer effective, are placed in prominent, easily defensible, locations but with poor soils (type D). These sites, instead of being attributed any agricultural function, should be probably related to the city's concern to control (1) its area of economic exploitation, (2) those areas beyond the direct visual control of the city and (3) the main routes connecting it to neighbouring territories.

Material distribution patterns offer meaningful information on the location and chronology of sites and the contrast of this information with viewshed analysis, topographic and soil productivity maps, allows generating valuable hypotheses about the relationship of Iberian sites with their territory and their generic function. However, definition of specific sites' character, including the existence of distinct economic practices or of defensive structures, cannot be satisfactorily addressed by employing survey data alone. Nonetheless, comparison with better known Iberian territories with a long trajectory of archaeological survey and excavation can help interpret this area's dynamics. Results obtained at la Carència show similar occupation patterns to those of the nearby Iberian cities of Edeta and Kelin (Fig. 1). Edetan hillforts are found on elevated places, along the edges of the territory in low agricultural potential soils whereas rural settlements are located on flat areas with medium potential soils, adequate for dry-land farming (Bonet et al., 2008, 171–179). The sites located on the plain surrounding the oppidum of Edeta offer a clear comparison to those surrounding la Carència: they have been interpreted as hamlets with simple domestic assemblages and without defensive walls, probably belonging to small landowners and dependent on the oppidum (Bonet et al., 2008, 178). A similar situation is presented in the territory of Kelin, where a

network of elevated fortified sites controlling strategic points is found in combination with settlements in flat areas without defensive walls (Mata et al., 2010, 37–39).

One of the most remarkable characteristics in the territorial organisation of this area during both the Iberian and Roman periods is the sustained importance of la Carència oppidum as a political centre. The results of the viewshed analysis show that all new Roman sites maintain a direct visual relationship with la Carència (Fig. 4), which suggests a continuing importance of this elevated settlement as a territorial centre also during the Roman period. In fact, ceramic assemblages found in this site corroborate this hypothesis and indicate that la Carència was abandoned towards the 3rd century AD, although coin data suggest the occupation of the acropolis until the 5th century AD (Ripollés et al., 2013). These observations are consistent with information documented at other eastern Iberian territories, where the traditional Iberian urban nuclei kept their role in structuring the landscape during the first stage of the Roman period (Arasa, 2001, 31; Grau, 2005).

Despite the continuing importance of la Carència during the Iberian and Roman periods, this project's results suggest an important shift during the imperial period in la Carència's territory. Many Iberian sites continued to exist during the republican Roman period according to the finding of both late Iberian and Roman imperial surface ceramics on them. 19 Iberian sites (including the two hillforts documented in the area) do not show any presence of Roman pottery and, therefore they were probably abandoned with the arrival of Roman forces. 9 new settlements appeared, as defined by the presence of Roman Imperial ceramic assemblages. The spatial pattern of newly founded Roman sites shows their significant concentration alongside the Magre River. The flooding model also showed that despite the fact that Roman sites are located in close proximity to the river, they never fall within floodable zones (Fig. 6). This stresses Roman knowledge of the Mediterranean hydrological system and their expertise in selecting locations of sites with high agricultural potential. Evidence of Roman settlements at the edges of flooding areas has also been documented in other eastern Iberian Mediterranean areas, such as the Ager Tarraconensis, Tarragona (Fiz and Orengo, 2008, 319; Palet and Orengo, 2011) and the territory around Valentia, Valencia (Orengo, 2012).

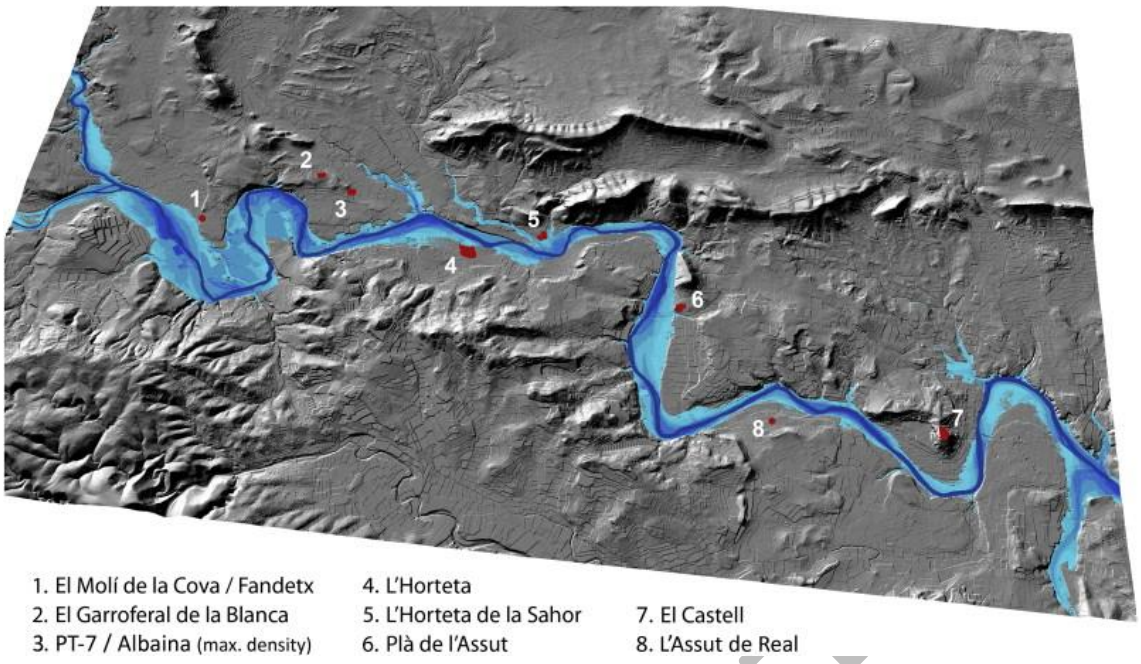

Figure 6. Magre River flooding area and Roman sites at its fringe

The newly founded Roman sites exerted a strong visual dominion over the Magre River and its surrounding areas. The Magre basin is considered as an important route joining the Mediterranean coast with the inland areas of the Valencian region and connecting the Iberian cities of Sucro, la Carència and Kelin (Bonet and Mata, 2001, 176, 178; Albiach et al., 2007, 97). However, this path could have difficultly followed the same route as that of the river due to the rough topography of the river basin, especially in its middle course, and the periodical but unpredictable flash floods, which might have rendered it impracticable. It is, thus, more likely that this route coincided with the path that connected the towns of Turís and Montserrat (Fig. 2). The Islamic origin of those towns, documented by early Christian sources (13th century), shows that this path was in use at least at the earliest stages of the medieval period. Also, the distribution of several Iberian sites along this path might verify the existence of this route and its relevance within the local communication network as early as the Iberian period.

Thus, rather than an interest for the control of the river as an important route, the location of these newly Roman sites along the immediate Magre floodplain can be related to agricultural exploitation. In fact, the deposition of fluvial sediments during flood episodes favours the development of deep and organic, highly productive, A type soils (Fig. 4). Equally, the river could have constituted an important seasonal water source to irrigate farmland crops in this area. While the use of irrigation practices during the Iberian period has not been yet attested (Araus et al., 1997), it is generally acknowledged that irrigation agriculture was introduced in the Iberian Peninsula during the Roman period (Leveau, 1997, López, 1995).

The archaeological evidence provided by the survey can also help reinforce the relation of these sites to agricultural activities. Most Roman sites located along the Magre include a very high proportion of amphorae and dolia sherds (Fig. 6, sites 2, 3, 5, 6) and, in some cases, dolia can still be found in situ. Many of these sites also have a high proportion of tegulae sherds (Fig.

7), which indicate the presence of covered constructions that could be warehouses for the storage of agricultural production.

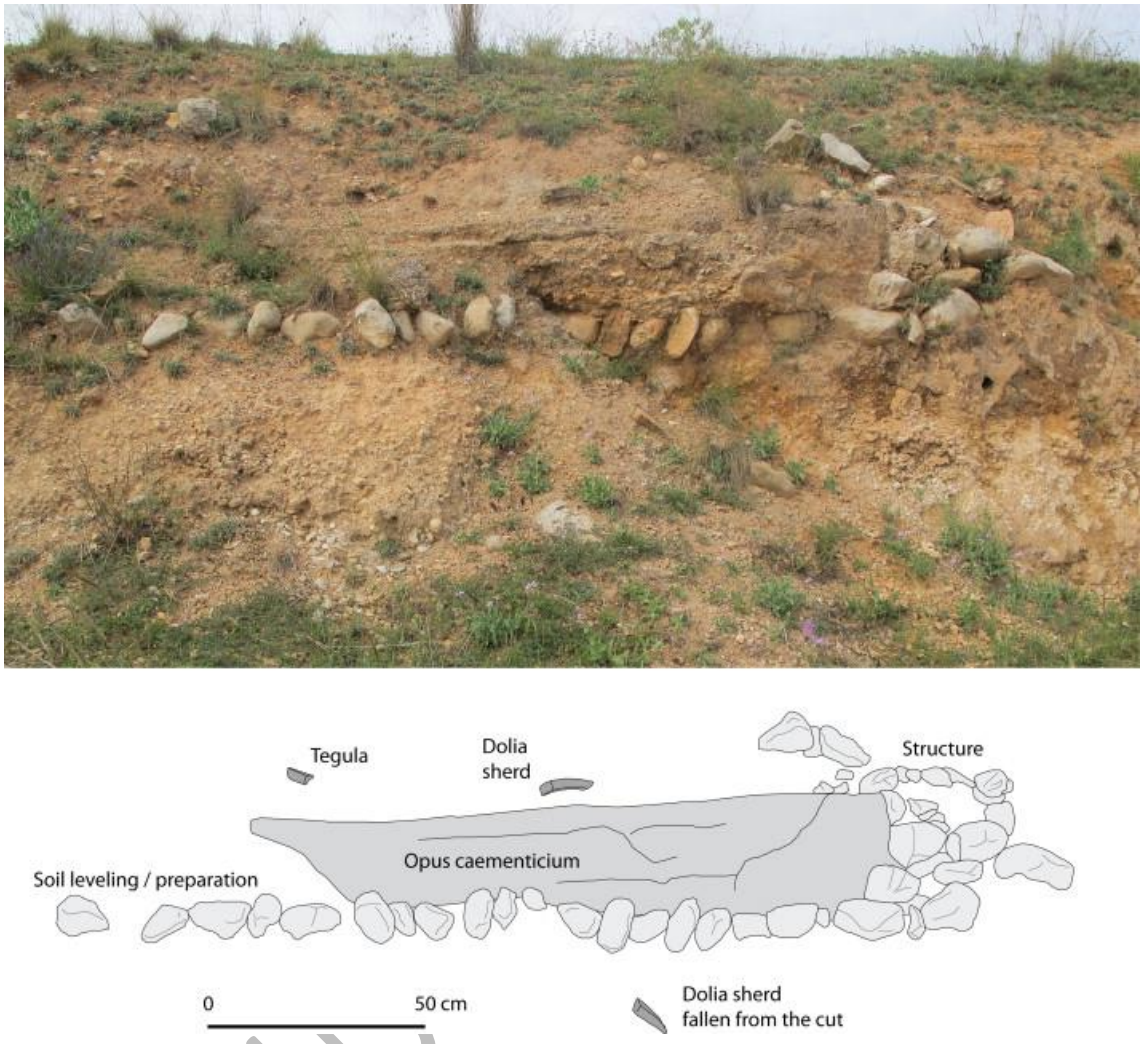

Figure 7. Roadside soil profile at Plà de l'Assut site where remains of a Roman construction and material are visible

The site of Molí de la Cova/Fandetx (Fig. 6, site 1) was characterised by a low ceramic concentration, which nonetheless included dolia fragments, and had no construction material. However, this site has been known since 1877 when a white marble head and fragments of a mosaic where found (Pla Ballester and Martí, 1988, 43). These materials, nowadays disappeared, prompt its interpretation as the urban part of a Roman villa.

This Roman tendency towards the use of deep rich soils in la Carència's hinterland can be also observed in the Calabarra area. The combined results of the archaeomorphological analysis, hydrological modelling and multispectral imagery classification show the existence of a palaeowetland at this spot. Pre-Roman sites avoided this area and the palaeochannels supplying it (Fig. 3). However, aerial photography recorded a buried structure inside this palaeowetland, which closely resembles a Roman villa in plan. The finding of surface Roman pottery in this area is consistent with this hypothesis. The existence of a Roman structure in an area prone to the accumulation of water would have not been possible without its drainage. The sedimentological trench cutting the medieval/modern drain found in the Calabarra

palaeowetland provided evidence for the existence of a drain of pre-Christian date. The conjunction of all these data suggests a temporary desiccation of the palaeowetland during the Roman period.

The flat surface and rich soils (type B) found in Calabarra area made the area highly valuable for cultivation and settlement after being drained. A similar process of desiccation by means of drains has been widely documented in wetlands in other areas of the Roman Empire (Cera, 1997, Leveau, 1993a, Ødegård, 1997). A well-known example of this is the drainage of the Fucine lake for agricultural purposes (Leveau, 1993b).

6. Conclusions

A landscape-based multidisciplinary analysis has been invaluable in generating solid research hypotheses for the analysis of la Carència's territory. The combination of archaeological survey with GIS-based analyses has allowed a better understanding of human–environment relationships in this Mediterranean area. Particularly, the analysis of water movement and accumulation and flood modelling have allowed the investigation of ancient settlement patterns in relation with water resources, flood episodes and soil productivity and their association with different land-use systems. The discovery of a palaeowetland through a combination of GIS, Remote Sensing and the digging of a geoarchaeological trench provided invaluable insights into Roman soil preferences and land management.

Iron Age Iberian settlement patterns evidenced at la Carència's territory suggest an Iberian agricultural exploitation of flat, dry and non-floodable areas. The presence of springs and other water sources within or very close to several of these sites also suggests the existence of irrigation practices during the Iberian period, based on small-scale water management systems, within a general context of a dry-land farming. Conversely, during the early stages of the Roman occupation a shift in settlement patters is observed, probably related to the development of new agrarian land-use practices. The Roman settlement pattern shows a preference for the occupation of areas with deeper, higher quality soils, suitable for the development of intensive crop production practices. Finds and architectural remains from Roman sites along the Magre seem to confirm that these sites strongly focussed on agricultural production. This shift is closely related to Roman water management practices, as it is suggested by the habitation of areas that required complex technical skills and an in-depth environmental knowledge in order to be effectively exploited. The results suggest that wetlands were drained, flooding soils were agriculturally exploited and littoral areas were inhabited in relation to this shift towards a more intensive agricultural production system. The landscape was apparently rearranged with the purpose of creating a new space to be inhabited and exploited in accordance with Roman agricultural preferences, technical capabilities and landscape perceptions.

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