ipaast-czo case study: Dehesa Boyal de Botija.

Report prepared by Victorino Mayoral Herrera

1.-The Estate and the farmer / landowner:

About the place, including any interesting history, general background, and who is currently managing it.

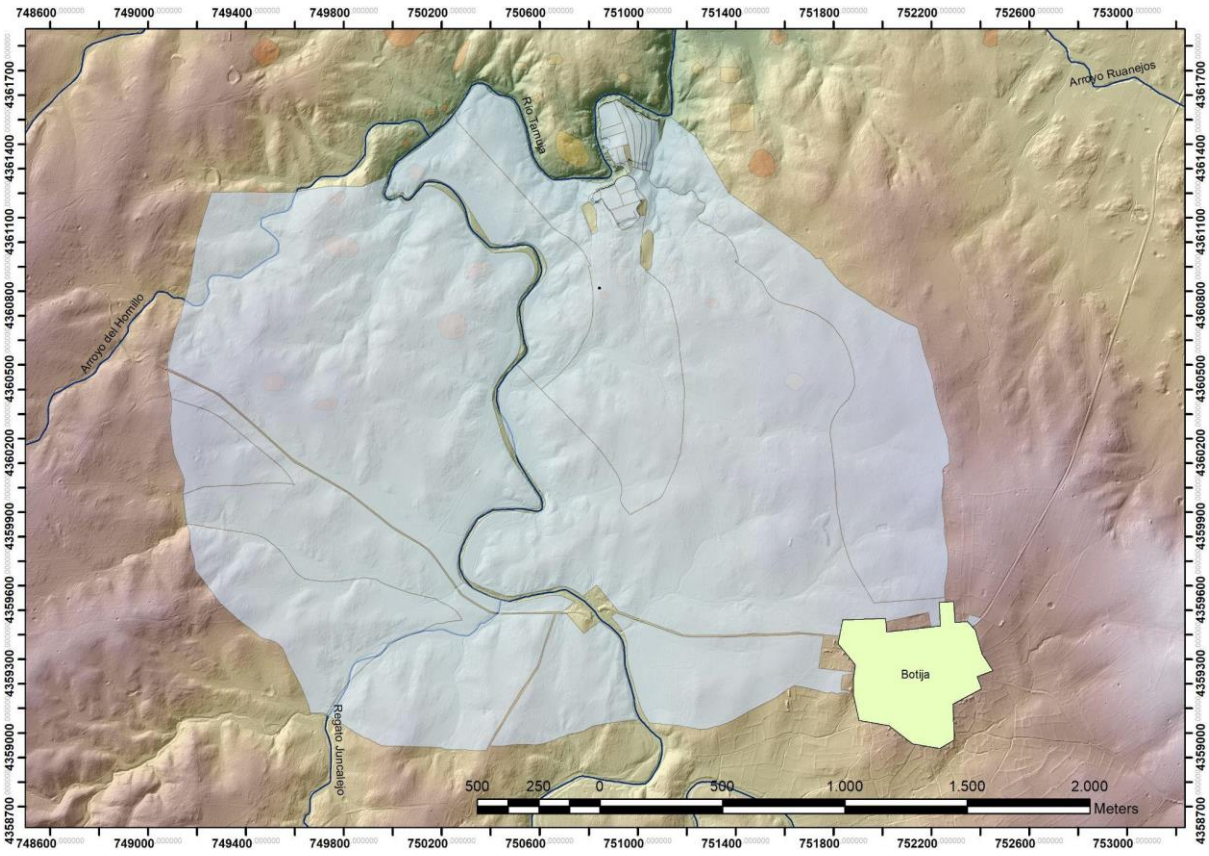
The communal dehesa of the municipality of Botija (Caceres Province, Spain) is a public pastureland that can be traced back to the Middle Ages, as part of the territorial structure of the small villages that integrated the territory assigned to the Military Order of Santiago Knights. They were rewarded with huge areas of land for their support during the conquest of these territories against the Islamic kingdoms. Traditionally the “dehesa boyal'' has been a public area where members of the local community were free to keep their livestock. Community member could also access small plots of arable lands that were intermixed with sparse forest dominated by oak trees. The ability to access public land is an important social dimension of the dehesa, because one of the most significant problems affecting peasant communities historically and smallholder agricultural communities today in this part of Spain is extremely limited access to privately owned land. To date, the surrounding dehesa landscape has been dominated by huge estates, owned by a small group of wealthy landowners and devoted to extensive stockbreeding. Today the dehesa boyal of Botija survives as one of the most extensive communal estates in the region. It is currently managed by the municipality of Botija.

Location of the dehesa boyal in the municipality of Botija, Caceres Province, Spain.

2.-Further stakeholders in land management:

Including archaeologists and heritage management agencies interested in the land, community groups, environment agencies, etc.

The dehesa boyal has been regarded by local and regional administration as a valuable cultural and natural resource. From the environmental point of view, the Tamuja basin is part of a zone of special protection for avifauna and is integrated in the *Natura 2000* network. This is managed at a regional scale by the Government of Extremadura. (http://extremambiente.juntaex.es/pdf/es0000071.pdf, http://visormontesup.gobex.es/index_comforest.php). Management for the area of influence of the Tamuja river corresponds to the Hydrographic Confederation of the Tagus basin. The regional Government also manages the cultural heritage and are responsible for inventory and protection. There are several archaeological sites within the dehesa boyal (see below), as well as a rich ethnographic record of livestock and agrarian activities. The archaeological zone of Villasviejas del Tamuja holds the highest level of legal protection and embraces the perimeter of an Iron Age hillfort and three related cemetery areas (https://www.boe.es/diario_boe/txt.php?id=BOE-A-2016-10600).



Map extents of the dehesa boyal of Botija.

3.-Current land use:

For example: farming practices, tourism, etc.

Current land use in the dehesa boyal is predominantly grassland and a sparse forest of holm oak trees for livestock use. Within these lands, cattle owned by the neighbourhood are usually grazed. There are herds of sheep, cattle and pigs. The feeding of pigs with acorns fallen from the trees is an important

activity because of their use in producing ham for domestic supply of meat and other derived products. Other traditional economic activities of the dehesa such as firewood extraction, charcoal production, beekeeping, the collection of medicinal or aromatic plants, etc., have been almost completely lost, but still have value. Some of these activities have great potential to reinvigorate the local economy through the production of artisan food products such as honey, cheese or cold meats. There is an active traditional cheese factory, showing the potential for this activity.

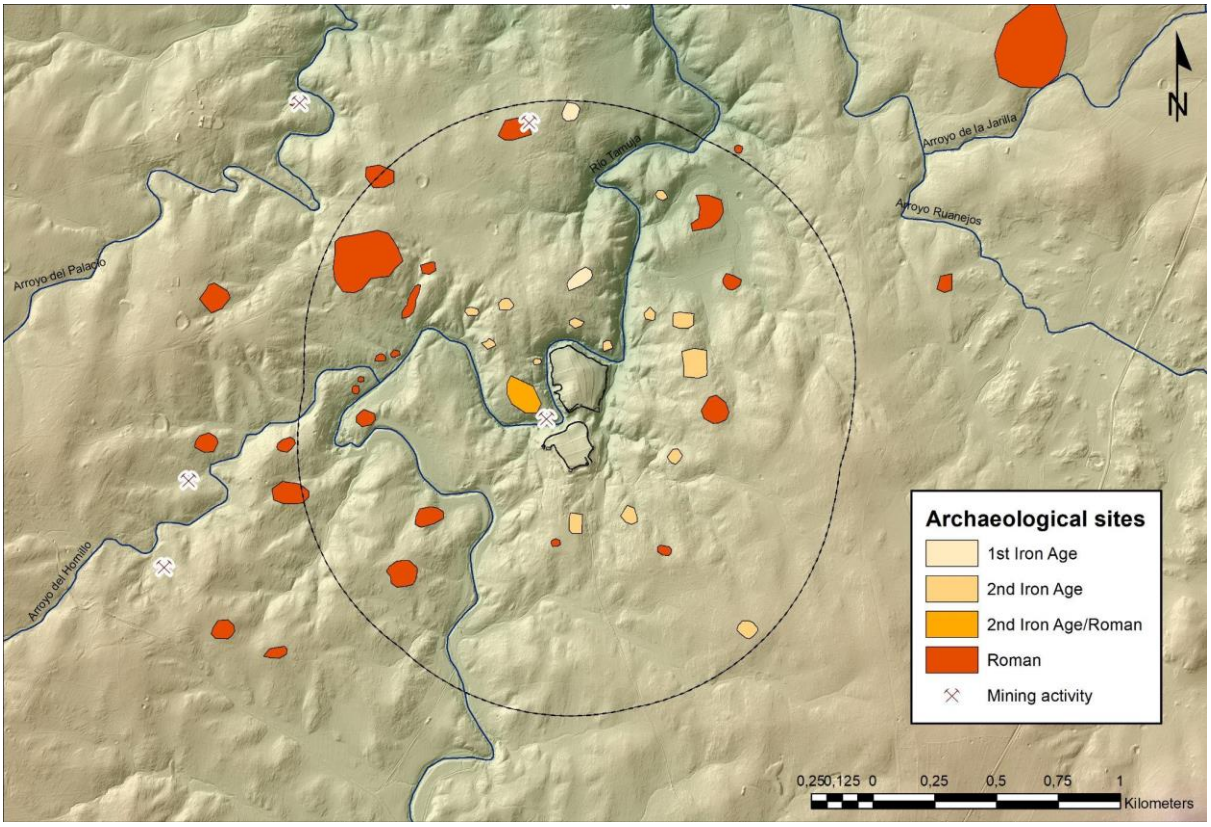
Current land use – predominantly grassland with sparse holm oak forest for livestock use.

4.-What we know about archaeology of the study area:

Any background on the significance of local archaeology, prior research etc.

The cultural landscape of the dehesa boyal has a very long diachronic sequence, with archaeological evidence of its transformation from late Prehistory (Plieninger, 2006; López Sã¡ez *et al.*, 2007). There are several outstanding fortified Copper Age sites in the hilltops of Plasenzuela, but the best known archaeological area corresponds to a Second Iron Age hillfort of 7 ha. size known as "Villasviejas del Tamuja". The site has been excavated since the 1960s (Hernández Hernández, Rodríguez López and Sánchez Sánchez, 1989; Hernández, Domingo and Bravo, 2009; Hernández Hernández and Martín Bravo, 2017) and it is currently the focus of a research project of non-invasive research through remote sensing and geophysics (Mayoral Herrera, 2021). Systematic surface survey during the 1990s and more recent work around the hillfort has revealed dozens of sites dating from the First Iron Age period to the Late Roman period (et alii Hernández Hernández, 2009).

For this case study, two study areas were chosen south of the hillfort of Villasviejas (Sector 1 and Sector 2 – see below Section 8)



The cultural landscape of the dehesa boyal – main archaeological sites according to period

5.-How precision agriculture is being used:

Past data collections, methods being used, if any – or ambitions to do this if it's not already happening.

To date, farm management of the dehesa of Botija has been carried out with traditional techniques, and no improvement has been proposed by using precision agriculture methods. From the moment we started working with non-invasive methods for the search for archaeological sites and for the historical analysis of the landscape, the project team realized that the same techniques could have a positive impact on the management of the economic resources of the dehesa.

This led us to consider the possibility of working together with agronomists to manage the pastures of the archaeological zone of Villasviejas with a triple purpose:

1.-Manage the vegetation, eliminate xerophytic species that represent a risk of forest fire, improve the sowing of pasture species and introduce sheep on the land.

2.-Keep the archaeological zone accessible and facilitate the conservation of excavated features.

3.-Intensify the contrast of the differential development of the vegetation, improving the quality of the "pasture marks" – local spatial variations in the vegetation – the make visible the results of remote sensing surveys at these sites.

Finally, on a broader scale of the entire dehesa boyal, the collaboration with the Agroinsider team (Spin-off of the University of Evora) creates the possibility for using satellite remote sensing (Sentinel2) to assess the carbon capture capacity of these lands, as an alternative way to obtain income and improve the management of public pastures.

6.-Management Challenges:

What the main land management problems are, especially with an eye to improving sustainability.

The dehesa faces many challenges that make its preservation as a balanced economic and ecological system uncertain:

- Climate change is causing the disappearance of certain tree species and an increasing clearance of the holm oak forest, resulting in vegetation communities and distributions more like the savannas which develop on marginal areas with increasing desertification.
- Increasing aridity and severe droughts intensifies soil degradation and erosion.
- Within this context, the increasing pressure on pasture lands with higher loads of livestock to make farming profitable, is breaking the equilibrium of the traditional dehesa system.
- Finally, the abandonment of agroforestry management techniques leads to the interruption of the active maintenance of the Mediterranean forest, increasing the risk of forest fires.

The impact of this collection of factors has significant implications for the preservation of the cultural heritage of the dehesa landscape.

7.-Sources of existing data:

Archival data or other existing data you were able to access, including previously collected precision agriculture data.

Previous spatial data for the study of the dehesa boyal were gathered from public repositories of geographic information, specially from the National Institute of Geography (https://centrodedescargas.cnig.es/CentroDescargas/index.jsp). It included:

- LiDAR data for terrain analysis
- Derived DEM data at different scales
- Vector files containing topographic features
- Vector layers with soil and geology data
- Historical series of orthoimages from 1956 to the present
- Specific drone flights with thermal IR and multispectral data gathered during previous research from the area of the Iron Age hillfort.

Distribution of previously known archaeological sites was digitized from existing paper publications and completed with additional fields containing published descriptions. No previous precision agriculture data were available.

8.-New data collected for the case study:

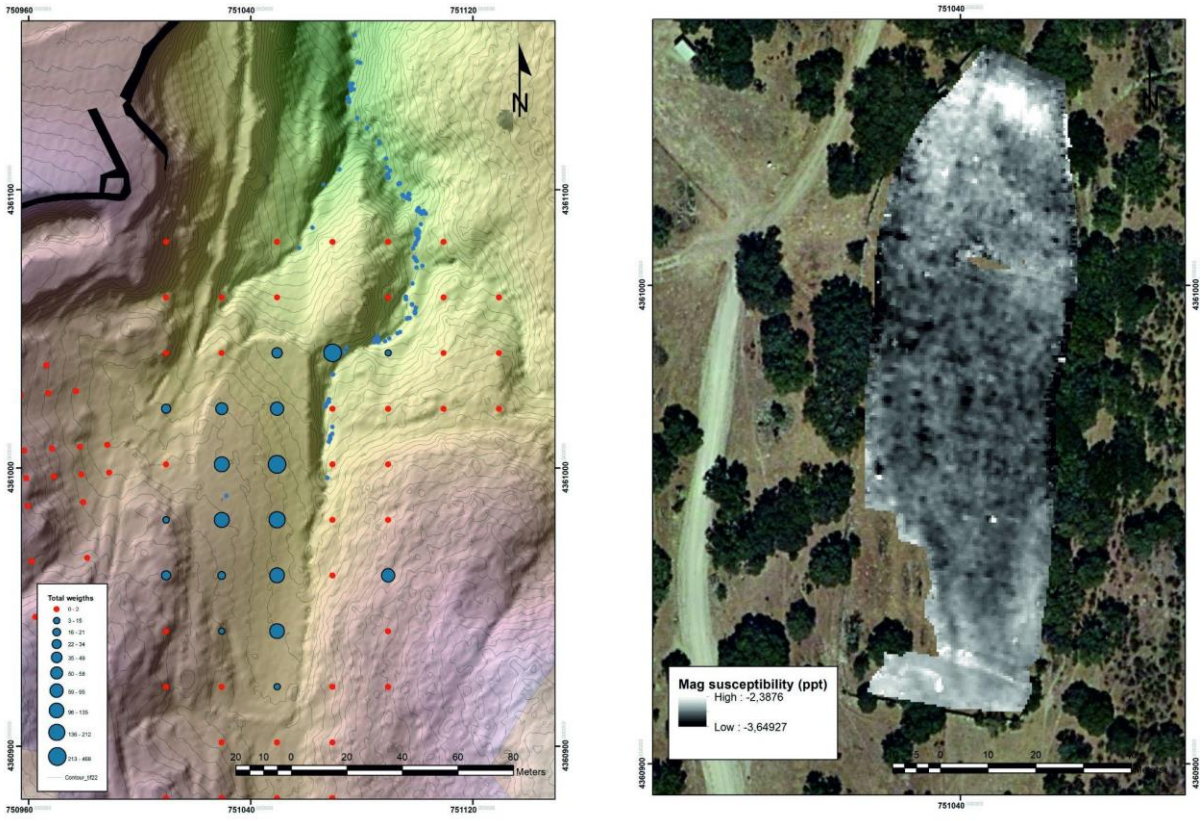
Two main methods for the exploration of the study areas (Sectors 1 and 2) in the dehesa boyal were used:

- Magnetic survey with a dual-sensor gradiometer system (Grad602) by Bartington
- Electromagnetic induction with a EM38Mk2 instrument by Geonics

Additionally, several areas within Sector 2 were investigated with GPR (Sensor&Software Nogging system).

To test different survey methods in the framework of the IPAAST project, three objectives were defined:

- exploring off-site activities around the hillfort of Villasviejas: traces of intensive agriculture, industrial activities, dumping areas, mining etc.
- assessing the composition and depth of soils in the area in order to evaluate the representativeness of surface finds and run a regression analysis to evaluate the potential distribution of arable lands during the Iron Age in the area.
- combining geophysical methods commonly used in precision agriculture and archaeology in order to evaluate their interoperability and the complementary information they can provide.

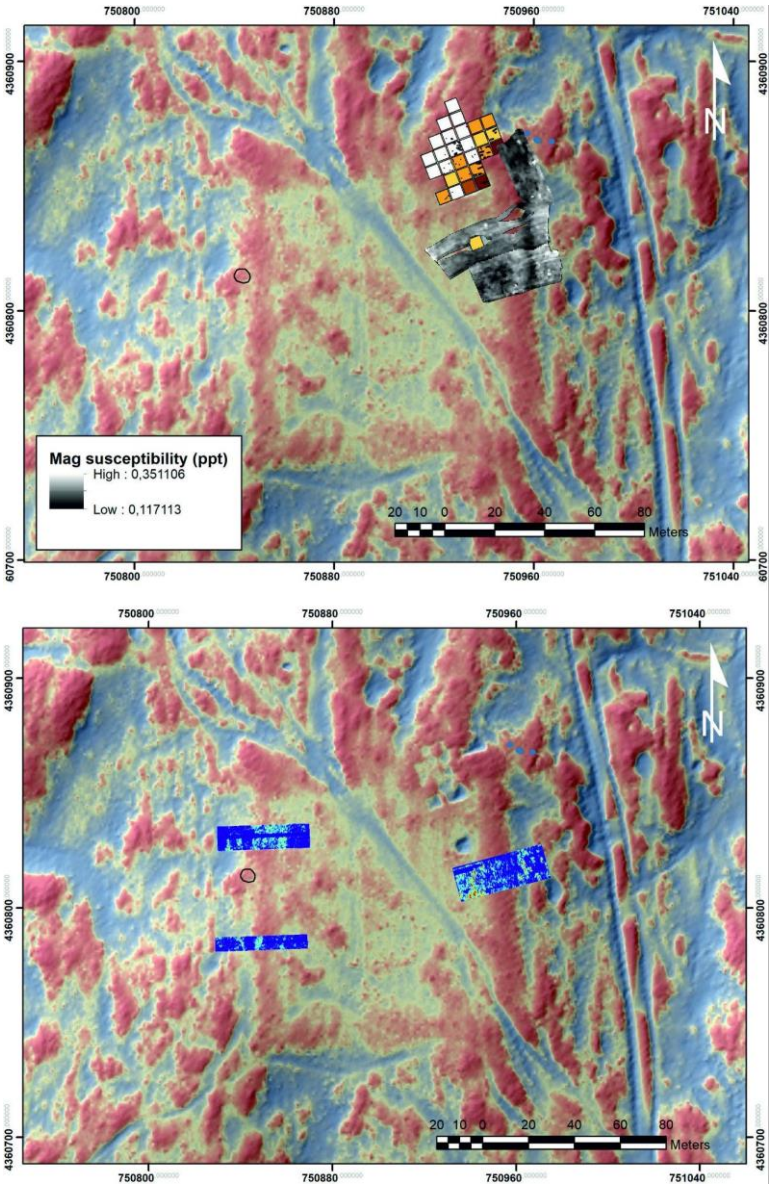


Sector 2 – surface survey plot (left) and EM magnetic susceptibility survey mapping (right).

With these objectives in mind, two sectors to the south of the hillforts were explored:

- Sector 1: Paraje del Mercadillo: an area of *c.* 3500 sq. m. 150 m south of the hillfort. In this sector, a funerary area corresponding to the earliest period of the hillfort (IV-II centuries BC) was excavated in the 1980s. Analysis of LiDAR data revealed that in the same area there were several topographic features that could be linked to off-site activity during protohistoric and early roman period. Data sets:
    - EMI01.
        - 01 Vector limits of survey area
        - 02 Vector file of point data
        - 03 Raster interpolation of quad-phase (conductivity) 0.5m

        - 04 Raster interpolation of quad-phase (conductivity) 1m
        - 05 Raster interpolation of in-phase (magnetic susceptibility) 0.5m
        - 06 Raster interpolation of in-phase (magnetic susceptibility) 1m
    - EMI02.
        - 01 Vector limits of survey area
        - 02 Vector file of point data
        - 03 Raster interpolation of quad-phase (conductivity) 0.5m
        - 04 Raster interpolation of quad-phase (conductivity) 1m
        - 05 Raster interpolation of in-phase (magnetic susceptibility) 0.5m
        - 06 Raster interpolation of in-phase (magnetic susceptibility) 1m
    - EMI03.
        - 01 Vector limits of survey area
        - 02 Vector file of point data
        - 03 Raster interpolation of quad-phase (conductivity) 0.5m
        - 04 Raster interpolation of quad-phase (conductivity) 1m
        - 05 Raster interpolation of in-phase (magnetic susceptibility) 0.5m
        - 06 Raster interpolation of in-phase (magnetic susceptibility) 1m
    - MAG01.
        - 01 Vector limits of survey area.
        - 02 Vector point file of vertices of survey area.
        - 03 Grid composite.
        - 04 Raster interpolation of magnetic data.
- Sector 2: Cerca del cementerio: an area of *c*. 5240 sq. m. 70m SW of the hillfort. Previous knowledge of the area revealed the presence of a high density of archaeological materials, but there was no clear evidence of buried structures. A particular feature of this sector was the great depth of soil deposits within the walled enclosure, in great contrast with the surrounding fields. Data sets:
    - EMI04.
        - 01 Vector limits of survey area
        - 02 Vector file of point data
        - 03 Raster interpolation of quad-phase (conductivity) 0.5m
        - 04 Raster interpolation of quad-phase (conductivity) 1m
        - 05 Raster interpolation of in-phase (magnetic susceptibility) 0.5m
        - 06 Raster interpolation of in-phase (magnetic susceptibility) 1m



Results of EMI and Magnetic survey in Sector 2.

9.-Insights from joint analysis and interpretation:

Interim results and anything you've learned from the data you've collected from both an archaeological and precision agriculture Perspective.

The specific results of the work carried out offer various lessons:

- "El Mercadillo" (Sector 1): prospecting with the GPR and magnetometer confirms the prsence of an artificial structure identified through LiDAR data, likely related to the initial presence of the Romans in this area. These results also make it possible to assess the variable depth of the soils in a context highly affected by erosion. This area is dominated by shallow erosive soils, and variations in the soil depth, linked to strength of erosion here, can be used to help interpret the representativeness of the finds in the surface (fieldwalking) survey data.

- “Cerca del cementerio” (Sector2): the combination of geomagnetic, EMI and GPR data confirms the absence of structures, and allows us to characterize this space as a dumping area outside the hillfort, dating from the last phase of its development (1st century BC). We have been able to record the remarkable preservation of sediments in this area, a process supported by modern land subdivisions, but which reflects artificial accumulation processes caused by intensive activity in the immediate surroundings of the settlement.

10.-Soil Health and Heritage futures:

How the data you collected could be used for sustainable management. What further data would be needed.

The data collected to date will be very useful to assess the impact of erosion on the landscape of the dehesa and its potential restoration through the introduction of pasture management systems and more sustainable stocking strategies. To get a more complete vision of these processes, it will be necessary to develop geomorphological studies, to dissect the "soil archive" in the sedimentation zones. This record must be complemented with dating and sedimentological studies that allow us to reconstruct the global dynamics of this landscape, its milestones and oscillations based on climatic variations and the intensity of anthropic pressure at different moments over time. It would also require an evaluation of the carbon sequestration capacity and, in general, the evaluation of remote sensing methods for monitoring the health of these forests.

In addition, the information collected is very useful for creating an inventory of cultural elements of the dehesa, from prehistory to the recent past, some of which can benefit from a joint management of natural resources, livestock exploitation and the revaluation of heritage.

11.-References

Hernández, F.H., Domingo, E.G. and Bravo, A.M.M. (2009) ‘El proyecto Villasviejas del Tamuja. Análisis global de un asentamiento prerromano’, in *Lusitanos y vettones: los pueblos prerromanos en la actual demarcación Beira Baixa, Alto Alentejo, Cáceres*. Consejería de Cultura, pp. 161–180.

Hernández Hernández, F. *et al*. (2009) ‘A la vista de las murallas : Análisis arqueológico del entorno del castro prerromano de Villasviejas del Tamuja (Cáceres)’, *Complutum*, 20(1), pp. 109–132.

Hernández Hernández, F. Martín Bravo, A.M. (2017) ‘Las necrópolis del Romazal y el conjunto arqueológico de Villasviejas del Tamuja’, *Arqueología y Patrimonio*. Madrid: La Ergástula.

Hernández Hernández, F., Rodríguez López, M.D. and Sánchez Sánchez, M. (1989) *Excavaciones en el castro de Villasviejas del Tamuja (Botija, Cáceres)*. Mérida: Editora Regional de Extremadura.

López, J.A. *et al.* (2007) ‘Origen prehistórico de la dehesa en Extremadura: una perspectiva paleoambiental’, *Revista de estudios extremeños*, 63(1), pp. 493–510.

Mayoral Herrera, V. (ed.) (2021) *Villasviejas del Tamuja (Botija, Cáceres). Desvelamiento del paisaje urbano de un Castro de la Edad del Hierro.* Instituto de Arqueología-Mérida (MYTRA : Monografías y Trabajos de Arqueología, 9). Available at: https://dialnet.unirioja.es/servlet/libro?codigo=836847 (Accessed: 1 December 2021).

Plieninger, T. (2006) *Dehesas de la penillanura cacereña: origen y evolución de un paisaje cultural*. Cáceres: Universidad de Extremadura.