

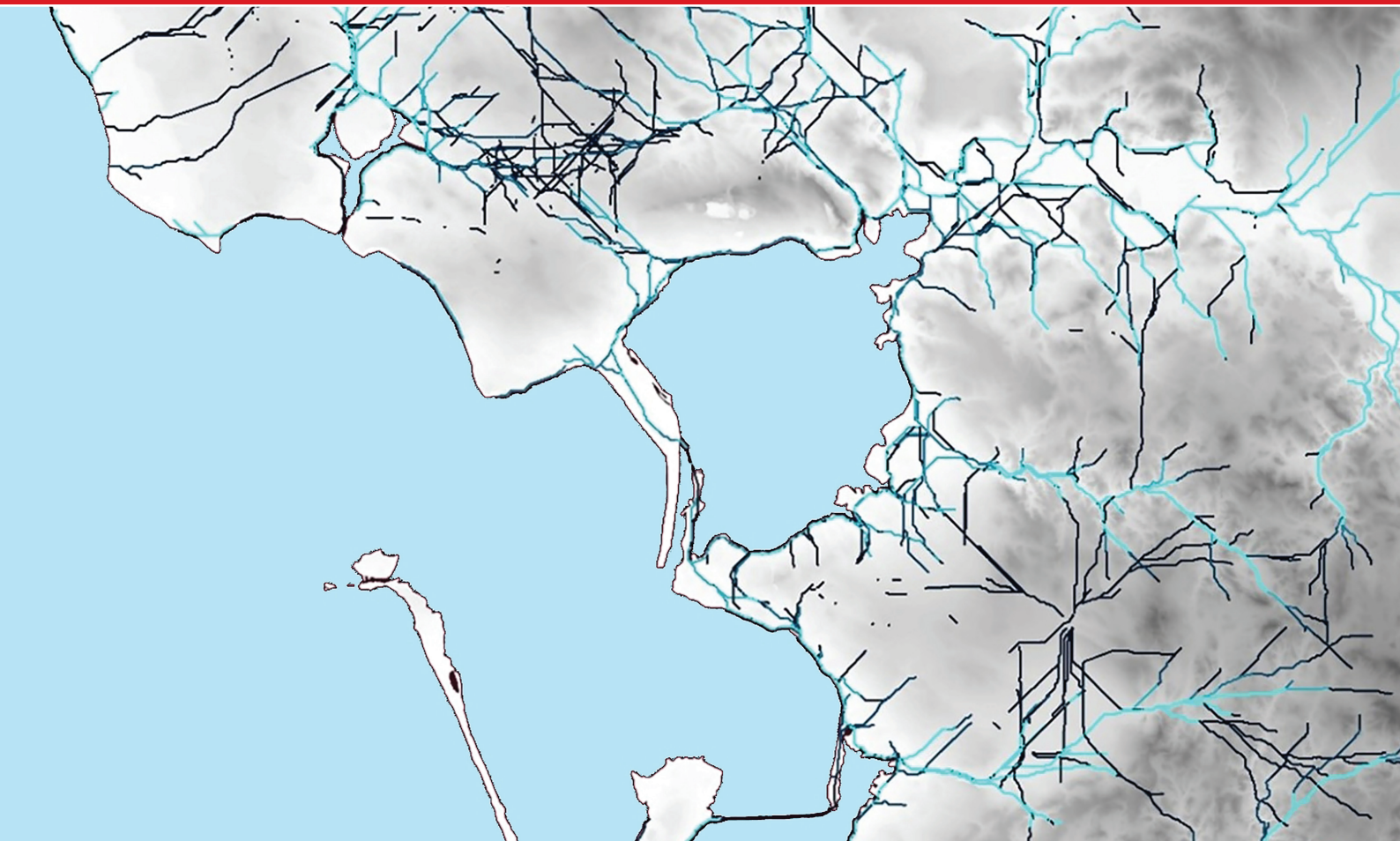
# GIS Applications in Roman Landscape and Territory

*Methodologies and models in Hispania*

EDITED BY  
PEDRO TRAPERO FERNÁNDEZ  
AND ANDRÉ CARNEIRO

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# GIS Spatial Analysis and the Roman Archaeology in Spain and Portugal: a brief overview

André Carneiro<sup>1</sup> and Pedro Trapero Fernández<sup>2</sup>

**Abstract:** In this brief introduction to the volume, we analyze the challenges of studying the Iberian Peninsula using Geographic Information Systems (GIS). The main issue lies in the current political boundaries between Spain and Portugal, which did not exist during the Roman era. Instead, there were provinces that evolved over time and were primarily divided into three: Lusitania, Baetica, and Tarraconensis. However, these administrative divisions did not imply differences in the flow of a geographical unit like the Iberian Peninsula. This has resulted in imbalances in the recent use of GIS since the 1980s. Spain has experienced a creative and research explosion in this field, unlike Portugal, and has enjoyed easier access to resources. Finally, we examine the challenges related to metadata and primary sources, emphasizing the need for improved academic training, which is relatively more extensive in Spain but still deficient in undergraduate and postgraduate programs.

**Keywords:** Hispania, Roman Times, historiography, access to resources, teaching GIS

**Resumen:** En esta breve introducción al volumen se analiza la problemática de estudiar con Sistemas de Información Geográfica la Península Ibérica. La principal cuestión son las fronteras políticas actualmente existentes entre España y Portugal que para época romana no existían. En su lugar, había unas provincias, que fueron modificándose con el tiempo y que se mantuvieron fundamentalmente en tres, Lusitania, Bética y Tarraconense. Sin embargo, estas divisiones administrativas no conllevaban diferencias en el trasiego de una unidad geográfica como es la Península Ibérica. Esto ha creado desequilibrios en el uso reciente de los Sistemas de Información Geográfica SIG a partir de los años 80. En el caso de España se ha dado una explosión creativa e investigadora, sin paralelos en Portugal, siendo también más fácil el acceso a los recursos en el primer caso. Finalmente se analiza la problemática de los metadatos y fuentes primarias que tienen que ser mejor trabajados partiendo de una más amplia formación académica, mejor en el caso Español pero aún deficiente en los programas de grado y posgrado.

**Palabras clave:** Hispania, época romana, historiografía, acceso a recursos, enseñanza SIG

## 1.1. Introduction

The Iberian Peninsula, as a diverse geographical region, has been historically divided into various entities. This division can be attributed to the influence of different cultures, such as the Celts, Greeks, and Phoenicians, as well as administrative divisions. During the Roman Era, multiple divisions existed, with the most significant one being Augustus' partitioning of Hispania into three provinces: *Lusitania*, *Baetica*, and *Tarraconensis*. However, it is important to note that these divisions were primarily administrative rather than spatial in nature. Presently, the territory is divided into two separate states,

Spain and Portugal, along a border that is political rather than geographical, not corresponding to the historical reality. Consequently, the capital of the Roman province of *Lusitania* is situated outside of Portugal, and a portion of the northern Douro region, which belonged to *Tarraconensis*, is now within Portugal's borders. This division holds significance as historical and archaeological studies must adhere to the laws and issues of each state, despite relating to the same historical reality.

In the context of this book, an even greater challenge arises due to disparities in the approach taken by researchers in Geographic Information Systems. Furthermore, disparities in education, including access to geographic resources, have resulted in significant differences between the two countries in a discipline that could have been shared. This discrepancy largely explains the variation in studies conducted in Spain and Portugal.

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## 1.2. Research on Roman Settlement Patterns

Archaeological investigations into Roman rural settlement networks in the Iberian Peninsula commenced much later compared to other countries. Archaeologists have traditionally focused more on the study of isolated sites, emphasizing excavations to uncover monumental structures, rather than considering the reconstruction of settlement networks. Analyzing the surrounding territories faced limitations due to various factors, such as a persistent lack of financial support, inadequate academic training in the field survey domain, and a lack of interest in understanding the structural components of settlement patterns.

The initial effort to systematically analyze the Roman presence in present-day Portuguese territory was, unsurprisingly, undertaken within the Anglo-Saxon context. Jorge de Alarcão (1988) compiled a comprehensive body of data aiming to document all types of sites (urban and rural), following the logic of the *Tabula de Imperii Romanii* (TIR), also produced in Spain by Álvarez and Cepas (2001). This systematic inventory provided feasible geo-locations for each archaeological site, with a sequential and organized approach specifically tailored to the Portuguese mainland. The three volumes of “Roman Portugal” were complemented by an additional one, independently edited in Portuguese and showcasing an original organization for its time. Reflecting the Anglo-Saxon perspective of transversal examination of ancient societies, it adopted thematic chapters rather than a diachronic structure.

Logically, the next step would naturally involve conducting systematic field surveys to gather data. In the academic context, researchers sought to understand regional settlement networks within the existing administrative boundaries. Interestingly, two studies within this context focused on Roman settlements in *Gallaecia*: Francisco Sande Lemos’ foundational study on eastern Trás-os-Montes (1993) and Carlos Brochado de Almeida’s study on the Minho Atlantic facade (1996). Additionally, João Luís Inês Vaz conducted a fieldwork-based study on the *civitas* of Viseu (1993), which incorporated a social and identity-based approach. Subsequent years witnessed the development of studies on *Lusitania*, including M. Conceição Lopes’ analysis of the *civitas* of *Pax Iulia* (2003), Pedro C. Carvalho’s extensive works on the Beira Interior region (2007), João Pedro Bernardes’ study of the *civitas* of *Collipo* (2007), and André Carneiro’s examination of the Roman settlement patterns in Alto Alentejo (2014). This shift towards the use of field prospection approaches instead of archaeological excavations represented a change in Portuguese Archaeology’s prevailing priorities. The lack of funding for large-scale excavations, until the 70’s typically carried out by the National Archaeological Museum, led to a preference for low-cost approaches focused on studying territories. As a result, these studies had limited incorporation of technological and

computer analysis tools, unlike their counterparts in other countries, particularly within the framework of French “*Archeogéographie*”. The primary focus stood on collecting information and conducting field prospections, with limited emphasis on technological and computerized analysis. A different approach was made by Helena Paula Carvalho’s study of *Bracara Augusta*’s hinterland (2008) followed a spatial analysis approach, extending beyond the bracarense region on occasion (Carvalho and Bernardes, 2008).

During the 1990s, Portugal experienced a process of increasing municipalization in its administrative system, transferring many management and safeguarding responsibilities to local municipalities. This resulted in a considerable effort to create archaeological maps and municipal inventories, occasionally including specific chapters on Roman period settlements (Lopes, Carvalho, and Gomes, 1997) or, rarely, publishing them as standalone monographs (Carneiro, 2004).

The Spanish case exhibits a similar process, influenced by foreign researchers and methodologies. While the 1980s witnessed an increase in archaeological survey works due to the establishment of new institutions and divisions within communities and provinces after the Franco dictatorship (Ruiz Zapatero, 1988), several studies were conducted in various regions. For example, studies were conducted along the Duero River (San Miguel, 1990), in the province of Soria (Borobio, 1985), the community of Catalonia (Castells, 1986), the province of Burgos (Clark, 1979), the community of Galicia (Criado et al., 1988), the province of Navarra (Ona, 1984), the province of Seville (Ruiz Delgado, 1985), the province of Cordoba (Vaquerizo et al., 1991), among others. During this period, there were important prospection works covering extensive areas and using new methodologies (Ponsich, 1991; Key and Millet, 1991), as well as studies on Roman roads (Sillières, 1990). Additionally, there arose a need within the administration to create archaeological charts for each municipality (Jimeno Martínez et al., 1991). While not all territories have their own charts today, extensive inventories are available in most cases, which have been reviewed and updated multiple times.

The main difference in this respect between Spain and Portugal may not lie in their research traditions, which have external influences and differing methodologies, making it challenging to integrate data from various surveys. The key distinction lies in the fact that Spain operates under different micro-governments or autonomous communities. While areas like Catalonia or specific provinces have a high profile and established traditions in this regard, they cannot be extrapolated to provide a comprehensive view. This means an advance in the methodology and amount of resources available per area in Spain, with other areas being less favoured. In the case of Portugal, this development is more homogeneous throughout its territory, dotted with small case studies.

### 1.3. Current GIS Studies

In the Portuguese context, a movement known as the “Fourth Generation” in Landscape Archaeology or settlement pattern studies during the Roman period emerged within the academic sphere. These studies explore specific areas of analysis or apply specialized analytical tools. This process began around the turn of the millennium and is ongoing, with a collection of academic works, including master’s and doctoral theses, that demonstrate high originality in their conceptualization of analysis perspectives. Unfortunately, due to the constraints resulting from the lack of investment in Portuguese archaeological research, these works often lack continuity as the authors have to seek professional alternatives. Consequently, these studies are confined to academic repositories and lack follow-up. Nevertheless, studies employing field and/or computer analyses have been conducted in various areas, such as the road network (Costa, 2010; Almeida, 2016), settlement networks from a typological and conceptual standpoint (Almeida, 2000; Osório, 2000; Brito, 2021), field survey strategies applied to territorial entities (Cosme, 2002; Perestrelo, 2003; Vieira, 2004; Barbosa, 2016; Matos, 2018), predictive models (Lacerda, 2017), and analytical studies using polygons (Marques, 2011) or spatial analyses in limited areas (Fernandes, 2016).

In this regard, the Spanish case is significantly different, as it boasts important research institutions and traditions that have now become references in GIS analysis. Works have been published to consolidate the accumulated knowledge in this area (Mínguez García and Capdevila, 2016), especially those generated by GIS modeling experts, such as “La aplicación de los SIG en arqueología del paisaje” (Grau, 2006) and “Archaeology and Geomatics. Harvesting the benefits of 10 years of training in the Iberian Peninsula (2006–2015)” (Mayoral, Parcero, and Fábrega, 2017). It is worth noting that there have been significant traditions of applying GIS and methodological study to history in various parts of the Peninsula, including the University of Alicante, INCIPIT, the Institute of Archaeology of Mérida (CSIC), and the Agustín de Horozco Seminar at the University of Cádiz, among others. The study of ancient landscapes and territories is implemented with well-analyzed case studies and a validated methodology that can be exported and replicated in multiple contexts, addressing not only territorial issues but also social and economic modeling (García-Dils de la Vega, 2015; Trapero Fernández, 2021).

In an overview, some key observations can be made:

- In academia, there is still limited production in Landscape Archaeology compared to more traditional fields of analysis, such as materials studies, despite a significant increase since the turn of the millennium. Despite the availability of technological tools, this situation has not changed in recent years.

- However, a recent shift is occurring, moving from field-focused studies that involve various levels of prospection to more theoretical and desk-based analyses using computer analysis. This shift, observed in Spain, is also influencing Portugal and can be seen in the transition from broader PhD theses to more focused and ambitious Master’s theses.
- Due to the existence of numerous areas with limited data availability, the analysis still heavily focuses on the search for primary data and the conceptual discussion of settlement categories during the Roman period. This emphasis often neglects the evaluation of metadata, legacy data, and ongoing reflections on analytical technologies in most European countries.

### 1.4. Teaching Context

Within the Portuguese university system, there is no distinct training program specifically dedicated to spatial analysis applied to Roman archaeology. Currently undergoing a reformulation phase, the Master of Archaeology & Environment at the University of Évora includes a specialization that combines GIS training with field survey practices. This specialization builds upon the practical curriculum of the Bachelor’s degree. A similar specialization can be found at the Faculty of Arts of the University of Coimbra, where the Master of Archaeology and Territory offers a specialization in Archaeogeography. However, in this case, the training does not include a specific field practice component.

Other universities incorporate GIS training in isolated modules, either as an integral part of the curriculum (University of Minho, University of Porto) or as an optional component. This variation has an impact on the students’ training profile. As mentioned earlier, the number of academic theses conducted in the Portuguese system is still limited compared to other countries. While contributions from the University of Coimbra and the University of Évora are increasing, with a more analytical focus in the former and a fieldwork orientation in the latter, the combination of these components is rare. Contributions from other universities are less frequent and irregular.

In general, the Spanish perspective is similar but more encouraging. In most History or Archaeology degrees, specific courses dedicated to GIS are not offered. Instead, GIS is integrated into more general subjects such as research methods and techniques, as is the case at the University of Cadiz. There are exceptions, such as the University of Alicante, where there are specific courses on introduction to cartography and GIS representation. However, in Masters programs focused on heritage within History or Archaeology, there are usually dedicated courses or doctoral programs. Nevertheless, Masters programs in Geographic Information Systems cater to a more general audience, primarily focusing on public management and natural resources rather than archaeological heritage or historical studies. Consequently, most professionals end up

acquiring skills in the use of these tools through external training courses of varying durations. The main challenge in their application lies in the lack of a standardized method and their limited focus on historical studies, needing the deconstruction of the landscape under potentially different conditions from the past. Some higher education institutions, like the University of Burgos ([https://www.ubu.es/te-interesa?field\\_term\\_interest\\_tid=653](https://www.ubu.es/te-interesa?field_term_interest_tid=653)) and CSIC (<https://www.csic.es/es/formacion-y-empleo/cursos-de-alta-especializacion-del-csic/aplicacion-de-las-tecnologias-de-0>), specialize in providing online or on-site courses for these services.

### **1.5. Access to resources**

Compared to other European countries, resources for territory studies using analytical tools are scarce in Portugal. Obtaining such data is challenging, as much of the available information is confidential or restricted. Additionally, the data is dispersed across various portals and lacks methodological coherence or support. In contrast, the Spanish case differs significantly, and understanding these disparities is crucial for comprehending the current development of each scholarship, as we will explore next.

The Army Geographic Institute (IGeoE) possesses photographic coverage of the Portuguese territory using aerial photography from 1947 to 2005. However, this data is not freely accessible. Consequently, the main repositories of information for establishing analytical foundations are found within Public Administration portals. These include the National Geographic Information System (SNIG) at <https://snig.dgterritorio.gov.pt> and the Directorate-General for the Territory (DGT) at <https://www.dgterritorio.gov.pt>. These portals are particularly useful for analyzing rural land registries and coordinating with information systems. For specific thematic areas, resources such as the National Engineering and Geology Laboratory (LNEG) at <https://www.lneg.pt> and the National Institute of Conservation and Forests (INCF) at <https://www.icnf.pt> can be consulted. An important information aggregator is ForestGIS, which provides shapefiles for the entire country at <https://forest-gis.com/2012/01/portugal-shapefiles-gerais-do-pais.html/>. Access to environmental and ecological mapping resources can be found through Epic WebGIS Portugal at <http://epic-webgis-portugal.isa.ulisboa.pt/>. For data related to the social and administrative structure of Portuguese territory, the Public Administration Open Data Portal at <https://dados.gov.pt/pt/> is available.

Regarding archaeological data, the traditional archaeological database known as Endovelico was established in 1995 and is now accessible through the Archaeologist's Portal at <https://arqueologia.patrimoniocultural.pt>. This aggregator consolidates references to known archaeological sites, enabling consultation and processing of the information. The database is constructed from archaeological works reported to the supervising entity, with georeferencing and essential details regarding the description and general

elements of the occurrences. However, due to issues related to data feeding and verification, the resource still exhibits frequent errors, inaccuracies, and duplication of data, as many sites are reported with variations in designation.

Satellite data for the Portuguese territory can be obtained from the Sentinel Scientific DataHub system. Other resources are available through general platforms such as the NASA Earth Observatory systems and the European Environment Agency (EEA) EU-DEM, which manages the Copernicus system. However, resources commonly accessible in other countries, such as LIDAR coverage, are either unavailable or subject to limited access due to public consultation restrictions. Finally, it is worth mentioning a valuable resource for studying Roman routes and tracks, the Roman Routes in Portugal, which aggregates all relevant information using a geoportal at <https://viasromanas.pt>.

In Spain, access to most resources is available online and free of charge. For example, the challenge of obtaining the 1956 American flights' orthophotography of Portugal is resolved in the Spanish case through a Web Map Service, providing unrestricted coverage of the entire country. Only access to archaeological information, which is sensitive to looting, or specific data such as spatial information of locations with military bases or other restricted layers, requires specific permissions. Otherwise, any citizen with sufficient GIS knowledge can access these resources. It is worth noting that, in accordance with the common protocol in Europe, all information is freely accessible for research purposes.

In this regard, Spain's spatial data infrastructure is considered one of the most advanced in Europe. The general download center, available at <https://centrodedescargas.cnig.es/>, allows access and download of relevant foundational information, including historical cartography, thematic resources, current and historical orthophotographs, digital terrain models, and LiDAR flights. The availability of LiDAR data is particularly valuable for conducting microspatial studies and remote sensing, providing access to both raw and processed data for analysis. Portugal is in the process of making similar materials publicly available in the near future.

However, one challenge in Spain is the presence of both a general infrastructure and specific infrastructures for each autonomous community. This creates disparities in different regions, resulting in varying levels of data accuracy. For instance, in Andalusia, the REDIAM platform at <https://portalrediam.cica.es/geonetwork/srv/spa/catalog.search#/home> provides access to an extensive range of environmental and territorial data, which significantly complements historical studies in this field.

In this brief introduction, we have questioned the traditions, current studies, training, and access to resources as fundamental elements for historical and



archaeological studies using GIS. Currently, the Iberian Peninsula as a territorial unit cannot be studied in the same comprehensive manner in both constituent countries due to differences in tradition and resource accessibility. This creates challenges for professionals with advanced knowledge who seek to conduct their work on the Portuguese side. The compilation of works presented here aims to showcase the latest trends in these studies on a global scale and highlight the potential differences for readers who are unfamiliar with the state of GIS in Portugal and Spain.

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**‘This monograph will have a significant impact on Roman archaeologists in the Iberian Peninsula. The potential applicability of the methods in other areas and periods suggests a broader contribution to the archaeological field.’**

*Dr Miguel Carrero Pazos, University of Santiago de Compostela, Spain*

Geographic Information Systems applied to the study of the landscape and territory of Roman times are currently a common practice in historical and archaeological studies. This book analyzes the issue for the Iberian Peninsula as a whole, Spain and Portugal, transcending the current administrative border. In this book, the most innovative methodologies and results for the study of the ancient rural environment in Hispania are shown through a series of selected case studies.

Los Sistemas de Información Geográfica aplicados al estudio del paisaje y territorio de época romana son una práctica común actualmente en los estudios históricos y arqueológicos. Este libro analiza la cuestión para la Península Ibérica en conjunto, España y Portugal, trascendiendo la frontera administrativa actual. En este libro, se muestran las metodologías y resultados más novedosos para el estudio del medio rural antiguo en Hispania a través de una serie de casos de estudio seleccionados.

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