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Mapping the anthropic occupation of the territory. Tracing dynamics of human settlement from archaeological records and historic cartographies

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ABSTRACT

The dynamics of anthropic occupation of a territory over time play a central role in shaping the cultural landscape we see today. This paper presents a methodology for visually representing this phenomenon. The method consists of transforming data from archaeological records and historic cartography into a series of maps that allow historic settlement patterns to be interpreted and the historic depth of contemporary urban areas to be revealed. To create these maps, a series of geospatial analyses were carried out, including density analysis and weighted overlay. The methodology was applied to the peri-urban area of Seville in southern Spain, although it may be extrapolated to other regions.

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Archaeological record; human settlement; landscape planning; historic landscape; cartography; GIS

1. Introduction

The cultural approach to the geographical sciences and the emergence of a paradigm proposing an archaeology of the landscape allowed an understanding of territory as the product of a process of transformation over time to develop throughout the course of the twentieth century. According to the tenets of cultural geography (Meinig, 1979), the landscape is a visible manifestation of the territory's value as a historical document; that is, the landscape shows that territory is the result of constant interaction between the natural and human factors operating on it over time, rather than a static entity (Ortega Valcárcel, 1998).

When the temporal, evolutionary dimension of the territory is taken into consideration, the importance of a diachronic analysis of the landscape becomes clear (Crumley et al., 2017). Research into methodologies revealing historic settlement patterns (Aucelli et al., 2020; Ławniczak & Kubiak, 2021), changing land use dynamics (Aldred & Fairclough, 2002; Beilin et al., 2014; Dolejš et al., 2019; Gu & Subramanian, 2014), past communication systems (Stanish et al., 2010; Supernant, 2017) and other historical anthropic processes occurring on the territory (Maio et al., 2013) is particularly relevant for this reason. Besides, it is essential that analysis of the environmental, cultural, social and economic phenomena which have historically shaped the landscape is incorporated into contemporary landscape planning and design (López Sánchez et al., 2020a). Thus, the study of the historical processes and dynamics of interaction between the human being and the territory are more than pertinent (Bavusi et al., 2015; Di Leo et al., 2018; Gioia et al., 2020), but it is also necessary to reflect on the way in which these specialised studies can be integrated in proactive decision-making scenarios (Roymans et al., 2009).

Against this backdrop, this paper aims to reveal the patterns and dynamics of human settlement of the territory over time using cartographic representation. It seeks to develop a cartographic method allowing georeferenced archaeological records and historic cartography relating to a particular territory to be simply and effectively transformed into a visual instrument. Mapping historical information facilitates its integration in planning and design processes, as well as the communication and dissemination of archaeological information to a broad audience. Therefore, the proposed map is also intended for use as a potential teaching or training resource.

The methodology proposed in this paper is applied to a specific territory, the rural land to the west of the city of Seville (Spain) (Figure 1) although it may be extrapolated to other areas. Seville is the most highly populated city in the south of Spain. It currently has a population of around 700,000 inhabitants, or 1,000,000 including the metropolitan area. The selected area covers approximately 800 km^2 and brings together five different landscapes: the foothills of Seville's Sierra Norte, to the north (1); the green corridor of the river Guadiamar, a protected area of

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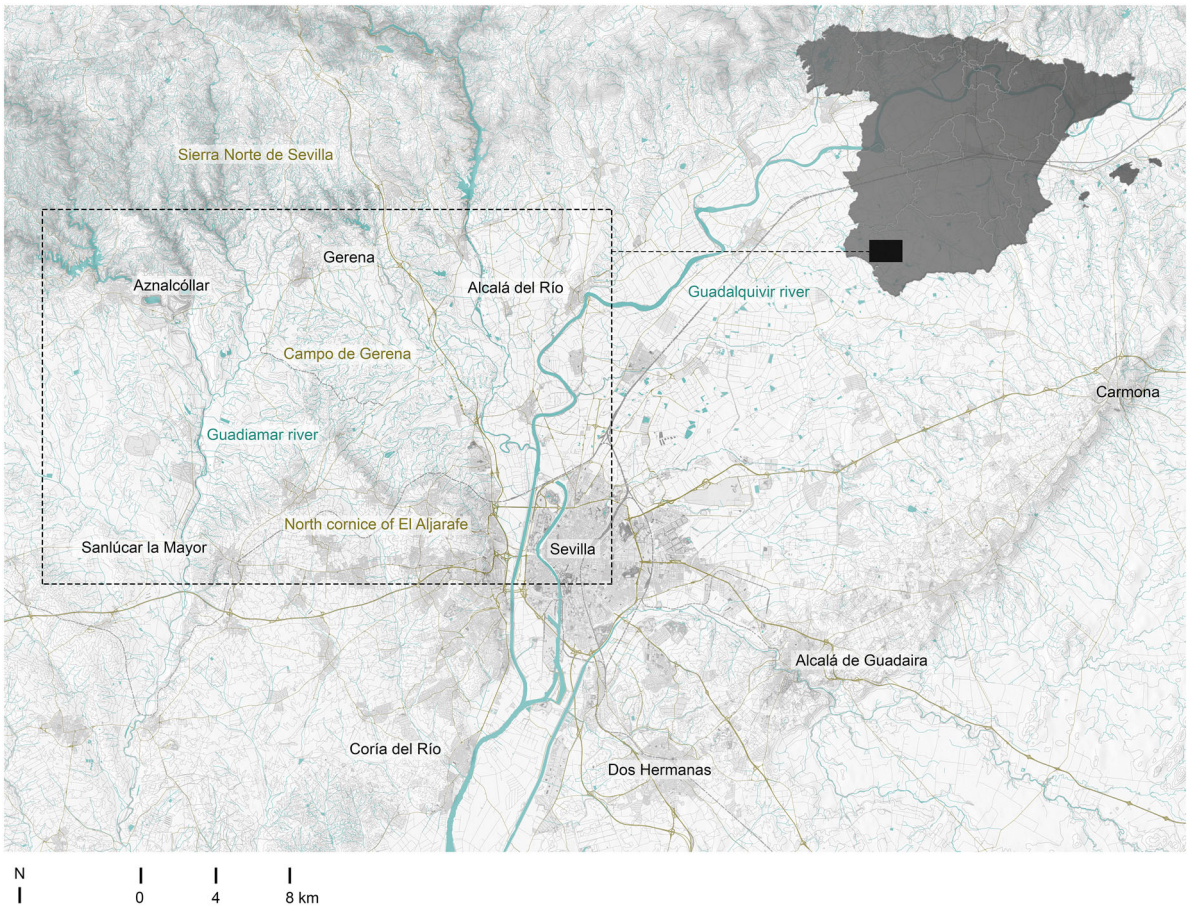

Figure 1. Case study area. Source: By the main author through ArcGIS® and ArcMap ™ 10.4.1. software by Esri., 2020.

ecological interest that has recently been restored, to the west (2); the plain of the river Guadalquivir, characterised by a mosaic of irrigated crops, to the east (3); the dry farming landscape of the Campo de Gerena in the central area (4); and the metropolitan landscape of Aljarafe to the south, where olive crops are found along with inhabited centres which in the last couple of decades of the twentieth century have increased their surface area exponentially through successive urban developments, especially those closer to Seville (5).

Aljarafe is bordered to the north by a ledge, which stands out over an agricultural landscape that is predominantly flat (Figure 2). It is an area with

Figure 2. North cornice of El Aljarafe. View from Campo de Gerena. Source: Main author.

historical-territorial cohesion, i.e. a heritage area where intertwined historic processes have taken place, due to being the territorial field associated with the last navigable branch of the river Guadalquivir, the main historical commercial route in the southern peninsula.

The entire area is a representative example of those rural territories located near to large cities, where the landscape diversity and historical depth of the territory coexist with fast roads, industrial areas, commercial infrastructures and intense residential developments that fragment the landscape and make it very difficult to perform a reading of its heritage (Figure 3) (Muñoz, 2010). Research into the historic landscape in fragmented spaces which have undergone aggressive recent urban development is fundamental for reworking landscape planning and management to incorporate new approaches reflecting a commitment to the landscape's cultural significance and heritage value.

2. Materials and methods

The raw data used to create the Main Map were taken from georeferenced records of archaeological sites on the territory. In the selected study area, this information is produced and managed by the Instituto Andaluz de Patrimonio Histórico [Andalusian Historical Heritage Institute] (IAPH). The Institute's Documentation and Study Centre supplied the research team with two point and polygon vector layers in *shape* format (.shp) corresponding to the study area. This information is georeferenced under the ETRS89 European Terrestrial Reference System. The polygon layer was processed by extracting the centroids for each polygon. These centroids were added to the other layer to create a single point vector layer. This unified vector layer of archaeological sites was completed and updated by the team. By consulting the archaeological maps of the municipalities in the study area and archaeological information from municipal planning documents, new sites that had not been listed in the original IAPH records were added. A systematic review of historical maps covering the study area was then carried out. The maps providing the most detailed representation of the settlements in the study area were incorporated into the study (Tables 1 and 2). Analysis of these historic maps revealed the presence of more recent urban and rural settlements (Ławniczak & Kubiak, 2021; San-Antonio-Gómez et al., 2014) (Figure 4). These settlements were added to the inventory. In total, 427 point data items were studied.

The second phase of the methodology involved defining three fields in the attribute table, which corresponded to: historical period, type of settlement and intensity of settlement. The fields 'type of settlement' and 'intensity of settlement' are complementary to each other. They are respectively the qualitative and quantitative expression of the same information. The data used to complete these fields were determined by historical research and archaeological evidence.

In the 'historical period' field, six broad phases of anthropisation were identified: prehistory (Palaeolithic, Neolithic and Chalcolithic), up to 2000 BC; protohistory (Bronze and Iron Age), up to 237 BC; Roman era and late antiquity, up to the end of the 7th century; early Muslim middle ages and late Christian middle ages, up to the end of the 15th century; modern era, up to the end of the eighteenth century,

Figure 3. View of industrial parks and fast roads in the river plain of Gualdaquivir from the North cornice of El Aljarafe. Source: Main author.

Table 1. Historic cartography consulted for the modern era. Source: Main author.

No.	Original Name	Autor	Date	Available at
1	Regni Hispaniae post Omnium editiones locuple[ti]ssima descriptio	Abraham Ortelius	1572	Instituto Geográfico Nacional. Code: 11-F-12.
2	Hispalensis conventus delineatio	Hieronÿmo Chiaves, Abraham Ortelius	1579	Instituto Geográfico Nacional. Code: 33-E-17.
3	Andaluziae nova descript	Jodocus Hondius	1606	Biblioteca de Andalucía (Granada). Code: md-2-40
4	Nova et accurata Tabula Hispaniae: Praecipuis Urbis, Vestitu, Insig nibus, et Antiquitatibus exornata	N. Johannis Visscher	1623	Instituto Geográfico Nacional. Code: 13-E-9
5	Tabla del Reyno de Andalvzia	Pedro Texeira	1634	Österreichische Nationalbibliothek (Viena). Code: 46 ff. 55v-56.
6	Andaluzia continens Sevillam et Cordubam	Willem Janszoon Blaeu	1650	Biblioteca de Andalucía (Granada). Code: md-2-18
7	Les Estats de la Couronne de Castille, dans les Parties Plus Meridionales de l'Espagne. et la ou sont Castille Nouvelle, Andalousie, Grenade et Murcie	Nicolas Sanson d'Abbeville	1652	Instituto Geográfico Nacional. Code: 32-F-3.
8	Regnorum Castellae Novae, Andalusiae, Granadae, Valentiae, et Murciae: Accurata Tabula in Episcopatus etc	Frederick de Wit	1670	Instituto Geográfico Nacional. Code: 32-F-14
9	Il Regni di Granata, e D' Andalucia	Giacomo Cantelli	1696	Instituto Geográfico Nacional Code: 30-G-10
10	Royaume d'Andalousie et de Granade = Kaart van Andalusien en Granade	Iohann Stridbek Iun.	1704	Instituto Geográfico Nacional. Code: 12-D-7
11	Regnorum Castellae Novae Andalusiae Granadae Valentiae et Murciae. Accurata Tabula	Nicolaes Visscher	1705–1714	Instituto Geográfico Nacional. Code: 32-F-21
12	Perfectissima geographica delineatio regnorum Vandalitiae, Granatae, et Algarbiae, tractuum meridionalium Portugalliae, Extremadurae ac Castellae Novae / suma diligentia correcta et edita a R. & I. Ottens	Ottens, Reiner & Josua	1745	Institut Cartogràfic i Geològic de Catalunya. Code: RM.6098 (3)
13	Map of the Reynado de Sevilla, executado por el Yngeniero en Gefe Dn. Francisco Llobet …	Francisco Llobet	1748	Instituto Geográfico Nacional. Code: 32-D-69
14	Partie Meridionale des Etats de Castille, où se trouvent La Castille Nlle. [Nouvelle] …	Didier Robert de Vaugondy	1751	Instituto Geográfico Nacional. Code: 12-M-26
15	Partie meridionale des costes d'Espagne ou sont les Royaumes de Granade et d'Andalousie …	Nicolas Guérard, Philippe V	1762	Bibliothèque nationale de France. Code: Collection d'Anville; 01706
16	Mapa o carta corographica que comprehende todas las provincias de marina, que componen el departamento de Cadiz	Joseph Antonio Espelius	1765	Biblioteca Nacional (Madrid). Code: Mr/43/036 Cádiz (Departamento marítimo)

Table 2. Historic cartography consulted for the contemporary era. Source: Main author.

No.	Original Name	Autor	Date	Available at
17	Mapa de Andalucía. the Bureau Topographique de l'Armée d'Espagne. Hoja n° 230.	J. Charles M. Bentabole	1811	Service Historique de la Défense, Département de Íarmée de Terre (Vincennes). Code: 6M L12 B2 11 02.
18	Li regni di Siviglia, Cordova e Jaen: compresi nell'antica Andalusia, ed il regno di Granata	A.B. Borghi	1817	Biblioteca de Andalucía (Granada) Code: md-6-34
19	Carte Politique de L'Espagne et de Portugal: pour servir au voyage pittoresque de M. le Comte Alex. de Laborde	Baron Bory de St. Vincent Ex Colonel, Gravé par Vicq, Écrit par Pelicier	1824	Instituto Geográfico Nacional. Code: 32-L-18
20	Mapa de Andalucía con las nuevas divisiones	Auguste-Henri Dufour, Bulla et Jouy	1837	Archivo Cartografico de Estudios Geograficos del Centro Geografico del Ejercito. Code: Ar.E-T.1-C.3-57 (3)
21	Mapa de la provincia de Sevilla. A la Dirección General del Cuerpo de Estado-Mayor / el Teniente Coronel del mismo	Federico Salazar	1844	Centro Geográfico del Ejército (Madrid). Code: Arm. G TBLA. 7ª carp. 2ª núm. 383.
22	Provincias de Sevilla y Huelva.	R. Alabern i Moles, Ramón y E. Mabon	1853	Instituto Geográfico Nacional Code: 41-K-21(MAP09)
23	Mapa Geográfico Itinerario de la Provincia de Sevilla.	C. Santigosa	1855	Biblioteca Nacional (Madrid) Code: M. 9v Sevilla
24	Mapa de la provincia de Sevilla	F. Coello	1869	Centro Geográfico del Ejército (Madrid). Code: Arm. G TBLA. 7ª carp. 2ª núm. 386.
25	Sevilla (Distrito militar). Mapas militares	Cuerpo de E.M. del Ejército	1881	Instituto Geográfico Nacional Code: 47-B-12
26	Sevilla. Mapa topográfico Nacional.	Dirección General del Instituto Geográfico y Estadístico.	1918	Instituto Geográfico Nacional Code: A-35-0984 (ED1918NNN)
27	Alcalá del Río. Mapa topográfico Nacional.	Dirección General del Instituto Geográfico y Estadístico.	1918	Instituto Geográfico Nacional Code: A-35-0962 (ED1918NNN)
28	Alcalá del Río. Mapa topográfico Nacional.	Dirección General del Instituto Geográfico y Estadístico.	1972	Instituto Geográfico Nacional Code: A-35-0962 (ED1972NNS)
29	Sevilla. Mapa topográfico Nacional.	Dirección General del Instituto Geográfico Nacional.	1988	Instituto Geográfico Nacional Code: A-35-0984 (ED1988NNN)

and contemporary era, up to the end of the twentieth century.

The 'type of settlement' field classifies into urban settlements, with very high, high and moderate intensity, and rural settlements, with high, moderate and low intensity. The criteria used to associate each settlement with one of these typologies are listed in Table 3. It is important to note that the criteria are intended to turn the information already available in the archaeological records, historical studies and

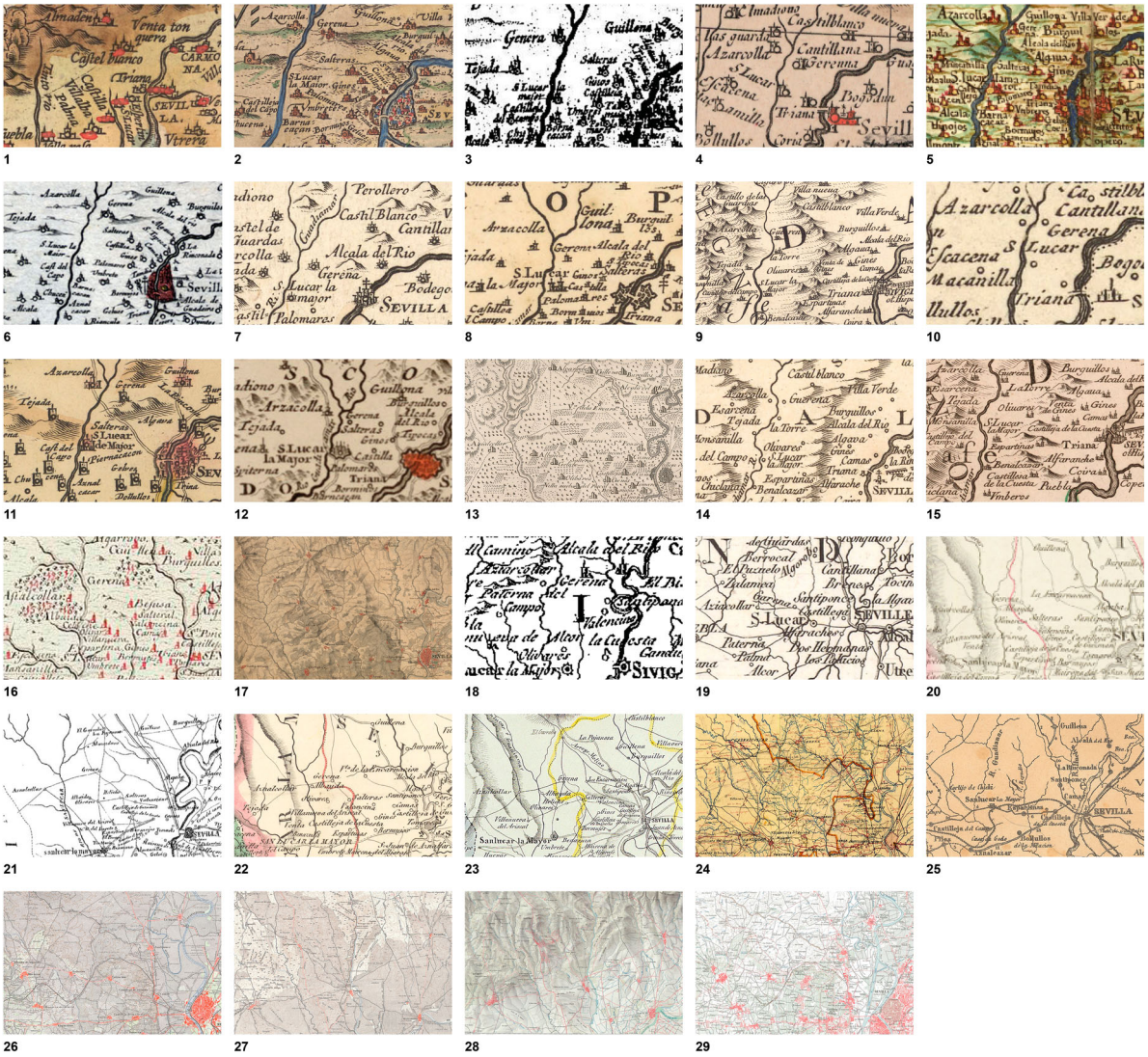

Figure 4. Miniatures of the historical cartographies consulted, cut out and framed in the area of study. The reference number corresponds to that specified in Tables 1 and 2. Source: Main author.

historical cartographies into a scheme of classification for settlements. Where possible, the typological classification already made by archaeologists is used as a reference. On the other hand, the 'intensity of settlement' field corresponds to the quantitative expression of the field 'type of settlement'. The 'intensity of settlement' field is a numeric value defined by the type of settlement allocated, as shown also in Table 3.

Once this information had been filled out, a kernel density analysis was conducted for each of the six historical periods identified. The search algorithm predetermined by the software applied the following bandwidth formula:

$$SearchRadius = 0.9 * \min\left(SD, \sqrt{\frac{1}{\ln(2)}} * Dm\right) * n^{-0.2}$$

where:

SD is the standard distance

D*m* is the median distance

n is the number of points if no population field is used, or if a population field is supplied, *n* is the sum of the population field values

The density value is higher at the point and falls as we move away from the point, reaching zero at the *SearchRadius* distance. The volume determining the density values is equal to the value determined in the *population field*, which corresponds to the 'intensity of settlement' field in this case. This produces a weighting which allocates higher density values to the points corresponding to larger settlements with a higher density of settlement and territorial significance.

When the density analyses were complete, a collection of raster-type layers was obtained. These images show the parts of the territory which, according to the archaeological evidence obtained to date and the historic cartography available, experienced the most intense settlement in each of the historical periods identified, revealing the patterns of settlement characterising each era.

Table 3. Fields added to the attribute table. Source: Main author.

'Historical period' field	'Type of settlement' field		Summary of the main criteria used to establish the classification	'Intensity of settlement' field
Prehistory/ Protohistory	Urban settlements	Very high intensity	Archaeological sites with evidence of urbanisation and shown by historical research to have played a relevant role in the territorial patterns of commerce and defence	18
		High intensity	Rest of archaeological sites with evidence of urbanisation	14
		Moderate intensity	-	10
	Rural settlements	High intensity	Archaeological sites with abundant and concentrated presence of lithic and/or ceramic material	6
		Moderate intensity	Archaeological sites with minor scattered ceramic and/or lithic fragments	4
		Low intensity	Sites with archaeological evidence from these periods but very punctual and limited	2
Roman era and late antiquity	Urban settlements	Very high intensity	Archaeological sites with evidence of urbanisation and shown by historical research to have operated as nodes in the roman road network and have had an official legal status	18
		High intensity	Archaeological sites with evidence of urbanisation and shown by historical research to have played a relevant role in territorial patterns of commerce and defence	14
		Moderate intensity	Rest of archaeological sites with evidence of urbanisation	10
	Rural settlements	High intensity	Archaeological sites with abundant and concentrated presence of ceramic and construction materials	6
		Moderate intensity	Archaeological sites classified as *villae*	4
		Low intensity	Archaeological sites classified as small agricultural settlements, farms, cottages or shacks	2
Middle Age	Urban settlements	Very high intensity	Main city: central position in the middle age road network; evidence of very relevant defensive structures and religious buildings	18
		High intensity	Archaeological sites classified as *villa* or *castillo* with relevant defensive structures	14
		Moderate intensity	Archaeological sites classified as *villa* without relevant defensive structures	10
	Rural settlements	High intensity	Archaeological sites classified as *lugar señorial* or *aldea*	6
		Moderate intensity	Archaeological sites classified as *alquería*	4
		Low intensity	Archaeological sites classified as agricultural building	2
Modern era	Urban settlements	Very high intensity	Main city: central position in the modern road network; appears as the major city in the available mapping	18
		High intensity	Towns drawn and named in the 16th-18th centuries cartography with relevant religious architecture	14
		Moderate intensity	Towns drawn and named in the 16th-18th centuries cartography without relevant religious architecture	10
	Rural settlements	High intensity	-	6
		Moderate intensity	Sites with archaeological evidence of the 16th-18th centuries that are not drawn in the cartography or sites drawn as *hacienda, cortijo* or *casa* in the 19th-20th centuries cartography with architectural features that date their origin to the 16th-18th centuries.	4
		Low intensity	-	2
Contemporary era	Urban settlements	Very high intensity	Main city: central position in the contemporary road network; appears as the major city in the available mapping	18
		High intensity	Major towns drawn and named in the 19th-20th centuries cartography	14
		Moderate intensity	Minor towns drawn and named in the 19th-20th centuries cartography	10
	Rural settlements	High intensity	-	6
		Moderate intensity	Sites indicated as *hacienda, cortijo* or *casa* in the 19th-20th centuries cartography	4
		Low intensity	-	2

The information obtained was then used to produce a summary map allowing the areas of the territory which had experienced the most decisive, intense processes of human settlement throughout history to be visualised. To do this, the duration of the settlement processes which took place in these areas and their historical depth were considered. In order to create the summary map, the values allocated to each of the raster cells on the output layers underwent geospatial reclassification. Since these raster layers are content layers, the reclassification table allows the cut-off values automatically classified by the density analysis to be imported. The reclassified values correspond to whole numbers from 1 to 10. The highest values correspond to the cells where settlement occurred with the greatest intensity. A weighted overlay analysis was then performed, which was applied over all the reclassified raster layers. The weighted overlay analysis allowed the values allocated to each raster cell in the different layers to be added, with the result that the areas of the territory which were occupied with the greatest intensity during the highest number of historical periods obtained the highest final values. In addition, a new criterion allocating greater weight to older settlements was incorporated to assess the historical depth of the territory.

This criterion was applied via the weights allocated in the weighted sum: a weighting of 22% was allocated to the prehistoric period, 20% to the protohistoric period, 18% to the Roman era, 16% to the middle ages, 14% to the modern era and 10% to the contemporary era. The result of this analysis was a new raster layer showing the historic occupation of the territory and revealing the areas that were most significant for human settlement.

3. Results

The results obtained allow historic settlement patterns in the area to be visually interpreted. They offer a concise overview, showing how evidence of settlement in the prehistoric era is concentrated in a very specific area of the ledge. These archaeological remains correspond to the Chalcolithic necropolis of Valencina de la Concepción. The concentration of archaeological evidence in this area is very high and there are almost no other prehistoric archaeological sites in the area, with the exception of those already identified in the foothills of the Sierra Norte. This casts light on the archaeological debates currently taking place in the area, which question whether the necropolis was associated with a significant town with high levels of territorial hegemony or, otherwise, if the dimensions of the necropolis are justified because it was used for episodic funeral rituals by various dispersed nearby settlements (Escacena Carrasco et al., 2018; Martínez-Sevilla et al., 2020; Sanjuán et al., 2018). In the second hypothesis, the symbolic variable supersedes the strategic-defensive variable in the occupation of the ledge.

The transition into the protohistoric era reveals far-reaching changes in settlement patterns. The settlement axes can be seen to shift towards river courses, especially the area surrounding the river Guadalquivir, and settlement in the foothills of the Sierra Norte intensifies. The economic variable stood out as the main shaping factor of the landscape (García Fernández, 2018). Trade routes produced an incipient concentration of the population around them, meaning the creation of the urban system in the territory. Three main trade axes were defined: the river routes of the Guadalquivir and Guadiamar and the mining and metallurgy belt of the foothills. The mining trade was an essential factor in the cultural, economic, social, and political transformations of the territory during this period (Amores et al., 2014; Garrido González, 2020).

The cartography corresponding to the Roman era shows an unprecedented intensity of settlement, which is characterised by significant territorial dispersion following patterns of imperial exploitation of the territory. Although the settlement pattern from the previous period partially persists and the main urban areas are still located in riverside areas and in the mountain foothills, there is a significant shift towards settlement in rural areas, which was driven by the importance of agriculture in the economy of the Roman Empire. The proliferation of Roman archaeological evidence dispersed through the rural area confirms that this period was key in the anthropisation process of the landscape in the western area of the lower Guadalquivir valley.

This dispersion contrasts with the results of the cartography for the middle ages, which indicates a reversal of the process of population concentration. The loss of power of Rome and the successive confrontations and changes of power reversed the phenomenon of territorial dispersion, resulting in an incipient model of centrality. The topographic conditions of the Aljarafe, together with its closeness to the central city *Ishbilia* (Seville), made it a prestigious rural environment given the ease of defending it, which encouraged its occupation to intensify considerably. The cartography clearly shows how intense settlement in this upland area differs from the plain extending to the north.

In the middle ages, the majority of the population was located in Seville, which was already consolidated as the central city. Outside this area, the population is primarily concentrated in Aljarafe in small urban areas with low settlement densities. These settlement patterns cast light on a key feature of the current landscape in the area: the marked contrast between Aljarafe and Campo de Gerena. Whereas the landscape in Aljarafe is characterised by the presence of urban areas, a dense communications network and olive cultivation (Figure 5), Campo de Gerena is a large agricultural area of arable crops with almost zero population density (Figure 6).

Finally, the cartography for the contemporary era shows a considerable rise in population density, revealing the intense processes of urban development taking place in the twentieth century. This intensification occurs in the areas closest to Seville, confirming the presence of an emerging metropolitan phenomenon. The resurgence of mining in the late nineteenth century explains the higher intensity of settlement in the foothills. Increasingly intense settlement on the floodplain of the river Guadalquivir, meanwhile, is the result of regenerationist hydraulic policies, through which irrigation became the main instrument for agricultural modernisation. In the twentieth century, a project was undertaken to irrigate the plain of the Guadalquivir, which provoked a substantial change in the landscape and the emergence of new urban areas or colonising settlements, built to house workers employed on the hydraulic works and other works to prevent flooding from the river channel as it passes through Seville.

These processes are represented on a summary map showing the four main settlement patterns in the area:

Figure 5. Landscape of the North Cornice of El Aljarafe from 'Santa Brígida' viewpoint. Source: Main author.

Figure 6. Landscape of Campo de Gerena from the trail 'ruta del Agua'. Source: Main author.

the foothills of Sierra Morena, given the historic importance of mining activity; the floodplain of the river Guadalquivir, due to the proximity of what was once the main commercial channel in the area; Aljarafe, given its symbolic and strategic conditions as an upland area close to the main city; and finally, the city of Seville itself, which gradually emerged as the central urban area for the region at the southernmost point at which the river Guadalquivir was navigable, allowing the city to function as a point of contact between the eastern and western territories of the ancient Kingdom of Seville.

4. Discussion

The proposed methodology offers a graphic output mechanism for archaeological records. When supplemented by historic cartography for more recent periods, these records represent a suitable tool for creating a hierarchical historical inventory of urban and rural settlements in a territory. The maps obtained offer a very useful summary explaining essential processes of anthropic occupation of the territory. Through a sequence of relatively simple geospatial processes, the visual and graphic potential of an inventory whose original purpose was to record and document archaeological data can be explored. The graphic representation of these records via maps make them a convenient resource for facilitating historic interpretation and the transmission of ideas. It allows georeferenced data from archaeological sites to be transformed into a resource with clear value as a visualisation and communication tool.

This cartographic method can be used in diachronic analyses of the landscape. In recent decades, progress has been made on consolidating methodologies which allow the historic landscape to be fully reconstructed from prehistory to the present day (Fairclough & Herring, 2016; Kolen et al., 2015; Poli, 2017). Monitoring the evolution of a cultural landscape through to the present day, as if producing a long-term overview of the

ongoing processes of restructuring and revaluation to which it is subject, holds intrinsic potential for creating powerful, innovative narratives concerning the ways in which communities have used, organised and read the territory over time (Kolen & Renes, 2015). The aim of these lines of research is to transpose the historical, cultural and heritage component of the territory into contemporary processes of landscape planning and design (López Sánchez et al., 2021).

Indeed, it is a relevant research challenge to explore how the long-term vision provided by historical and archaeological studies on the landscape, as well as by historical documents directly related to said analyzes, such as historical cartography, are integrated into current landscape planning and design processes (Burgers et al., 2014; Kolen et al., 2014). The use of Geographic Information Systems is particularly relevant in this regard, as their intrinsic integrating potential allows them to function as a shared tool and language for use between different stakeholders and areas of expertise (López Sánchez et al., 2020b). Furthermore, exploring graphical outputs and mapping mechanisms is pertinent in the search for those synergies between spatial disciplines. Specifically, the need for convergence between historical research and landscape planning is directly linked to the development of mechanisms which are capable of synthesising historical data into an information layer for application to the contemporary territory. In this regard, the summary map compiled as part of this study allows valuable information from archaeological records and analysis of historic cartography to be used in decision-making relating to processes of landscape protection, planning and spatial design by showing the parts of the territory which have experienced the most significant, intense settlement patterns over time.

Software

ArcGIS® and ArcMap ™ 10.4.1. software by Esri were used to store and process the archaeological records, conduct all the geospatial analyses described and produce the six maps of density by historical period and the summary map. The layout of the Main Map provided as supplementary material alongside the article was produced using Adobe Indesign CC 2019.

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Data availability statement

The georeferenced information with which these maps have been developed cannot be publicly available. A part of the used spatial information has been provided to the authors through an external institution for the exclusive purpose of research and was not aimed to be distributed by the authors.

Declaration of interest statement

The interest of the proposed method lies in its capacity for extrapolation to different territorial areas and its use by researchers from different disciplinary backgrounds. The paper also contributes to research into cartographic techniques, creating a methodological sequence based on specific geospatial processes to produce a graphic output which enables the results to be read visually.

Disclosure statement

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References

Aldred, O., & Fairclough, G. (2002). *Historic landscape characterization. Taking stock of the method. The National HLC method review*. English Heritage y Somerset County Council.

Amores, F., García Vargas, E., Garrido González, P., Hunt Ortiz, M. A., Vázquez Paz, J., & Rodríguez Mellado, J. (2014). Los Paisajes Históricos del Valle del Guadiamar (Sevilla): la minería y la metalurgia en el extremo oriental del Cinturón Ibérico de Piritas [The Historical Landscapes of the Guadiamar Valley (Seville): mining and metallurgy at the eastern end of the Iberian Belt of Piritas]. *CPAG*, *24*, 203–237. https://doi.org/10.30827/cpag.v24i0.4093

Aucelli, P. P., Valente, E., Di Paola, G., Amato, V., Cesarano, M., Cozzolino, M., Pappone, G., Scorpio, V., & Rosskopf,

C. M. (2020). The influence of the geological–geomorphological setting on human settlements and historical urban development: The case study of isernia (southern Italy). *Journal of Maps*, https://doi.org/10.1080/17445647.2020.1794989

Bavusi, M., Bianca, M., Izzi, F., Di Leo, P., Parisi, S., Pulice, I., & Schiattarella, M. (2015). Methods and technologies for the cultural heritages in Basilicata region: A case-study from the coastal belt of metapontum. *Rendiconti online societa geologica italiana*, *34*, 101–106. https://doi.org/10.3301/ROL.2015.46

Beilin, R., Lindborg, R., Stenseke, M., Pereira, H. M., Llausàs, A., Slätmo, E., Cerqueira, Y., Navarro, L., Rodrigues, P., Reichelt, N., & Munro, N. (2014). Analysing how drivers of agricultural land abandonment affect biodiversity and cultural landscapes using case studies from scandinavia, Iberia and oceania. *Land Use Policy*, *36*, 60–72. https://doi.org/10.1016/j.landusepol.2013.07.003

Burgers, G., de Kleijn, M., & van Manen, N. (2014). Urban landscape archaeology, geodesign and the city of Rome. In D. J. Lee, E. Dias, & H. J. Scholten (Eds.), *Geodesign by Integrating Design and Geospatial sciences* (pp. 183–192). Springer.

Crumley, C. L., Kolen, J. C. A., de Kleijn, M., & van Manen, N. (2017). Studying long-term changes in cultural landscapes: Outlines of a research framework and protocol. *Landscape Research*, *42*(8), 880–890. https://doi.org/10.1080/01426397.2017.1386292

Di Leo, P., Bavusi, M., Corrado, G., Danese, M., Giammatteo, T., Gioia, D., & Schiattarella, M. (2018). Ancient settlement dynamics and predictive archaeological models for the Metapontum coastal area in basilicata, southern Italy: From geomorphological survey to spatial analysis. *Journal of Coastal Conservation*, *22*(5), 865–877. https://doi.org/10.1007/s11852-017-0548-y

Dolejš, M., Nadvornik, J., Raška, P., & Riezner, J. (2019). Frozen histories or narratives of change? Contextualizing land-use dynamics for conservation of historical rural landscapes. *Environmental Management*, *63*(3), 352–365. https://doi.org/10.1007/s00267-019-01136-z

Escacena Carrasco, J. L., Rondán Sevilla, I., & Flores Delgado, M. (2018). El gran cementerio. Hacia una nueva interpretación de la Valencina Calcolítica [The great cemetery. Towards a new interpretation of the Chalcolithic Valencina]. *Cuadernos de Prehistoria y Arqueología*, *44*(44), 11–34. https://doi.org/10.15366/cupauam2018.44.001

Fairclough, G., & Herring, P. (2016). Lens, mirror, window: Interactions between historic landscape characterisation and landscape character assessment. *Landscape Research*, *41*(2), 186–198. https://doi.org/10.1080/01426397.2015.1135318

García Fernández, F. J. (2018). El bajoguadalquivir en época turdetana: Caura y su entorno. [The Bajoguadalquivir in Turdetan times: Caura and its surroundings.]. In J. L. Escacena Carrasco, A. Gómez Peña, & L. Gethsemaní Pérez Aguilar (Eds.), *Caura. Arqueología en el estuario del Guadalquivir* (pp. 97–127). Editorial Universidad de Sevilla.

Garrido González, P. (2020). El territorio de Itálica: análisis locacional de un antiguo paisaje agrominero. [The territory of Itálica: locational analysis of an ancient agricultural and mining landscape]. In A. Tejedor Cabrera, M. Linares Gómez del Pulgar, M. López Sánchez, & R. Merino del Río (Eds.), *Innovación para la gestión integrada del patrimonio, el paisaje y el turismo* (pp. 242–273). Editorial Universidad de Sevilla; Ediciones Universidad de Valladolid.

Gioia, D., Bavusi, M., Di Leo, P., Giammatteo, T., & Schiattarella, M. (2020). Geoarchaeology and geomorphology of the metaponto area, ionian coastal belt, Italy. *Journal of Maps*, *16*(2), 117–125. https://doi.org/10.1080/17445647.2019.1701575

Gu, H. Y., & Subramanian, S. M. (2014). Drivers of change in socio-ecological production landscapes: Implications for better management. *Ecology and Society*, *19*(1), 41. https://doi.org/10.5751/ES-06283-190141

Kolen, J., Hermans, R., & Renes, H. (2015). *Landscape biographies: Geographical, historical and archaeological perspectives on the production and transmission of landscapes*. Amsterdam University Press.

Kolen, J., & Renes, J. (2015). Landscape Biographies: key issues. In J. Kolen, J. Renes, & R. Hermans (Eds.),. *Landscape Biographies. Geographical, historical and archaeological perspectives on the production and transmission of landscapes* (pp. 21–47). Amsterdam University Press.

Kolen, J., van Manen, N., & de Kleijn, M. (2014). History matters: The temporal and social dimension of geodesign. In D. J. Lee, E. Dias, & H. J. Scholten (Eds.), *Geodesign by Integrating Design and Geospatial sciences* (pp. 173–181). Springer.

Ławniczak, R., & Kubiak, J. (2021). Changes in the settlement network in the noteć forest (Poland) in a historical perspective. *Journal of Maps*, *17*(1), 14–22. https://doi.org/10.1080/17445647.2020.1866701

López Sánchez, M., Linares Gómez del Pulgar, M., & Tejedor Cabrera, A. (2021). Historic construction of diffuse cultural landscapes: Towards a GIS-based method for mapping the interlinkages of heritage. *Landscape Research*, *46*(7), 916–931. https://doi.org/10.1080/01426397.2021.1921717

López Sánchez, M., Tejedor Cabrera, A., & Linares Gómez del Pulgar, M. (2020a). Guidelines from the Heritage field for the integration of landscape and Heritage planning: A systematic literature review. *Landscape and Urban Planning*, *204*, 103931. https://doi.org/10.1016/j.landurbplan.2020.103931

López Sánchez, M., Tejedor Cabrera, A., & Linares Gómez del Pulgar, M. (2020b). Arquitectura y Sistemas de Información Geográfica: Hacia un Proyecto de Paisaje Informado [Architecture and Geographic Information Systems: Towards an informed landscape design]. *Proyecto, Progreso, Arquitectura*, *22*(22), 72–87. https://doi.org/10.12795/ppa.2020.i22.04

Maio, C. V., Tenenbaum, D. E., Brown, C. J., Mastone, V. T., & Gontz, A. M. (2013). Application of geographic information technologies to historical landscape reconstruction and military terrain analysis of an American revolution battlefield: Preservation potential of historic lands in urbanized settings, Boston, massachusetts, USA. *Journal of Cultural Heritage*, *14*(4), 317–331. https://doi.org/10.1016/j.culher.2012.08.002

Martínez-Sevilla, F., García Sanjuán, L., Lozano Rodríguez, J. A., Martínez Jordán, J. M., Scarre, C., Vargas Jiménez, J. M., Pajuelo Pando, A., y López Aldana, P. (2020). A New perspective on Copper Age technology, economy and settlement: Grinding tools at the Valencina mega-site. *Journal of World Prehistory*, *33*(4), 513–559. https://doi.org/10.1007/s10963-020-09150-4

Meinig, D. W. (1979). *The interpretation of ordinary landscapes: Geographical essays*. Oxford University Press.

Muñoz, F. (2010). Urbanalisation: Common landscapes, global places. *The Open Urban Studies Journal*, *3*, 78–88. https://doi.org/10.2174/1874942901003010078

Ortega Valcárcel, J. (1998). El patrimonio territorial: el patrimonio como recurso cultural y económico [Territorial heritage: heritage as a cultural and economic resource]. *Ciudades*, *4*, 33–48. https://doi.org/10.24197/ciudades.04.1998.31-48

Poli, D. (2017). Processi storici e forme della rappresentazione identitaria del territorio [Historical processes and forms of identity representation of the territory]. *Scienze Del Territorio*, *5*, 42–53. https://doi.org/10.13128/Scienze_Territorio-22230

Roymans, N., Gerritsen, F., Van der Heijden, C., Bosma, K., & Kolen, J. (2009). Landscape biography as research strategy: The case of the south Netherlands project. *Landscape Research*, *34*(3), 337–359. https://doi.org/10.1080/01426390802381185

San-Antonio-Gómez, C., Velilla, C., & Manzano-Agugliaro, F. (2014). Urban and landscape changes through historical maps: The real sitio of aranjuez (1775-2005), a case study. *Computers Environment and Urban Systems*, *44*, 47–58. https://doi.org/10.1016/j.compenvurbsys.2013.12.001

Sanjuán, L. G., Jiménez, J. M. V., Puro, L. M. C., Caramé, M. E. C., Uribe, M. D. G., Bonilla, M. D. Z., Flores, ÁF, Pérez, V. H., Aldana, P. M. L., Izquierdo, E. M., & Pando, A. P. (2018). Assembling the dead, gathering the living: Radiocarbon dating and Bayesian modeling for Copper Age Valencina de la Concepción (sevilla, Spain). *Journal of World Prehistory*, *31*(2), 179–313. https://doi.org/10.1007/s10963-018-9114-2

Stanish, C., de la Vega, E., Moseley, M., Williams, P. R., Chávez, C., Vining, B., & LaFavre, K. (2010). Tiwanaku trade patterns in southern Peru. *Journal of Anthropological Archaeology*, *29*(4), 524–532. https://doi.org/10.1016/j.jaa.2010.09.002

Supernant, K. (2017). Modeling Métis mobility? Evaluating least cost paths and indigenous landscapes in the Canadian west. *Journal of Archaeological Science*, *84*, 63–73. https://doi.org/10.1016/j.jas.2017.05.006