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An in-depth look at the application of GIS for industrial heritage documentation

Uma análise detalhada da aplicação dos SIG para a documentação do património industrial

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Abstract

The use of geospatial technologies to identify and document architectural heritage, with the associated benefits for managing information, is already relatively widespread. However, there has been little discussion about the difficulties, decision-making process and problems encountered when using GIS to digitize data, identify and document this heritage. This study sets out to propose a conceptual work to explore the relationship between immovable industrial heritage documentation and GIS application on the basis of case studies, in particular: the identification and documentation of the industrial heritage in the Eurocity of Guadiana and the olive mills in Écija. After discussing the workflow developed, the difficulties and problems encountered, and how these determine the structure of the GIS model, the decision-making process and the results, this paper concludes that further progress is still necessary to acquire a more pragmatic vision of the use of GIS in the field of industrial archaeology.

KEYWORDS
Immovable industrial heritage
Industrial archaeology
GIS applied in heritage documentation
Information management
Decision-making process
Safeguarding of industrial heritage

Resumo

A utilização de tecnologias geoespaciais para identificar e documentar o património arquitectónico, com os benefícios associados à gestão da informação, está já relativamente difundida. No entanto, tem havido pouca discussão sobre as dificuldades, o processo de tomada de decisão e os problemas encontrados na utilização dos SIG para digitalizar dados, identificar e documentar este património. Este estudo pretende propor um trabalho conceptual para explorar a relação entre a documentação do património industrial imóvel e a aplicação dos SIG com base em estudos de caso, em particular: a identificação e documentação do património industrial na Eurocidade do Guadiana e dos moínhos de azeite (Écija). Após discutir o trabalho desenvolvido, as dificuldades e problemas encontrados, e como estes determinam a estrutura do modelo SIG, o processo de tomada de decisão e os resultados, conclui-se que são necessários mais progressos para adquirir uma visão mais pragmática da utilização do SIG no domínio da arqueologia industrial.

PALAVRAS-CHAVE
Património industrial imóvel
Arqueologia industrial
SIG aplicado na documentação do património
Gestão da informação
Processo de tomada de decisões
Salvaguarda do património industrial

Introduction

Industrial archaeology is defined as the multidisciplinary study of the tangible evidence of social, economic, technological and scientific development of the period since industrialisation [1-2], usually considered to stretch from the mid-eighteenth century until the 1960s. The timeline for the process of industrialisation may vary according to the country or even a particular region. In the case of Portugal and Spain, the differences are regional. For example, in Spain industrialisation had a greater impact in Catalonia and the Basque Country, while the same is true of the north-west Lisbon-Porto region in Portugal. In this context, industrial heritage may be defined as the movable, immovable and intangible assets that bear witness to past and ongoing industrial processes related to production, the extraction of raw materials, their transformation into goods and the associated energy and transport [3]. However, some authors consider that the timeline defined by the Industrial Revolution merely "facilitates" the study of evidence but does not reflect the historical reality, and they therefore believe that the definition should include assets from periods before the eighteenth century (proto-industrial heritage) [4]. Despite the lack of a general consensus on the timeline, there is broad agreement that industrial archaeology implies the use of methods derived from the discipline of archaeology as well as from anthropology, geography, architecture, history, economics, engineering, etc. [5-6]. This interdisciplinary nature is also accompanied by approaches based on collaborative projects and, more recently, by the use of digital methods. The field of digital humanities is a core component of the case studies presented here, insofar as they are exploratory projects that generate empirical hypothesis models and testing models aimed at finding alternatives to the methods traditionally used to record and study industrial heritage.

Spatial information science, and GIS (Geographical Information Systems) in particular, currently offer several applications for the field of cultural heritage [7-8]. GIS permits the analysis of cultural heritages in continuous spatial scales considering historical buildings, courtyards, historical towns, archaeological sites, and landscapes [9-10]. Also, they have been used for heritage management to achieve better planning and preservation [11]. The GIS "model" used is defined according to the characteristics and objectives of the study or project in question [12]. The purpose of these models is to simplify the reality by incorporating the necessary data to observe a particular phenomenon. This ranges from a simple visualisation of specific attributes, to more complex spatial analyses that include diachronic and synchronic studies, the interaction with pre-existing elements, the transformation of the landscape or asset, etc.

This work examines two case studies focused on immovable industrial heritage: the Guadiana Eurocity and the olive mills in Écija. The main objectives of this paper are:

- present the methods and materials used in the workflow to identify and document the industrial heritage;
- highlight the difficulties and problems encountered in the development of both cases;
- identify the impact of the difficulties and problems on the decision-making process and the product generated.

It is important to reiterate the complexity of managing an industrial heritage asset and the impact of the physical environment in which it is located, which is essential for carrying out the industrial activity. Analyses related to these two case studies conducted from different disciplines (anthropology, architecture, history, etc.) confirm that the industries and their associated activities did not only play a role in the anthropisation of the built landscape. They were also instrumental in transforming the lifestyles and characteristics of their communities and their identity. In the case of Eurocity, among others, we could cite the relevance of: studies about woman workers in Ayamonte [13], the canning industry in Algarve [14-15], the industrial

urbanization of Vila Real de Santo Antonio [16-17] and historical and territorial approach [18]. In the case of Écija, the studies carried out previously include, among others: in the field of pre-industrial archaeology [19-21], territorial planning [22] and industrial landscape [23].

The Guadiana Eurocity

The aim of this case study was to generate a preliminary inventory of the immovable industrial heritage in the Guadiana Eurocity, recognised as a European Grouping of Territorial Cooperation in 2018, as the basis for the construction of guidelines for developing sustainable cross-border cultural tourism. The territorial scale adopted for this case study is regional–inter-municipal. Specifically, the Guadiana Eurocity has a cross-border, trans-national inter-municipal scale encompassing the Portuguese municipalities of Castro Marim and Vila Real de Santo Antonio and the Spanish municipality of Ayamonte (Figure 1). Together, they form an area of approximately 500 Km².

The three municipalities are mainly connected by an industrial past centred around fishing and salt production, while the river Guadiana is the physical link that has enabled them to share knowledge, techniques, people and goods since time immemorial. The industrial elements were largely associated with these two productive activities that were carried out in what is now the Eurocity from the mid-nineteenth century to the beginning of the twentieth-first century. Despite the inter-connections in the development of these industries, such as the resulting landscape, few studies have treated the Eurocity as a single entity. The predominant tendency has been to carry out isolated studies related to a particular discipline, topic or place. We were able to identify 138 elements: 57 in Vila Real de Santo Antonio, 9 in Castro Marim and 72 in Ayamonte (Figure 2).

Figure 1. Map showing the location of the Guadiana Eurocity.

Figure 2. Examples of assets in the Guadiana Eurocity: *a)* and *b)* canning factories (Ayamonte); *c)* canning factory (Vila Real de Santo Antonio); *d)* salt marsh (Castro Marim).

Olive mills in Écija

The second case study takes place on the historical olive mills in Écija, a rural town in the Sevilla province with an olive oil tradition dating back hundreds of years. These buildings, which had beam and weight presses, were the main oil production units for centuries. Their presence was documented as early as the seventeenth century when a population census in 1640 identified 240 mills [24]. Bundles 358 and 908 at the Écija Archive of Notarial Records contain the plans of two olive presses at sixteenth-century mills whose spatial and functional structures are the same as those found in the other mills identified in the field visits. This figure remained practically unchanged until the mid-twentieth century [25], when many units fell into disuse and began to disappear.

The mills formed part of a complex process associated with the agro-industrial activity, from picking the fruit to shipping the end product to national and international markets. In our view, the mills should therefore be considered in a holistic manner with all the elements of the olive groves: the type of cultivation; the road transport and communication system; the water collection, transfer and storage system; and the facilities associated with the agricultural and domestic activity of the mills. However, in this paper we focus solely on the mills. The scale considered for this case study was determined by the jurisdictional boundaries of the municipality, approximately 980 Km^2 (Figure 3 and Figure 4).

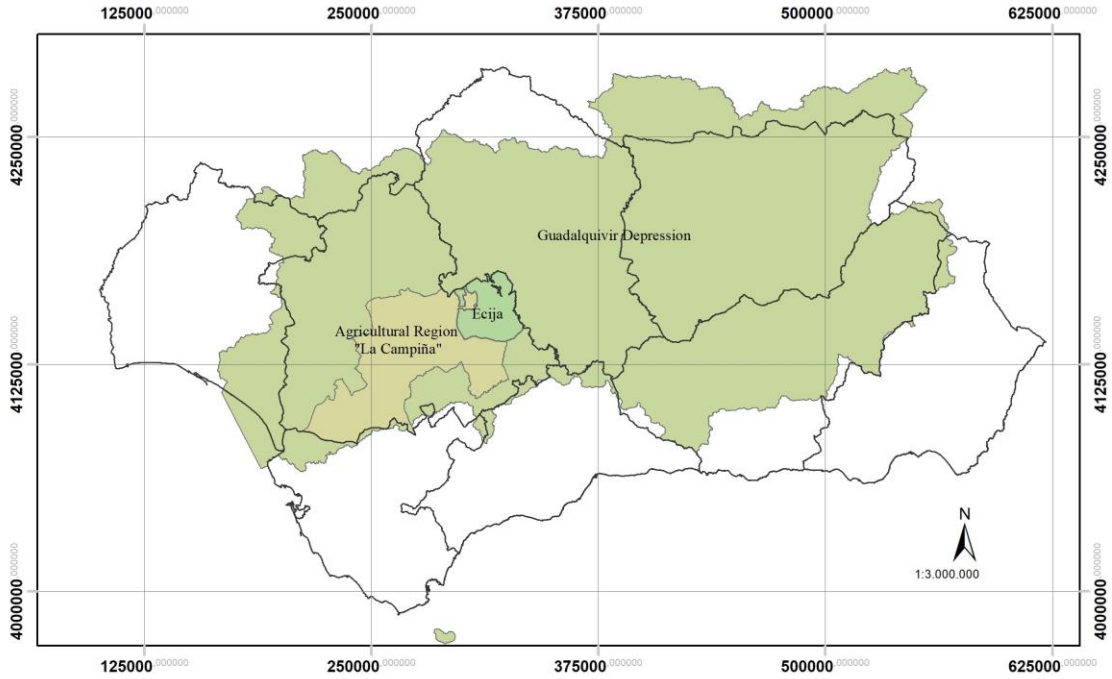

Figure 3. Situation of Écija in the Agricultural Region of the Guadalquivir Depression in Andalucía, Spain.

Figure 4. Charcón mill in Écija. It still contains the robust counterweight tower characteristic of beam and weight presses.

Materials and methods

Intrinsic to industrial archaeology, the chain of processes involved in heritage work includes conservation, with view to preserving the heritage, as well as actions designed to enhance its value: identification, research, dissemination and protection. Heritage "value" emerges when we can identify cultural assets, so it is therefore crucial to understand the value of these assets and how to enrich it [26]. Since research and management are lengthy processes, for the two

case studies we have adopted as our basis the "value chain", defined as a sequence of interrelated phases that provide a holistic view of the heritage. These are: 1) identification; 2) documentation and recording; 3) assessment and implications; 4) intervention; 5) dissemination and socialisation; 6) economic impact and reflection [27-28]. In this paper we focus primarily on the aspects and issues related to the first two phases of the "value chain", which according to the Nizhny Tagil Charter play an important role in the assessment and knowledge of heritage [2, 29].

The Faro Convention on the Value of Cultural Heritage for Society [30] changed the path of legislation by focusing on the elements that give value to cultural heritage through a people-centred approach. It defined the European cultural heritage as elements connected to a context of common remembrance, identity and healthy cultural diversity. In consequence, knowledge and use of heritage form part of the citizen's right to participate in cultural life. Heritage is seen as a resource for human development, the enhancement of cultural diversity and the promotion of intercultural dialogue, and as part of an economic development based on the principles of sustainable resource use.

Having embarked on the study of the social and cultural aspects connected to the local industry, we focused on immovable industrial heritage as the first phase of our research of the built past. The two case studies share the main objective of documenting and recording the immovable industrial heritage through the same methodology and the application of the GIS.

Method for identifying and documenting the immovable industrial heritage

As the method for identifying and documenting the immovable industrial heritage assets in the two case studies mentioned above, we defined the same workflow comprising six phases that impact the architecture of the GIS model: 1) identification of the heritage type and time frame; 2) selection of sources and data collection; 3) design of the geodatabase; 4) data processing and digitalisation; 5) data visualisation; 6) output package (Figure 5).

Regarding the GIS's tools used in the institutions, we find a similar scenario. In Portugal, the Directorate-General for Cultural Heritage (DGPC) is the organization in charge of the protection and care of the national heritage. For the inventory of architectural heritage, the DGPC uses a relational database linked to a spatial data infrastructures (SDI) called SIPA [31]. The DGPC uses *ArcGIS* software as a base tool, and its public visualization uses *ArcGIS online* [32].

In Andalusia, the Andalusian Institute of Historic Heritage (IAPH) is the organization in charge of the protection and care of the regional heritage [11]. The information system called *Guía Digital del Patrimonio Cultural de Andalucía* [33] provides structured semantically enriched data and a map viewer of the assets. The Guide is an open and public platform and its linkage with the IAPH's internal relational database management system [34], and an internal SDI. For the updating and management of the SDI, *ArcGIS* is also used. However, unlike in Portugal, the public geographic viewer provided is through *Mapea* [35]. Both case studies used *ArcGIS* software during phases 3 to 6. The Eurocity case also used *QGIS* and *Tableau* software for phase 5.

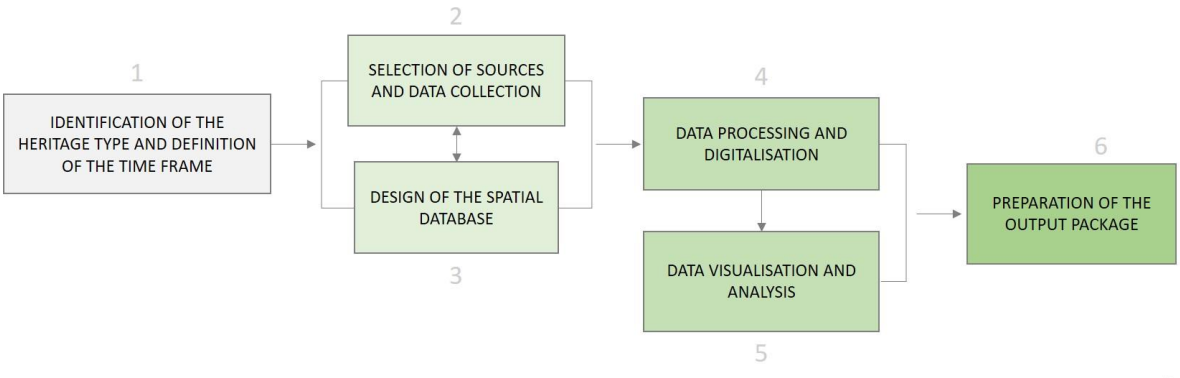

Figure 5. Workflow for the identification and documentation.

Definition of the heritage type and time frame

For the Guadiana Eurocity case study, the project focused on the industrial assets that were mainly used between 1840 and 1960 (mid-nineteenth to mid-twentieth century). The fishing and salt production activities carried out in this geographical area translated into numerous canning and salting factories as well as salt marshes. The initial inventory work identified 21 different types of industrial heritage in eight sectors.

In the case of the Écija olive mills project, the research identified seven different types in three sectors, including the elements from the proto-industrial period, with a temporal arc stretching from the sixteenth century to the mid-twentieth century. The olive oil production boomed in the sixteenth century due to the demand for oil from the Americas [19]. This historical aspect, coupled with the existence of a plan in the Écija Archive of Notarial Records (APNE) of a sixteenth-century mill with the same functional layout as the mills studied, suggests that constructions of this type proliferated in that century (Table 1).

Table 1. Industrial heritage types.

Sector	Type	
	Guadiana Eurocity	**Écija**
Agri-food	Flour factories Salting factories Canning factories Ice factory Jam factory Warehouses Windmills Tide mills	Oil mills Warehouses Olive oil production waste pond (*bejinero*)
Transport	Railway buildings Railway stations Transport infrastructures	Railway buildings Railway stations Transport infrastructures*
Energy	Hydraulic infrastructures: Dams	
Mining and quarrying activities	Salt marshes - Salt pans	
Construction, ceramics and glass	Earthenware factory	
Cork, wood and furniture, paper and graphic arts industry, leather and footwear industries	Printing: Lithographic workshops	
Industrial urban planning, housing and social facilities	Housing for large landowners, workers' housing Refectories	Housing for seasonal workers
Other elements	Market buildings Fresh-fish market (*Lonja*)	

* Roads from the olive grove to the mill and from the mill to a main.

Selection of sources and data collection

Both cases studies required the consultation and selection of primary sources, mainly historical documents with unstructured information (comprising historical, economic, architectural and other data), plans and old photographs. The main secondary sources were published articles, books and/or institutional documents about the object of study or its historical context.

In both cases, fieldwork played an important role for gathering data about the assets. The territory itself is a living and dynamic source of documentation in which it is still possible to identify and visualise material witnesses and remains of the industrial past. In this case, we are not only talking about built material witnesses but also the cultural landscape of each area of study. In the case of the memory of the production culture, these industrial landscapes have left a still visible trace on the territory and, in the case of the Eurocity, there is still the living memory of those who worked in the old factories and salt marshes. The contact and collaboration with various local stakeholders in Spain and Portugal were crucial in this respect.

As regards the use of existing layers, in both cases we employed feature layers and raster layers (aerial photographs) from public institutions and international servers. This facilitated both the fieldwork and the generation of new records (Phase 4 – Data processing and digitalisation) (Table 2).

Table 2. Sources for data collection.

Case study sources	Guadiana Eurocity	Ecija
Primary sources	Documents, photographs, maps and plans from the following archives, libraries and institutions: Vila Real de Santo Antonio Municipal Archive; District Cuncil of Vila Real de Santo Antonio; Vila Real de Santo Antonio Muncipal Library; Andalusian Virtual Library; Ayamonte Municipal Archive; Faro District Archive; Huelva Provincial Archive; Map Catalogue of the National Geographical Institute (IGN), the Andalusian Institute of Statistics and Cartography (IECA); Catalonian Cartographical Institute and Simancas General Archive (AGS); Digital Periodical and Newspaper Library of the National Spanish Library.	Documents, photographs, maps and plans from the following archives, libraries and institutions: Cartographic Archive of Geographical Surveys of the Geographical Centre of the Army; Seville Cathedral Archive; APNE; AGS; Nobility Historical Archive; Écija Municipal Archive (AME); Murcia Municipal Archive; Santa María de Écija Parish Archive; Hispanic Digital Library; Spanish Digital Library; Royal History Academy Digital Library; Spanish National Library; Andalusian Virtual Library; Bibliographic Heritage Virtual Library; French National Library; Strasbourg National and University Library; Map Catalogue of IGN; IECA; Seville University Ancient Collection; Catalonian Cartographical Institute; Écija Institute of Secondary and Vocational Education.
Secondary sources	Papers, books, monographs, etc.	Papers, books, monographs, etc.
Fieldwork	We visited on several occasions to the assets.	18 routes subdivided into 43 sections [25] where we identified the mills as well their service infrastructure.
Layers sources (raster, vectorial and servers)	For the layers of the physical environment of Andalucía we used the feature layers of DERA100 of REDIAM. For the context layers in the Algarve, we used OSM. Aerial photographs of the US Army flight (Series B 1956-57) of the IGN, the inter-ministerial flight (1977-1983) of REDIAM, of the IGN; World Imagery from Esri, Maxar, Earthstar Geographics, and the GIS User Community.	Écija Municipal Council supplied a *shapefile* of the mills, but it was incomplete. The transport layers were obtained from the IGN while the ones related to the physical environment were obtained from REDIAM. Aerial photographs of the US Army flight (Series B 1956-57) of the IGN, the inter-ministerial flight (1977-1983) of REDIAM, the SIGPAC flight (1998-2003) of the IGN and the latest PNOA orthophotos (2019) of the IGN.
Stakeholders	Governance Laboratory of the Guadiana Eurocity, Vila Real de Santo Antonio Municipal Council, researchers of Algarve University, researchers of Huelva University, technicians of the Vila Real de Santo Antonio Archive, technicians of the Ayamonte Archive, residents of Ayamonte, residents of Vila Real de Santo Antonio, residents of Castro Marim.	Researchers of Seville University, researchers of the TUTSOMOD Project, technicians of the Écija Notarial Records Archive, technicians of the Écija Municipal Archive, Écija Municipal Council.

Design of the geodatabase

The use of GIS enables us to present many different layers of information. This means that we can have different thematic layers for a given area which enhance our understanding of it. The first step to creating a model was to define the geographical feature type (a feature associated with a real location on Earth) for both case studies to generate a feature vector (point, line and/or polygon). The aim of generating feature vectors is to represent real-world phenomena, in our case the immovable industrial heritage. The data structure designed for each case study corresponds to the objectives pursued.

In the case of the Guadiana Eurocity, the objective was to create a preliminary inventory of the immovable industrial heritage in the three municipalities, including both demolished and existing assets, to generate an information model of the industrial memory of the Eurocity and record its current state of conservation. This model would subsequently form the basis for the heritage classification and management and for the development of cross-border industrial tourism guidelines. We used the IAPH Thesaurus to ensure a controlled vocabulary in the table of attributes and facilitate subsequent interoperability with public administrations.

For the Écija olive mills, the principal aim was to identify all the olive oil mills that had ever existed in the municipality, including those now lost, and then to drill down to a more detailed level in order to provide two outputs: a source of knowledge for the classification of the mills contemplated in the Écija general land use plan; and a heritage management tool (Table 3).

Table 3. List of data structure fields.

Field/Attribute	Case study	
	Eurocity	Écija
Shape (point/line/polygon)	×	×
Province	×	×
Municipality	×	×
Municipal code	×	×
Name	×	×
Other name	×	×
State of conservation	×	×
Level of protection	×	×
Historical period	×	×
General type	×	×
Specific type	×	×
Activity	×	×
Historical description	×	×
Architectural description	×	×
Geographical coordinates	×	×
Sources	×	×
Owner	×	×
Date founded	×	-
Date closed	×	-
Address	×	×
Old Address	×	×
Registration	-	×
Village/Zone/Plot	-	×
Year disappeared	-	×

Data processing and digitalisation: creation of the feature layers

In both case studies the spatial database was constructed by vectorising the immovable assets. This process consisted in creating point, line or polygon feature layers for the geographical location of each asset. Viewing and comparing aerial photographs and maps from different periods of the areas of study played a vital role in this phase.

In the Guadiana Eurocity, we used point and line layers as well as polygon layers. The points were used to represent certain longitudinal infrastructures and assets, specifically the dams and salt marshes found in the municipality of Castro Marim. We also had to generate line layers to represent the railway tracks that had been vital for the entire industrial production system in the area. The polygon layers contain the most records since these were used to represent industrial and infrastructure buildings as well as the houses of the workers' and large landowners.

We also worked with the three types of feature vector in the case of Écija. We treated the asset as a polygon due to the scale of both the architectural asset and the mill habitat, while for larger territorial scales we worked exclusively with points. This circumstance was repeated in the case of the infrastructure associated with the mill, whereas the elements of the water storage, collection and transfer system were represented according to their geometry. Lastly, the communication and transport system were represented with lines and the olive grove with polygons.

Data visualisation

Once we had created the feature layers and organised them in the GIS table of contents, we were able to visualise the vector files using any of the pre-existing maps as the base layer. The graphical representation of the vector files can also be used to visualise one or more of the assigned attributes, such as the state of conservation, timeline, building type or level of protection (Figure 6 and Figure 7).

Figure 6. Maps shows the polygon records and some of the photographs of the buildings linked to them: *a)* the Vila Real de Santo António assets; and buildings: *b)* 1; *c)* 17 to 20; *d)* 19; *e)* 36; *f)* Ayamonte–Guadiana Eurocity assets; and buildings: *g)* 0; *h)* 8; *i)* 10; *j)* 31-33.

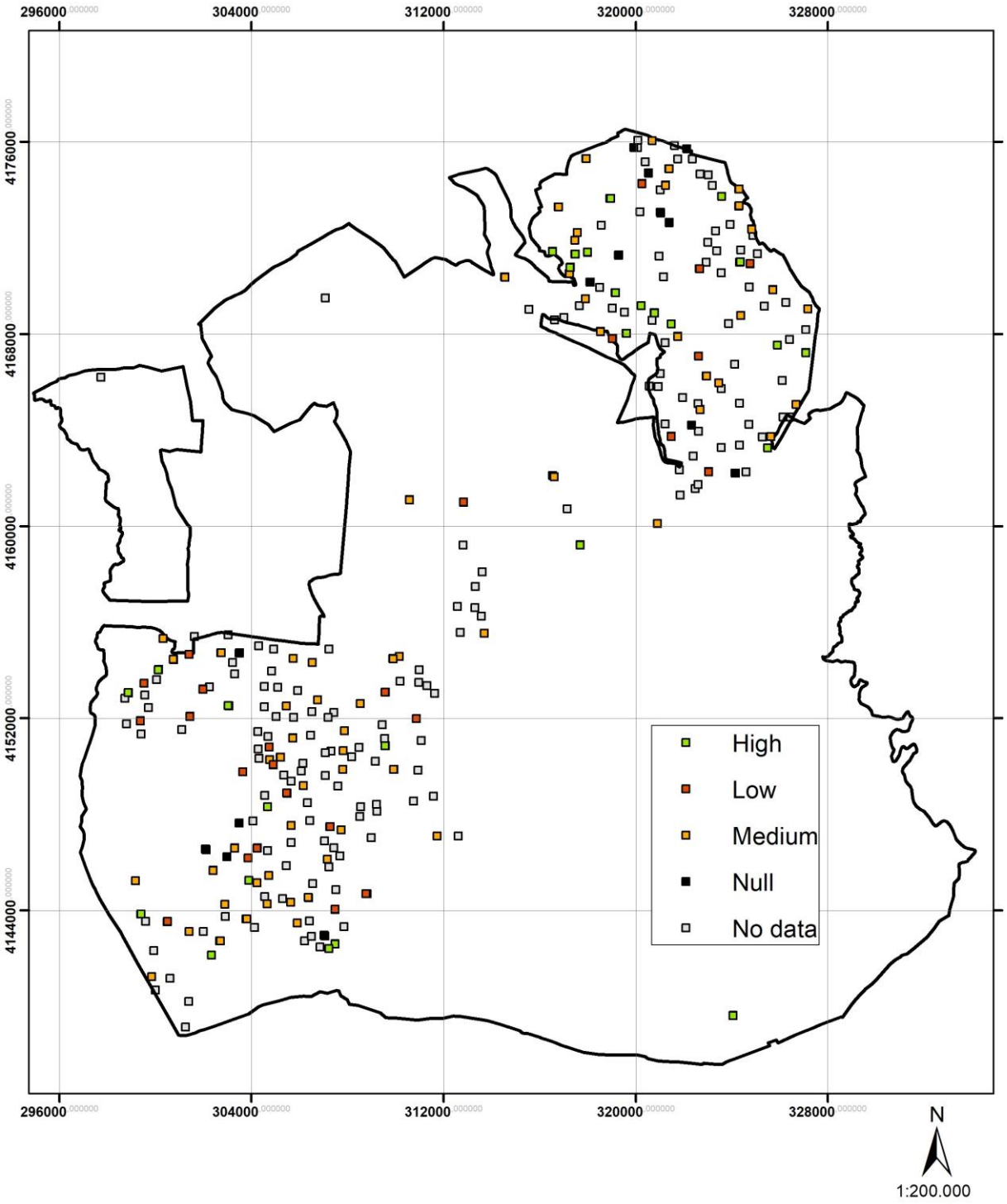

Figure 7. Level of architectural merits according to the 2009 land use plan: high (green); medium (orange); low (red); none (black). Grey represents the mills not included in the land use plan.

Creation of the output package

The last phase of the process was the creation of "output package", consisting of the feature layers in *shapefile* with their respective metadata, such as the record tables, in *.xml* format. The publication of these files in the institutional repositories will facilitate greater accessibility as well as the reuse and sustainability of the data. In both cases the University of Seville repository [36] will be used, and in the case of the Guadiana Eurocity the output package will also be published in the digital repository of the Andalusian Institute of Historical Heritage [37]. In the

case of the Écija mills, the elements of the spatial database will be added to the existing spatial data infrastructure currently used by Écija Municipal Council.

Challenges in the development of the case studies

The first challenge related to the data collection was to determine which data to consider and which to ignore. Although at the outset of both projects we had every intention of collecting as many data as possible, in practice the particularities of each case determined the data to include. For the Eurocity, it became clear while we were compiling the documents that the initial approach was not viable because of the resources, time frame and characteristics of the project. The Guadiana Eurocity research project lasted six months and was carried out with a single STIP grant. In the case of the Écija mills, it was possible to acquire more data because of a longer time frame and exclusive dedication to the project (part of a four-year pre-doctoral project with funding to match).

The second challenge affected the Eurocity case study only and concerned the need to work with documentary sources in two countries (namely, Portugal and Spain), which revealed different ways of recording industries in the nineteenth and twentieth centuries. This aspect involved critical analysis of the volume of documents and the type and characteristics of the data contained in them. In this case, after analysing the sources we made the decision to simplify the data that would be included in the geodatabase to prioritise data quality over data quantity. We therefore selected a restricted number of attributes that would allow us to create a preliminary inventory without losing sight of important elements of the Eurocity.

The third challenge was to identify the exact location of the assets. In the case of the Eurocity, many of the documents do not include the full address of the asset; most of the time only the street is mentioned, without the number. Besides, the names of streets have changed over the years, which further complicated the matter. In the case of the municipality of Vila Real de Santo Antonio, there was a rigorous work done previously on the changes of the toponymy of the streets [38] which has helped us to identify the locations. On the other hand, in the case of Ayamonte, we have had to make comparisons by juxtaposing old plans with the current plan. To prevent the loss of the identified records, we decided that the feature layers would only include assets for which we had discovered the exact location and that we would simply record the others in the output package tables. In the case of Écija, the continuity of olive oil production until the mid-twentieth century, the isolated location of the mills and the existence of a sizeable number of maps and orthophotographs made it easier to identify the olive mills with graphical resources, although it was more difficult when we encountered inaccuracies in the nineteenth-century maps and name changes. We backed up this identification of the location of the mills by cross-checking the initial information with bibliographical references and the data obtained from our field visits. However, with regard to mill infrastructures located outside the mill proper, only the topographical map (1951–58) contained accurate information.

The fourth problem was to deal with the lack of certain historical data. There are several reasons for the omission of certain data. In the first place this is because the information about the asset found in historical documents tends to be vague. In the case of the mills, since these are buildings that emerged over the course of several centuries (some mills disappeared and others were only built in the nineteenth century) the exact date of construction is not always known (it was not recorded in any document). This is also true of the documents we consulted about the Eurocity, which only contain a brief reference to the construction of the asset and the date it opened. Another difficulty encountered in the Écija case study was the fact that important documentary sources such as the Ensenada Land Registry and the Accounting Ledger have yet to be transcribed.

The omission of certain data is also explained by the difficulty of collecting them in situ, mainly due to the impossibility of accessing the asset or parts of it. In both case studies, certain field data could not be collected. The reasons for this varied:

- lack of structural safety of the asset;
- access refused by the owner;
- no access roads;
- overgrown vegetation in certain areas or rubbish accumulation;
- closed due to rehabilitation works (Eurocity);
- intense cultivation around the asset (Écija).

Based on the experience of both case studies, it is clear that working with data from earlier centuries presents a great challenge and that the database should therefore allow certain fields to be left blank. In this case, the decision to use the GIS and the spatial database provided the necessary flexibility to correct, add and update information. This means that the process can be an ongoing one, which is extremely useful for heritage management.

Conclusions

Knowledge of industrial heritage contributes to cultural identity and its systematic spatial identification can contribute to the preservation of industrial and architectural heritage, raising cultural sustainability. This paper discusses two case studies concerning the identification and documentation of immovable industrial heritage that share the same workflow and use of the GIS. Knowledge of built industrial heritage provides valuable information about the history intrinsic to production processes and the environments in which they are carried out. The paper also highlights the need for greater knowledge and dissemination of a type of heritage that has yet to be fully appreciated – namely, immovable industrial heritage in Portugal and Spain.

The comparative approach adopted for the two case studies and the discussion of the problems encountered and decisions made demonstrate the role played by the solutions adopted in the identification and documentation of the assets. In other words, although the methods and tools used to create the models are very similar, the end product is the result of a series of decisions, often personal and/or agreed with the stakeholders.

It is clear that the GIS information model is a significant tool for carrying out Phases 1 and 2 of the "value chain" because it permits the systematisation of information, interconnected field and desktop work, greater interoperability and the opportunity to reuse the generated model. However, as demonstrated [9, 39], the complexity of the heritage means that it is not always compatible with the simplification required by digital information modelling. One of the significant results obtained was that, despite the difficulty and/or impossibility of acquiring certain data, the flexibility of the tool allows the omission of these data, while supporting a continuous process and the possibility of adding data in the future. This is a key issue for public administrations, as it allows the possibility to improve the quality of information.

Although we observe many benefits in the use of GIS, three issues related the sustainability and reuse of the data have yet to be resolved: 1) the credits for the data generated, since the models are created by researchers and then implemented in public administration systems, often without preserving any reference to the authors; 2) the institutions have to bear the cost of maintaining and updating the information; 3) the institutions often lack upgraded tools and the technical knowledge to use them. These issues are particularly significant in the case of the Eurocity because although the model was initially created jointly, the "output package" will be managed and used differently in each country.

The team hope that these initiatives will enable institutions and communities to develop decision-making skills and manage their development processes in a way that ensures that industrial architecture heritage contributes to the social, cultural and economic dynamics of

the communities of the Guadiana Eurocity and Écija. Faro Convention Action, through its heritage-led work, creates field-based platforms where transversal issues and the Council of Europe institutional knowledge and experience are brought together around concrete actions, setting examples for the type of society we aspire to build.

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