

CHAPTER I

ARQUEOS. THE INFORMATION SYSTEM OF THE ANDALUSIAN ARCHAEOLOGICAL HERITAGE

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I. BACKGROUND

I.a. CRM in Andalusia

Archaeological Resource Management in Spain is largely de-centralized throughout the autonomous regions in which the country is divided (Querol *et alii*, 1995). The autonomous government of Andalusia (the largest region of the Spanish territory –87.000 km²) became fully responsible for the management of its historical, archaeological and cultural heritage in 1985. Since then, the General Directorate of Cultural Properties or *Dirección General de Bienes Culturales* (henceforth DGBBCC), one of the general directorates that integrate the Cultural Board of the regional government, has been in charge of the protection, conservation, research and dissemination of the Andalusian archaeological heritage.

In 1989 the Andalusian Institute of the Historical Heritage (henceforth IAPH) was created as a body organically dependent from the DGBBCC. One of its main legal functions was to promote the systematisation of all forms of information pertaining to the Andalusian historical heritage. In order to tackle this legal mandate, the IAPH was provided since its inception with a Documentation Centre responsible for the design and implementation of an information system suitable for the input, processing, retrieval and output of heritage-related data.

After ten years of sustained effort on the data entry front, the Andalusian Historical Heritage Information System (henceforth SIPHA in its Spanish acronym) holds several thousand records containing alphanumerical, graphic and cartographic information related to sites, monuments and objects of cultural and historical value. As far as its structure is concerned, at the time the SIPHA project was initiated in the early 1990s, there was little or no experience in Andalusia (or in Spain by extension) in the elaboration of heritage documentation standards and database design. For this reason, the SIPHA was conceived as a series of “thematic subsystems” that were developed separately but which are inter-connected and operate as a single system. The different subsystems involve the following themes:

- *SIBIA*: Architectural and Urban data.
- *ARQUEOS*: Archaeological sites.
- *ETNOS*: Sites of ethnographic interest.
- *MUEBLES*: artefacts.

- Documentary information (text, graphic and bibliographic).
- Information on heritage protection activities.

I.b. The development of the andalusian archaeological SMR

Work on the archaeological component of *SIPHA-ARQUEOS*, started as late as in 1994, dealing with important problems such as the lack of documentary standards for data recording and description, data dispersion or pre-computing data management. Regarding these problems, the DGBBCC had put forward in 1992 a relatively straightforward but comprehensive paper-based data model for the description and recording of archaeological sites. These card-indexes were to contain the information of the Andalusian Inventory of Archaeological Sites (henceforth IYAA), superseding the older model that had been in use between 1985 and 1991. In the early 1990s, this duplicity of card-indexes for archaeological site data was further complicated by the existence of other inventories and site lists (held by various other administrations), plus the existence of documentation generated by other bodies involved in excavation and survey such as museums, as well as documentation concerning protection and conservation reports. In addition to this high dispersion of the data there was the problem of the complete absence of computer tools to handle them. Altogether, data retrieval and, therefore, decision-making in the domain of heritage policy was rather slow.

Considering that background, the design and implementation of *ARQUEOS*, the archaeological component of *SIPHA*, was tackled on the basis of the following principles.

- It would proceed from the general to the particular, encouraging an extensive perspective of the regional archaeological heritage. An excessive concentration of information on certain specific sites of special value was to be avoided if it was in any regard detrimental to the achievement of a minimum level of documentation for the whole set of sites.
- It would have a flexible design in order to integrate any kind of information relevant for the management of the archaeological resource by the Cultural Board and in relation with other administrative bodies involved (such as the Environment Board).
- Computer tools for data input and retrieval were to be the backbone of the system in order to speed up and simplify decision-making procedures with the central and peripheral services of the Cultural Board.
- Data structure should describe adequately not only the basic aspects of individual archaeological sites (location, morphology, associated contexts and artefacts, documentation, etc.) but also their physical environments.
- Documentation standards implemented within the systems should include terminology, output reports format, criteria for inclusion and updating within the databases, access levels to information, validation and quality control.

In order to achieve these objectives, information systematisation started with the two paper-based card-index series mentioned above and which set up the Andalusian Inventory of Archaeological Sites. The sustained support from the DGBBCC, which employed a four

full-time staff for this task, allowed the successful migration of the full IYAA into ARQUEOS within three years, which can be considered a relatively short time (Ruiz Zapatero & Jimeno, 1999). At present other data sources mentioned earlier have also been uploaded into SIPHA-ARQUEOS, but the fact remains that the transference of the IYAA was fundamental to obtain a perspective of the physical and morphological characteristics, as well as spatial distribution, of the archaeological entities at a regional scale. This, in turn, has led over the last three years to the production of increasingly accurate and sophisticated analyses and diagnostics concerning the Andalusian ARM.

Figure 1.2 shows the main events cited in relation with the process of normalisation of archaeological information since 1985 as well as other events that will be cited later in this chapter.

2. RECORDING ENTITIES IN ARQUEOS

2.a. What gets recorded?

The ARQUEOS system is aimed at various types of users, including bodies with CRM responsibilities, bodies with urban and land planning responsibilities, researchers dealing with archaeological evidence and non-professional users with a general interest in the Andalusian archaeological heritage. Because of this diversity of users, the definition of the archaeological entities recorded within the database has necessitated a careful assessment of discrete criteria. These criteria have evolved since the early stages of ARQUEOS, but in synthesis, an item subject to record is a "spatially delimited cluster of material remains derived from human activity, or relevant for their correct interpretation, that request the fundamental use of archaeological methodology for their analysis". Concerning this definition, it is of relevance to note:

- a) The main bulk recorded within the database is that of sites for which the use of archaeological methodology is fundamental and not auxiliary or complementary to their methodologies.
- b) This also includes sites of paleontological and geological interest relevant for the understanding of any aspect of past human communities (i.e. "*relevant for their correct interpretation...*").

Archaeological entities included within the database are classified according to four basic categories:

1. Isolated Find. Scatter of artefacts or architectural elements not associated to one identifiable *archaeological site* (the cluster of artefacts and constructive material lacks systematic association, so that it has not been proven or suggested to be meaningful at a larger scale).
2. Archaeological Unit. Part of an archaeological site. One specific part of a site may become a record within ARQUEOS if it satisfies one of the following criteria:
 - *Legal*: An archaeological entity is recorded as an *archaeological unit* if, although being part of a site, has been subject to specific legal protection.

- *Urban Planning*: An archaeological entity is recorded as an *archaeological unit* if it is documented as a result of an intervention in an urban land lot or historical building which is part of a larger settlement or city.
- *Functional*: An archaeological entity is recorded as an *archaeological unit* if, although being part of a larger site, it displays a clear functional characterisation in comparison to other parts of the site, so that:
 - a) It is possible to achieve a more clear-cut functional characterisation updating it as an independent record.
 - b) It is possible to apply independent preventive measures in terms of land planning and protection.

On the one hand, this set of concepts makes it possible to achieve a more accurate recording of complex archaeological sites. On the other hand, it enables the establishment of relationships between entities that have been recorded as separate units if it is required at later stages.

3. *Archaeological site*. A site is conceived as a spatially continuous set of material remains derived from human activity, or relevant for their correct interpretation, that request the fundamental use of archaeological methodology for their analysis.
4. *Archaeological area*. An area is defined as a set of archaeological sites which are integrated within a landscape characterised by specific cultural values.

Once the preliminary stage of data input and description has advanced significantly, a main line of activity in the near future will precisely seek to link, associate and connect the various classes of archaeological entities described above. The various types of entities plus the relationships established among them and with the environmental variables should allow a more integrated management of the spatial and territorial dimensions of the archaeological evidence.

2.b. Where and how get things recorded?

Data input in *ARQUEOS* is made through its database module *DatARQUEOS* (Figure 1.3), an application designed in *ACCESS* that provides a straightforward and comfortable user environment. This application is organised as a series of routines that can easily be installed as separate, independent programs.

The data structure is based in a number of fields grouped in eight modules that have evolved during the life of the database, but which at present can be described as follows:

1. *Identification*: This information provides unique identifiers for all the entities recorded within the database, including a unique id code (which is the main key for all other computer applications), type of entity, name, project, person responsible for the record update and sources utilised.
2. *Location*: This refers to all sorts of data pertaining to the spatial location of the entity, including UTM coordinates, ground access, cadastre references and textual justification of the spatial delimitation suggested. Contextual environmental infor-

mation is also included, but only for variables not available within the series of digital cartography produced by the national and regional governments.

3. *Description*: This contains textual descriptions of all elements and parts of the archaeological entity in question, whether it be because detailed information has been obtained through excavations or because good quality surface evidence is available. This module also includes fields relating to the chronology and functional classes to which the entity can be ascribed.
4. *Conservation*: This module has not been adequately developed as yet. It includes fields referring to the state of preservation of the entity, observed or potential causes of deterioration as well as suggested measures for protection.
5. *Interventions and materials*: This includes administrative and bureaucratic information concerning any kind of research or documentation intervention carried out on a given entity, including scientific results.
6. *Documentation*: This module includes three main tables containing bibliographic, graphic and textual information, respectively. In each of them, fields are grouped in three sections (identification, content and location) according to the specificity of the information recorded.
7. *Legal status*: This module records information concerning the past and current legal status of an archaeological entity. The two main legal figures for the protection of archaeological properties in Andalusia are the designation as BIC (*Bien de Interés Cultural*) or the inscription in the General Catalogue of the Andalusian Historical Heritage. Both represent legal categories that grant planning and administrative protection to sites of special value. Other items of information refer to further legal protective statuses issued at municipal (local planning documents), national (national monuments in pre-devolution administration schedules) or international level (world heritage sites).
8. *Observations*: This module contains information of a more general character that does not easily fit within any of the other modules.

3. THE INTRODUCTION OF GIS WITHIN ANDALUSIAN ARM

3.a. Precedents

Since its very inception in the middle to late 1990s, GIS was regarded as a fundamental component of SIPHA-ARQUEOS. At that time, the utilisation of GIS in order to overcome the limitations of traditional databases (mostly in the area of associated environmental information) had already become extended practice within the ARM systems of several European countries such as Holland, Denmark, France or the United Kingdom (García Sanjuán & Wheatley, 1999).

In Spain, various ARM institutions and universities also started projects aimed at exploring the capabilities of GIS in the visualisation and analysis of spatially referenced archaeological data. At a national level, pioneering work in GIS-based SMR management and predictive modelling was carried out by the *Comunidad Autónoma de Madrid* (Madrid regional government) (Baena, Blasco & Quesada, 1995; Blasco, Espiogo & Baena, 1996).

In Andalusia, the University of Granada started to develop, together with the DGBBCC, a comprehensive Archaeological Information System that embraced all spatial levels of reference, from micro (intra-site) to macro (territorial) and included the utilisation of GIS (*ArcInfo* and *Genamap* for workstations and *Grass* or *MapInfo* for personal computers). This system has not been formally set up for management purposes, but has conveyed a great deal of conceptual and methodological advance (Esquivel *et alii*, 1997). A University of Seville project carried out between 1995 and 1997 was oriented towards the migration of the above mentioned IYAA (the regional SMR available at the time), into Arc-Info and towards the multi-variable assessment of risk parameters in both territorial and urban environments (Amores *et alii*, 1998; 1999). This led to the creation of the first digital map of archaeological sites at a regional level. Since then, the updating and expansion of that regional digital coverage of archaeological entities became a priority within SIPHA-ARQUEOS. The accomplishment of this task was delayed until 1999 due to limitations of staff and various other problems with the quality of the information.

3.b. GeoARQUEOS

The necessity of a computerised tool matching high requirements of quality and speed and suitable for the management of the newly created digital archaeological map was materialised in the creation of GeoARQUEOS, a piece of software intended effectively for the updating and validation of the Andalusian archaeological cartography. GeoARQUEOS was developed in ArcView 3.1 on Avenue and Visual Basic and has as its main function the automatic generation (and quality control) of digital cartography from the alphanumeric data supplied by DatARQUEOS, the database module of ARQUEOS (Fernández, Blasco & Navascués, 2000) (Figure 1.4). Thus, GeoARQUEOS performs three basic functions:

1. Elaboration of digital coverages departing from ARQUEOS alphanumeric data. The program works directly on DatARQUEOS data tables without any kind of previous data processing such as change of UTM zone (Andalusia is split between zones 29 and 30) or discrimination of geometric representation for the archaeological entities (points or polygons).
2. Detection of errors in the resulting coverage and comparison with previous coverages. One of the conclusions drawn from the two previous experiences in transferring the database of sites into a GIS was that the site co-ordinates were often subject to a number of errors (some of them existing in the original sources, and some others made at the input stage) (Figure 1.5). The program detects automatically the following errors:
 - Point and polygon entities outside their municipality. This error is detected when the municipality to which the site is related does not coincide with the site location according to the municipal boundaries set within official Andalusian administrative digital map.
 - Polygonal sites with disordered correlativity between nodes. This fault exists when those pairs of coordinates delimiting an archaeological site have been allocated at random, causing the loss of its right Geometric shape.

- Polygonal sites with faulty coordinates. This occurs when errors take place (at the input stage) while allocating one or more coordinates, generating unrealistic polygonal forms.
3. Comparison of the resulting coverage with previous coverages. The program maintains a permanent updating of the archaeological cartography comparing new coverages with older ones to avoid redundancies. This involves the addition of new point and polygonal sites, the deletion of old ones as well as the recording of changes related to the location and surrounding area of a site (if more accurate geo-referencing has become available).

Finally the program produces a series of *Crystal Reports* outputs reflecting all the changes carried out during the validation process.

The most important benefit derived from the development and application of Geo-ARQUEOS has been the *qualification* (i.e. establishment of a systematic quality control) of the data stored in the database. The program not only allowed a massive leap forward when it was first passed to the enlarged regional archaeological coverage in July 1999, but it provides the basis for periodical controls, as new information is poured from the field into the DGBBCC files (Figure 1.6).

3.c. From object to territory. A methodological change in the access to archaeological information

In order to facilitate access and retrieval to the spatially referenced information stored in ARQUEOS, a further software application has been developed. ARQUEOSMapa (Figure 1.7) is an application developed on *Visual Basic* using the drivers library of ESRI *MapObjects LT* (a free-disposition reduced version of *MapObjects*), which allows dynamic applications with cartographic capabilities within a *Windows* environment.

Within the Andalusian traditional SMR, data retrieval was performed by means of card indexes or (at most) alphanumeric databases. These queries were normally based on the selection of a set of records according to a number of criteria chosen by the user (municipality, functional class, legal status, etc.). If the user wanted, after this preliminary selection of data, to advance to a spatial image of the query results, paper maps, if available, were needed. With ARQUEOSMapa a complete change of perspective in the way the data stored are queried and retrieved, has been achieved. Queries may depart from a global perspective (mapped against a large number of other environmental variables) of the regional archaeological resource, to then proceed to consulting specific items of alphanumeric information stored in the data tables of DatARQUEOS.

Thus, it is not only possible to perform a locational analysis of the very distribution of the archaeological entities (in general or after a selection by any of the variables included in the data model), but also it is possible to analyse that against several other variables of key importance in the shaping of the landscape (hydrology, topography, soil, communication networks, etc.). This has hinted at a number of entirely new perspectives concerning the Andalusian archaeological resource, including the existence of severe informational gaps, locational errors and an informed assessment of risk factors, which in turn has led to the constructions of more informed policies and strategies. In addition,

it has also led to a major epistemological shift: from a perspective that takes the object itself as the conceptual centre, to another one that regards it within the general framework of the territory.

ARQUEOSMapa provides a user-friendly environment and works on an unexpensive hardware and software configuration (a personal computer with Windows 95 or higher). It has provided the technical staff responsible for the management of the Andalusian heritage with a working environment that facilitates data input, access, retrieval and output, therefore increasing the quality of assessment and decision-making.

4. SCOPE AND POTENTIAL OF THE SYSTEM

Over the last five years ARQUEOS has been implemented within both the central and peripheral services of the DGBBCC. At present they all use the DatARQUEOS database for data input and upgrading as well as ARQUEOSMapa for data querying and retrieval. In addition, the IAPH distributes copies of the system to the survey teams that carry out periodical fieldwork intended to update and increase the regional inventory of archaeological entities. When the teams report their work to IAPH, the resulting new records are tested and validated by the system before being finally updated into the database.

Furthermore, ARQUEOSMapa has also been delivered other bodies competent in environmental management as well as heritage protection. Such is the case of SEPRONA, the Guardia Civil service for the protection of the environment that is deployed in nine provincial headquarters. SEPRONA is responsible for the investigations of cases of looting and illicit traffic of heritage objects, a form of crime that has experienced an important increase in the region over the last years (Fernández Cacho & García Sanjuán, 2001).

The forthcoming migration to a single ORACLE database of all the information stored in the discrete thematic databases that integrate SIPHA (including archaeological entities, monuments and places of ethnographic interest) shall allow a fully networked access (which is only partly available at the moment) to all heritage records.

The extension of ARQUEOS throughout the different services and instances of the regional Cultural Board has conveyed better agility and quality control in data management, the introduction of documentation standards as well as greater accessibility by other social agents. Immediate developments beyond this point will explore predictive models for risk assessment and methods for the analysis of significance and value of sites and monuments.

The MAPA project (Andalusian Model for Archaeological Prediction) draws on the information currently stored in ARQUEOS and aims at defining the variables (and relationships among variables) that are significant in order to explain the distribution of archaeological entities at a local and regional scale. Three main classes of indicators are being considered: reconnaissance, selective character and perdurability.

- *Indicators of Reconnaissance.* They represent the variation in the extent and depth of the information on archaeological heritage produced by fieldwork and other scientific activities. These variables account for the intrinsic characteristics and representativeness of the archaeological information, including for example the degree

of surface reconnaissance throughout the territory, the presence or absence of intra-site reconnaissance (excavations, sondages, geophysical surveys, etc.) as well as information offered by other data sources.

- *Indicators of Selective Character.* They account for the variables that have historically conditioned or determined the suitability of specific areas and regions for human settlement, thus influencing demographic density. This includes several environmental variables such as topography, potential agricultural capability, edaphology, lithology, hydrology and water resources, mineral resources, etc.
- *Indicators of Perdurability.* They account for the variables that affect directly the degree of preservation of the archaeological evidence, including historic and modern land uses, slope, erosion, extractive activities (mining, quarrying), etc.

5. INFORMATION DISSEMINATION

One of the main targets of SIPHA since its origins has been to grant public accessibility of the information and dissemination of the Andalusian historic heritage among non-professional users. The main channels utilised to give the general public access to the information contained in the system have been:

- Publication of thematic bulletins. Different thematic bulletins dealing with specific aspects of DatARQUEOS are available at the IAPH library. An abstract of each of them has been published in parallel in the pages of the IAPH official bulletin (*Boletín del Instituto Andaluz del Patrimonio Histórico*).
- Elaboration of CDs. The IAPH Documentation Centre has published various digital documents on CD ROM that include selections of information contained within the system databases. As far as archaeological heritage is concerned, the series has started with a CD about the megalithic phenomenon within the Seville province.
- Specialised monographs and conferences. The IAPH publication services has been editing since 1992 a series of general and technical papers (*Cuadernos* and *Cuadernos Técnicos*), of which the forthcoming issue will deal with ARQUEOS. In addition, the IAPH has participated in the organisation of various seminars and conferences (of which *Mapping the Future of the Past* is one example), of regional, national and international character, dealing with ARM issues.
- Internet access. Basic information about ARQUEOS is available at the IAPH web site (www.iaph.junta-andalucia.es). Further queries can be filed to the Information Service (Documentation Centre, IAPH) through fax, telephone, letter or personal visit.

6. REFERENCES

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