sustainability

Article

Contribution to the Knowledge of Cultural Heritage via a Heritage Information System (HIS). The Case of "La Cultura del Agua" in Valverde de Burguillos, Badajoz (Spain)

Victoria Domínguez-Ruíz [1], Julia Rey-Pérez [2,*] and Gloria Rivero-Lamela [3]

[1] Instituto Universitario de Arquitectura y Ciencias de la Construcción, Departamento de Construcciones I, Escuela Técnica Superior de Arquitectura, Universidad de Sevilla, Av. Reina Mercedes 2, 41012 Seville, Spain; v_dguez@us.es

[2] Instituto Universitario de Arquitectura y Ciencias de la Construcción, Departamento de Historia, Teoría y Composición Arquitectónicas, Escuela Técnica Superior de Arquitectura, Universidad de Sevilla, Av. Reina Mercedes 2, 41012 Seville, Spain

[3] Departamento de Proyectos Arquitectónicos, Escuela Técnica Superior de Arquitectura, Universidad de Sevilla, Av. Reina Mercedes 2, 41012 Seville, Spain; grivero@us.es

* Correspondence: jrey1@us.es

Received: 14 November 2019; Accepted: 30 January 2020; Published: 5 February 2020

Abstract: Modern science is going through a period of important reflection on the role of different agents and multiple disciplines in the management and safeguarding of architectural heritage. This new focus generates a greater amount and diversity of information, so the implementation of a unifying tool in the framework of digital information models would mean a better knowledge of cultural heritage as well as aiding its safeguarding and protection. In addition, it must be taken into account that, for the correct management of information in its broadest dimension, this tool must make it possible to relate alphanumeric data about an item of heritage to its spatial location. In this sense, this article proposes a Heritage Information System (HIS)—understood as a digital knowledge tool—that consists of a relational database and a map manager with Geographic Information System (GIS) technology (a geodatabase). The methodology suggested here sets out the steps that make up the HIS, so that the system can be applied to other geographical elements or realities. For this reason, a study was made of "La Cultura del Agua" in Valverde de Burguillos (Spain), a heritage ensemble that consists of rural architecture and dispersed preindustrial elements, which are currently at risk. The HIS seeks to develop a more complete identification of these elements (individually and as a system) and a justified argument for their being given value and great visibility. This new approach encourages sustainable development in terms of efficiency and effectiveness for the analysis, diagnosis, and reactivation of cultural heritage, always placing importance on the balance of social participation with the territory in which the system is applied, and with global society.

Keywords: rural heritage; heritage management; geographic information systems (GIS); vernacular architecture; cultural heritage

1. Introduction

The technological change of recent decades means a renewal of access to culture and the way in which the collective memory of cultural events is managed. The evolution of new information and communication technologies has given place to substantial transformation in the activities of contemporary society [1]: the economy of work and research as well as the related fields of learning is organized differently today to meet the problems of the knowledge society [2]. Digital immersion has changed the ways of accessing and managing information, permitting greater and more creative possibilities compared with the static model. According to Pinto [3], when it comes to heritage management processes (registering, research, identification of values, protection, dissemination, decision-making processes), it is necessary to revise the mechanisms for highlighting the item of heritage. It is not be enough to just consider the historic value of the building, but all those values (landscape artistic, geological, environmental, scientific…) inherent in the cultural fabric in which it is contained [4–6].

These technological advances have benefitted the digital information models used in the heritage field, and these have grown in strength due to the growing availability of information in recent years to international administrations that support digital knowledge and the opening up of management processes of cultural heritage properties for the integration of knowledge [7,8]. However, in the digital era, where closed and sector-defined knowledge should have been superseded, the majority of initiatives developed for the management of information about items of heritage take place within the framework of isolated disciplines and scarcely related elements. In addition, they are not updated, which leads to stagnant and fixed information. From the point of view of the effectiveness and sustainability of these integrated information systems over time in the field of heritage, the panorama is, on one hand, confused by the diversity of procedures employed [9]. These frequently lack the necessary methodological reflection and alignment with the objectives of a true global cultural management project [10,11], so fail to generate or disseminate real knowledge. On the other hand, the situation is doubtful concerning the usefulness of this information for activating genuine safeguarding initiatives, losing all possibility of benefiting cultural heritage [12–14].

In this proposal, with regard to the traditional methods of generating and managing heritage information, geographic information systems (GIS) are presented as an apt tool for documenting cultural heritage as they permit the incorporation of the perspective of different disciplines and agents as well as the spatial localization of the heritage. The correct management of all these approaches makes it possible to discern a new panorama for heritage where new values are incorporated that, without doubt, will modify the current systems of safeguarding and protection. In short, today, GIS are considered by numerous studies, to be an effective, flexible, and integrating tool from a management and knowledge perspective [15–17]. In addition, its graphic versatility and its recent use in dissemination platforms have qualified GIS as an educational tool for society.

Considering the aforementioned shortcomings of current examples of heritage documentation and the potential of GIS, the aim of this project is to unite GIS and heritage to create a new Heritage Information System (HIS). This article describes the methodology used to develop the HIS—understood as a digital knowledge tool—that consists of a geodatabase and a map manager with GIS technology (a geodatabase).

For that reason, there follows a section devoted to the theoretical framework that reflects on the current use of HIS and GIS, and analyzes examples of international heritage systems to identify the shortfalls that the new HIS can fix; Section 3 presents a specific case study in which the HIS was used to test its usefulness and potential. The case study looked at "La Cultura del Agua" in Valverde de Burguillos, a heritage ensemble made up of rural architecture and dispersed pre-industrial elements that needed water to work. Section 4 describes the steps that make up the HIS, so that the system can be applied to other elements or geographical realities. In Section 5, the HIS is applied to the specific case study. Within the elements that make up the ensemble of "La Cultura del Agua", a significant construction was chosen to visualize the implementation of the HIS. Finally, in Section 6, the possibilities of the HIS are shown compared with traditional systems, and our evaluations are presented of the use of the HIS in the case of Valverde de Burguillos.

2. Knowledge Systems and Information Systems Applied to Cultural Heritage

Digital culture as a field of applied research constitutes a theoretical framework for tackling key concepts regarding heritage knowledge strategies. Numerous international publications have collected the conclusions of the first scientific studies of the potential of new technologies when applied to cultural heritage [18,19]. In these, it is directly linked to the concept of the digital in the so-called knowledge society [20]. Since then, technological rollout has been necessary to bridge the digital gap that exists in the globalized world. However, as well as solving the knowledge gap reported by United Nations Educational, Scientific and Cultural Organization (UNESCO), a parallel effort must be made to adapt content to digital media [7] (p. 23). In this way, this theoretical framework considers what content to incorporate in strategies such as characterizing, cataloguing, researching, and transmitting knowledge [21]. In addition, it contemplates how these should be modelled in HIS to enable heritage properties to be better known and understood by society [22].

It has been shown that GIS have a key role in heritage knowledge and management. Recent studies [23] have brought together scientific publications that use GIS in projects such as inventory and cataloguing [24], analysis and research [25], heritage dissemination [26], development of protection and management plans [27], and prediction and evaluation of impacts [28], in descending order. This technology has the potential to incorporate multi- and interdisciplinary focuses [29] and work in an integrated way from different scales of approximation, from the territorial to the object [30]. As tools, they are capable of storing and retrieving great amounts of data. As systems, they are powerful supports for the analysis of, and decision-making on, the role of heritage in sustainable development [31]. A problem arises when information about the heritage elements is not thorough or does not appear to be sufficiently related to its environment. Consequently, a badly designed data model makes research and conservation projects difficult [9].

It is not just the field of science that makes use of this technology. It is also used by agents such as institutions, administrations, technical specialists, and the public, who are involved in the identification of items of value and decision-making regarding the protection of heritage properties. The CHERPLAN transnational partnership [32] is composed of eleven partners (consisting of universities, technology centers and administrations) and two observers. The project aims to provide a strong basis for ensuring compatibility and synergy between cultural heritage conservation and socio-economic growth to promote efficient participatory management of cultural heritage sites by establishing Cultural Site Management Partnerships across South East Europe. In Spain, the Red de Ciencia y Tecnología para la Conservación de Patrimonio Cultural (Network of Science and Technology for the Conservation of Cultural Heritage) has existed since 2011 and has three areas of activity: (1) research (Consejo Superior de Investigaciones Científicas—Higher Scientific Research Council—and various Spanish universities); (2) cultural institutions, foundations, and museums; and (3) businesses in the sector [33]. The purpose of the network is to foment collaboration between the actors in the science–technology–business system for the sharing of ideas and experiences that might help solve problems and make technology transfer possible. This convergence effort is also relevant from an operational point of view. The INSPIRE Data Specification on Protected Sites thus serves as the starting point for modeling cultural heritage information in order to implement, distribute, and share it in an interoperable framework: the Spatial Data Infrastructures [34].

In the evolution of the role of the public as users of this cultural heritage, and principle actors in relation to it, we define as a frame of reference the "Recommendation on the Historic Urban Landscape (HUL)", adopted by UNESCO in 2011 [35]. This recommendation promotes an approach based on landscape, where an inventory of resources and the identification of values and vulnerabilities are considered as essential factors when thinking about urban development policies. Moreover, this recommendation gives particular emphasis to the necessity of involving different disciplines and other stakeholders, mainly citizens, in heritage management and urban development. The HUL approach forces the municipalities not to consider the historic building as an isolated object, but as an element that belongs to an urban context, it is inserted into a landscape and is part of the day-to-day life of citizens. This approach is a challenge due to the scope of its conceptualization; however, in order to implement the HUL approach, UNESCO has proposed a six-step process: (1) map human, natural, and cultural attributes and values; (2) incorporate citizenship in decision-making on what to protect and why; (3) assess the vulnerability of those attributes to socio-economic pressures and the effects of climate change; (4) the integration of information generated (heritage values and vulnerability status) in an urban development framework; (5) prioritization of actions for conservation and development; and (6) establish local partnerships.

Most of these steps are implemented by municipalities, but what is new is the idea of involving citizens in decision-making in their cities, since, under current policies, this is not usual. What is sustainable for heritage is not a use imposed by the municipality, but a use decided by all. As examples, we could mention the case studies of Ballarat in Australia and Cuenca in Ecuador [15,36,37]. In both cases, the six steps were developed, resulting in a set of sustainable urban development measures decided upon by the administration, citizens, and experts, in equal conditions.

To detect possible limitations in the research, other cultural management projects in non-monumental fields were considered with the aim to reduce material and personnel costs. Being multidisciplinary has not been a reality among technical teams and professionals [38]. In the experience of projects on a smaller scale, cultural heritage digital models could sometimes be carried out relatively quickly by a small implementation team, making sustained support from top management less critical than with global projects [11]. However, this must be done with scientific rigor, not letting the project be too influenced by emotion or the aesthetic appearance of the ruin [39]. In cultural management projects that deal with non-monumental environments—with little budget and with a small staff—the lack of cooperation between the participating teams and agents at a political level is common. Within the framework of the Territorial Agenda of the European Union, the final report of the URNSTE project (Urban–Rural Narratives and Spatial Trends in Europe) [40] recommends connectivity between actors on a local, regional, and global scale. However, it is expensive to implement a GIS for a local administration [41]. The investment in a specialized GIS by an administration can only be justified if it returns a profit. Therefore, there are many projects aimed at potentializing heritage for economic motives such as tourism [42,43]. Good design and implementation of a HIS can contribute to that.

For the design of the HIS, we fixed the theoretical framework on the most frequently mentioned GIS applications in scientific reviews: "heritage inventory, analysis and research, which are similar to the first phases of process of an integral management model: identification, documentation, registering and signification" [44]. On the other hand, in models for reduced or individual areas, the consideration of other authors was that the design begins with the assumption that there is not a fixed problem to be solved nor a specific technical solution. This makes it possible to balance the simplicity of the system with the difficulty of the particularization of the case as "the system needs to represent faithfully the community's knowledge of the land, the complex relationships between people and with significant places" [45].

The theoretical framework is set by the institutions of reference in matters of heritage documentation. As it deals with the concept of rural heritage, this is not contemplated by the conventions of the Council of Europe. However, International Council on Monuments and Sites (ICOMOS) considers it in its action principles when it alludes to the local value of vernacular architecture or the promotion of ecotourism as a factor in local economic development [46]. In international documents, the most common type of rural landscapes considered are "Continuing Cultural Landscapes". In addition, there is a classification of rural landscape systems based on nine categories [47]. This framework considers the thematic component of the rural landscape in the HIS and the identification of heritage of value within it ([47] p. 17), [48]. With regard to architectural or built heritage, it brings together a more integrated concept. Therefore, the figure of Historic Site appears as collective typology. For its part, the concept of Industrial Heritage for the International Committee for the Conservation of the Industrial Heritage (TICCIH, special advisor to ICOMOS on questions of industrial heritage) or for the Andalusian Historic Heritage Law (Ley de Patrimonio Histórico de Andalucía) has an interest in being more extensive, wider ranging, and not establishing chronological limits [49,50]. On the other hand, the contribution of the current heritage legislation has been considered [51–53]. With regard to digital databases, reference has been made to the Database of Historic Spanish Heritage Properties (Base de Datos de Bienes Inmuebles del Patrimonio Histórico Español) [54] and cartographic databases, especially regional ones [55–58].

Due to its special relevance for the implementation of the HIS, the theoretical framework deals with GIS applications in different scientific areas such as landscape archaeology and archeogeography [59]. These fields are interesting because they consider architecture that is intimately linked to the physical medium and space as an integrated system, resulting from human transformations throughout the history of societies and not as just another record for geographical restitution at a specific time. For its part, the role of historic cartography in the construction of the landscape is critical as a complement to the generation of new cartographic databases that are appearing today [60].

3. Case Study: "La Cultura del Agua"

The name of Valverde de Burguillos, a municipality situated in the southeast of Extremadura (Spain), alludes to its location in a green valley (*valle verde*) that is a wide depression crossed by four fluvial channels and numerous springs. Its nature also marks the name of the higher administrative authority to which it belongs, the region Zafra-Río Bodíon. It shares natural and socio-cultural similarities with other municipalities of the same area as well as serious depopulation problems as it currently has only 280 inhabitants. The ecological, economic, and social functioning of the region is breaking down, causing the progressive deterioration of the rural heritage and the loss of bio-cultural knowledge. Such is the case with the pastureland, its most emblematic landscape, which has been severely affected as an engine of development. Consequently, in the domestic sphere, the social life and local economy have lost their roots, endangering their future. In Valverde, nature and the landscape are the foundations of the way of life, which has been sustainable for centuries.

Once the cultural support of this place was detected and the serious problems of depopulation and changes in the functionality of the region were identified, we noticed one of its main heritage ensembles, known as "La Cultura del Agua". The elements that make it up include fountains, pillars, water tanks, a mill, and a hydraulic conductor. More recently, the Valverde be Burguillos Council (Ayuntamineto) has requested the inclusion of the electrically powered flour mill "San Luis" (Figure 1) as well as the dam and the path that leads to it. It is an ensemble that is made up of ten cultural properties, situated in the village center and its immediate surroundings. The architecture of the elements of the ensemble shows great links to the territory, to the crops grown there, and to its hydrography, with other features of the communication infrastructure such as roads and paths, etc. It features elements that should not be understood separately, but as part of a system that made the functioning and development of the municipality's society possible. The existing water resources have provided the village with a public system of fountains, irrigation canals, channeling, and various points of flour production, which have characterized the socio-economic profile of the village for centuries. In addition to their material and architectural qualities, these elements also played an important role in the development of the social life of the village, so they have great symbolic value that must be conserved and protected as a legacy, in the best conditions possible, for future generations [53]. Despite this, the state of abandonment and ruin of these elements is very high, and urgent action is required to prevent their disappearance.

Recently, the elements of "La Culture del Agua" have been categorized as a Place of Ethnological Interest, defined according to Article 6.1 of Cultural and Historic Heritage in Extremadura Law 2/1999, of March 29. The following ten elements were considered: (1) Fountain-trough of "El Pilar"; (2) Fountain-washing place "El Charco"; (3) Water tank "Fuente Nueva"; 4. "La Presa" and the footpath along the old canal that leads to the electrically-powered flour mill "San Luis"; (5) Fountain-trough "El Pocito"; (6) Fountain-trough "La Reina"; (7) Water tank number 1; (8) Water tank number 2; (9) Mill "Molino del Najarrillo"; and (10) Electrically powered flourmill "San Luis". In the report that accompanies the document, they are described thus, 'these elements of varied architecture that are related to the traditional use of our agro-ecosystems (…) as previously forgotten witnesses, which fell into a state of ruin and were disappearing, before being properly studied and recorded, as a consequence of the abandonment of the countryside and the disappearance of traditional agriculture" [53]. However, although this new beginning means a step forward in their process of conservation, protection, and in their institutional recognition, concrete measures to start safeguarding them have not been taken. In addition, the report does not analyze their elements in depth, limiting itself to a brief description of each object that does not consider its territorial dimension or its interaction with the landscape. A deeper analysis of "La Cultura del Agua" was necessary, which would document, characterize, and locate all the elements, always contextualized, to contribute to their evaluation and preservation, making future interventions easier.

Figure 1. Electrically powered flourmill *San Luis*. Photograph of the authors.

4. Methodology

The HIS to be developed was conceived as a process tailored to a set of heritage elements in a local context that are rural in character. The objectives were to contribute to the integrated knowledge by means of its identification (KNOWING) and effectively transmitting the information contained in it (MAKING VISIBLE). To establish the basis for the methodological design in the theoretical framework, a broad conceptual, methodological, and thematic review was conducted from publications that specialize in cultural heritage and GIS. In parallel, international case studies that implemented GIS were reviewed. From these was extracted: the importance of the definition of the system's objectives, the importance of the needs of the end user, and the integrated focus for the themes to be dealt with. Finally, the existing heritage regulations (European, national, and local) as well as access to digital cartographic databases were used to identify specific objects of interest for the case study.

The phases that comprised the methodology are as follows:

1. Definition of the data model, in which is decided: the datasets to be introduced, their characteristics and the relationships between them; also, the HIS model will be raster or vector after making a selection based on the theme being tackled and the complexity of the project. To achieve an integrated approach, the case study must be analyzed both in a geographical sense and in terms of its social and cultural perception, with the changes and requirements having to be mapped. This requires, as a matter of priority, a selection of the attributes and their characteristics that will be involved in later phases. According to Fernández-Freire et al. [34], it must be generic, in order to embrace any kind of cultural heritage data, directly or indirectly georeferenced; extendable, to allow any kind of data producer to adapt the model to the nature of their own information; and interoperable, to combine spatial datasets from different sources through network services via the Internet.
2. Design of the georeferenced database or geodatabase (GDB). This must have a global focus that spatially and thematically collects the values of the previously defined attributes. The information will vary according to the field considered, the profile of the end user, and the interests of the disciplines involved in the use of the HIS as well as the role of the expert.
   It features, in turn, the following stages:

- Identification of the heritage elements. This involves using the existing systemized information (inventories, catalogues, heritage databases, etc.) and extracting categories and attributes. This can also be a phase that involves the incorporation of subjective data if the local inhabitants' perception of the heritage has been recorded. Other methods of identifying the heritage are reviewing literary sources, in situ observations, reading maps, looking at aerial photos, comparing old and current property registers, and looking at images, drawings, sketches, etc.
- Spatial content: orthophotos, aerial photographs, topographic and property register maps, web server maps, and from cartographic archives. The system uses aerial photography and photointerpretation to learn the location of the elements and their morphology as well as their placement, organization, and distribution within the territory. This makes it possible to make a later study of the spatial distribution of the elements in relation to other thematic layers.
- Thematic or alphanumeric content: A great part of the review of the theoretic framework took place in this stage. Depending on the sample of heritage elements for the HIS, the essential basic thematic fields were named as follows: IDENTIFICATION attributes (Code, Name); LOCALIZATION attributes (X, Y and Z coordinates; municipality, region, country; cadastral reference, etc.); MANAGEMENT attributes (reference of heritage protection, town planning, etc.); DESCRIPTIVE attributes (built elements, general use, hyperlink with associated image, author, dating, etc.); HERITAGE VALUE attributes (Architectural value, Typological value, Environmental value, Historic value, etc.); DOCUMENTARY attributes (references and/or links to graphics, images, literary sources, etc.).
- Metadata, consisting of data that describes each set of data in terms of the quality of data (the origin of certain datasets, method, accuracy of the data, creation time of the data, spatial coverage, etc.).

3. Implementation of the GDB. For this, the software Arc GIS 10.4 (ESRI) was chosen, by agreement with the University of Seville. An area of work has to be selected, and then its location must be defined as well as its sphere, scale, and spatial resolution. Using the software, specific values are given to the thematic fields, creating or updating fields if necessary. Control points have to be defined and layers of spatial entities loaded, while also defining system coordinates and other data for the precise localization of the maps, etc.
4. Data management. Once the data is collected and organized in the GDB, the procedures are designed for its management and later retrieval for analytical purposes. Here, the functionality of the software comes into play: spatial and attribute-based searches, algebraic searches, and field calculator. The searches can be simple or linked, alphanumeric or graphic, etc.
5. Information retrieval. Two different forms of presenting the information were established. For each one of these, the most accurate form of representation must be designed so they can be understood.

- Factsheets. The results of the operations carried out with the data introduced can be brought together in factsheets that combine both components, even having sub-factsheets if the analysis is deeper or if there is a great quantity of information to retrieve. When it comes to the theme of heritage, it is considered of great interest to reserve space for the bibliography and image attributions, with the contribution of a field for virtual recovery (HBIM, photogrammetry).
- Maps. This is the most user-friendly way to present information [32] (pp. 42–46). They can be based on the location or on the properties of an object, or in the data presented in the image or in a linked database table. Control of visualization elements will also be established (such as scale, geographic north, legends, symbols, control points, etc.)

5. Results and Discussion

After the literary revision and following the methodology, the following groups of results were considered. This includes a discussion of the limitations encountered and proposed improvements so that the HIS can be extrapolated to other cases.

5.1. Results of the Design of the Data Model and the Geodatabase (GDB) of a Heritage Information System (HIS)

Of all the characteristics of the data model and GDB, this article highlights those with a specific heritage relationship. That is to say, which heritage information resources are introduced and how they are related. In the previous sections, the integrated approach to focus, disciplines, and methodologies was key. On one hand, the bibliography provided orientative datasets. The indications of specialized authors on GIS from the 1990s [41] corresponded with the current contents of local cartographic servers [55–58], which are used by the local administration and the teams of GIS experts. The recommendations and principles relating to heritage and the rural landscape made by the heritage management and protection institutions [48], even without referring to GIS, have served to define the datasets and their relationships.

Responding to the complexity of a GIS in a rural environment and one that is related to heritage, the following subsystems are proposed for its design. First, natural environment and rural resources; economic activities based on the natural environment (agriculture, cattle farming, forestry, dishing, etc.); vegetation maps; elements and animal dynamics; soil types; quality and quantity of water; climate and air quality (temperature, rainfall, pollution, etc.); and environmental quality. Then, economic and urban characteristics of the land: plot division; buildings and dwellings; property; ground use; urban characteristics; condition of the buildings and dwellings. Additionally, the socioeconomic and population characteristics: demographics; education and levels of training; economic sectors (primary, manufacturing industry, construction, commerce, tourism, leisure and hospitality), and labor market (offer, demand and unemployment). Infrastructure and facilities: roads and rivers; energy production and distribution; water and water treatment facilities; healthcare and education facilities; and cultural and sports facilities.

On the other hand, conducting the process of the creation of entities, types, subtypes, and their relationships in the GDB in the conceptual review [29,38] was very enriching. Upon implementing it for the case study, it obtained the necessary characteristics to be used as a generic and extendable HIS, as was required. It can be used generically thanks to the great number of disciplines dealt with; different categories were recorded both for bringing together elements that could be represented on maps and for bringing together others that were more difficult to give a geo-reference (such as immaterial attributes, heritage values, recommendations and actions, etc.). It managed to become extendable because of the integration of diverse methodologies (of heritage documentation [34], of action on rural heritage [46] (pp. 79–100), and of public participation in the perception of the heritage [35], etc.). This all made the data model adaptable.

As a specific example of the conceptualization of the data model, the research looked at the association between thematic attributes of cultural knowledge and spatial entities of the rural landscape. Nine official categories for rural landscape systems have been adopted [47]: Agriculture (soil retaining systems; water management; cultures associated with each other, live fences); Agriculture and Husbandry (cultures associated with livestock, agrosilvo pastoralism); Forestry; Husbandry (livestock systems: long transhumance, sedentary or semi-sedentary extensive grazing, intensive sedentary grazing); Fishing; Hunting and gathering (wild-food gathering, wildlife hunting through vegetal architectures, e.g. catching migratory birds); and Extraction (salt production landscapes). These are related to cultural knowledge, practical traditions, expressions of identity, and belonging of the local human communities, values, and associated cultural meanings as well as with the technical, scientific, and practical knowledge linked to the relationships between humans and nature [48]. To implement the relationships, an adaptation of the Standard for the Integration of Cultural Information has been proposed [61].

Thanks to the integrated methodology, the results obtained from the crossing of thematic layers and attributes have an interdisciplinary focus, which allows each user, by means of the careful design of the system variables, to interpret the result in light of their own interests.

5.2. Implementation of the HIS for "La Cultura del Agua"

The success of the HIS is also based on the existence and availability of the data and on the real possibilities that the data can be combined. For that reason, the HIS was applied to "La Cultura del Agua" as a pilot project.

The following tasks and decisions were performed:

1. Specific objectives: To create a geodatabase to collect all the information possible about the elements of the case study. To broaden knowledge by carrying out spatial and thematic analysis. To represent the information in various formats by combining images with text.
2. Model type: It was decided that it would be vectorial due to the nature of the data collected and the planned final product.
3. Study area: Municipality of Valverde de Burguillos. A scale of between 1:500 and 1:5000 was established for vector models with a variable between the urban and rural areas, which corresponds to a rural-sphere GIS [41].
4. Choice of system: The proprietary software ARC GIS 10.4 ESRI was chosen. In contrast with open-source software, much less programming is needed and with it the final GIS is often less difficult to handle [62]. For the GIS architecture, Desktop-GIS was chosen. This is easy to use and has different levels of functionality that are within those required for the analysis proposed. The University of Seville has an agreement with the company that makes it possible to reduce costs. The required interoperability is also guaranteed thanks to this system. This is also true because the corporations of the area of study are users of the software. In addition, there is an official tool used in the region for the management of cartographic and territorial information (the Sistema de Información Territorial de Extremadura or SITEX), which provides the diffusion and interoperability of the data with a process of quality control.
5. Implementation: The information resources of the HIS come from official digital cartographic servers as indicated in the square brackets below, in which the quality of the data provided has been tested by means of its metadata. This gives information about the source of the data, the procedure for the creation of the layer as well as the version, the date of publication and any update, the scale of references, and the restrictions on the use of the information, etc.
6. Spatial implementation: The WGS 84/UTM zone 29N-EPSG:32629 coordinate system was used. A cartographic base was prepared with layers that came from different mutually compatible databases (Shapefiles, WMS base, orthophotographs, etc.). So, for the productive system, the following layers were vectored to entities: Pasture (geographical area with a predominantly agroforestry system that is characteristic of the area); Mountainous (set of smallholdings suitable for feeding animals, the products of which are specific to the area); LIC (Site of Community Interest); and ZEPA (Special Protection Area for birds) and Landscape Elements (isolated trees, boundaries, pools, lakes, ponds and natural watering holes, small shelters for the flora and fauna, etc.) [63]. The productive system and the use of ground layers was woven together with the subsystem of settlements (population setters and municipalities) [56], buildings and property structure [property register (the *catastro*)]. These were superposed on the supporting subsystems: road infrastructure (road network and network of cattle paths); hydrography (rivers, reservoirs, lakes and dams, and emergence points); contour lines (10 m) [55]. Following this, the ten included elements were represented. To do this, the layers Cultura del agua_point.shp and Cultura del agua_polygon.shp were created, with point and polygonal entities, respectively, to respond to the different scales of analysis. Finally, current orthophotography was included [58] and one from 1945 [64], when the structures in the case study were in use.
7. Alphanumeric implementation: The spatial layers that came from the cartographic data contained tables associated with attributes. For the newly created layers, new information fields were generated in columns in the associated table. This is the case with Evolución-edificaciones.shp, a polygon layer that brings together buildings according to their date of construction, and then categorizes them in a numerical field according to information from local

records [65]. A new point layer called Percepción.shp contains places that are representative for the local citizens. A set of maps in which the citizens expressed their own thoughts during heritage awareness meetings was taken as a source [66]. In this layer, an attribute called Valoración was created including evaluations such as positive and negative. In the same way, new fields were created in the shapefile of "La Cultura del Agua". In addition to the groups of attributes previously indicated (IDENTIFICATION, MANAGEMENT, DESCRIPTIVE, HERITAGE, DOCUMENTS), the field called VALUE was expanded, specifying if the value was real/potential (column 1); direct/indirect value [46] (p. 12) (column 2), architectural, typological, environmental, historic, social, tourist, cultural, economic, educational and documentary value; an element of singular or rare value (column 3); key word as suggestion in the framework of future projects or potential investment (column 4).

The data management consisted of linking thematic and spatial queries. The identification of new heritage values for "La Cultura del Agua" was achieved, many of these had not previously been considered by management tools and are shown in the last column of Table 1. After the data management and analysis, the system makes the extraction of object information possible such as protected properties, state of conservation, etc. In addition, subjective information can be extracted such as which properties are the most valued by the inhabitants and which actions they recommend (conservation, rehabilitation, restoration, change of use, etc.).

Use of the information: According to what has been stated previously, the system makes it possible for specialists to carry out deep analysis, but also makes decision-making easier for the agents involved, even attracting new investors or potentially interested entrepreneurs. For each outcome, the best way must be considered to communicate the information obtained. In this project, for each element of "La Cultura del Agua", a factsheet was prepared containing the main thematic fields, the main results of the crossing of information, and the graphical references of the element itself and of its surroundings. The distribution of contents is done by means of sub-factsheets containing objective information (description, for administrations and scientists) and sub-factsheets of subjective information (evaluation, with potentialities extracted from the uploading and analysis of data).

Below can be seen the factsheet that corresponds to the "Molino del Najarrillo" (Figure 2). The factsheet makes the inclusion of graphic documentation possible. In the case of the mill (Molino), an aerial photograph is included where the building's structure can be seen. An experimental Building Information Modeling (BIM) model is included as a metric survey [67]. The mill is on a private estate and its graphic representation makes it possible to access it virtually. It has also been possible to understand the situation of the mill by observing the water sources and nearby streams as, despite its name, this mill did not function because of the flow of the Najarrillo Stream, but because it had a dam at a higher level that powered the machinery and whose water then emptied into the Najarrillo.

Having the elements implemented with greater thematic precision and geometric resolution has provided better results for the factsheets. This was also the case when they were subjected to the analysis process in the HIS. This was the case with this mill and the electrically powered flourmill. Local written sources were consulted; however, those with references were scarce. This lack of information is something that has to be improved.

The interesting contribution resides in, on one hand, being able to have quality up-to-date digital cartography. On the other hand, the possibility of considering the elements of "La Cultura del Agua" as a system and not as isolated elements means being able to relate their location to defining territorial information about the cultural landscape where they are placed. It is also useful for the detection of possible positioning errors for the documents. For its part, the use of orthophotos and aerial photography taken in the period when the hydraulic elements being studied were working has been crucial for the possibilities of territorial analysis for the construction of landscape (Figure 3).

Table 1. Identification of new heritage values for "La Cultura del Agua". Table made by the authors.

Data Model	**Geodatabase**		**Result of the Analysis (Information Management)**		**Information Output**	**Potential Outcome: Proposal for Action**
Input Information	**Data Type in the HIS**	**Sources**	**Values**	**Description**	**Element of "La Cultura del Agua" Affected**	**Potential Interest**
Drovers' roads	Vector feature class (line)	[55,56]	Historic	The drovers' roads that cross the village centre and those that run across the territory of the entire municipality still have a close relationship with the elements studies, as all, which are found in the village centre, are situated on a drovers' road. This is indicative of historic routes for cattle farmer and travellers heading to their land or nearby municipalities.	3. Water tank Fuente Nueva; 4. La Presa and the pedestrian path along the old canal that leads to the electrically-powered flour mill San Luis; 5. Fountain-trough El Pocito; 6. Fountain-trough La Reina; 7. Water tank number 1; 8. Water tank number 2; 9. Mill Molino del Najarrillo; 10. Electrically-powered flour mill San Luis.	Tourism Educacional Agrosylvopastoralisme
Municipal delimitation of the local Region	Vector feature class (polygon)	[55]				
Urban centres of the local region	Vector feature class (polygon)	[56]				
"La Cultura del Agua" elements	Vector feature class (point)	Own elaboration				
Historic cartography	Raster layer	Not available				
Aereal photography 1958	Raster layer	[64]				
Land use	Vector feature class (polygon)	[55]	Territorial	As is stated in Carnicero Valero, it can be determined that the route of the drovers' roads that cross and make up the municipality of Valverde de Burguillos responds to the need of the population to communicate with nearby municipalities or agricultural and non-irrigated crop-growing lands near to the village centre. This is	1. Fountain-trough of El Pilar; 2. Fountain-washing place El Charco; 3. Water tank Fuente Nueva; 4. La Presa and the pedestrian path along the old canal that leads to the electrically-powered flour mill San Luis; 5. Fountain-trough El Pocito; 6. Fountain-trough La Reina; 7. Water tank number 1; 8. Water tank number 2; 9. Mill	Transhumance Environmental
Drovers' roads	Vector feature class (line)	[55,56]				
Municipal delimitation of the local region	Vector feature class (polygon)	[55]				

Urban centres of the local region	Vector feature class (polygon)	[56]		known as transterminance and is a type of transhumance characterised by the short-distances travelled, normally of no more than 100 km. The elements studied are situated along this route. These roads make up their own cultural system, brought together in the constructions of "La Cultura del Agua" and in folkloric displays around them and the drovers' roads.	Molino del Najarrillo; 10. Electrically-powered flour mill San Luis.	
"La Cultura del Agua" elements	Vector feature class (point)	Own elaboration				
Historic Cartography	Raster layer					
Aereal photography	Raster layer	[64]				
Land use	Vector feature class (polygon)	[55]				
Orthophotographic map	Cartographic data sources	[58]	Functional	The direct relationship has been detected that exists between one of the points where water emerges, the concentration of elements that exists to the west of the village centre and the location of stream. The terrain supports these fountains and water tanks that, for the most part, are made up of, as well as being vehicles for water storage, a system of irrigation canals that take water to the nearby vegetable gardens. An ethnological value as a witness to the use of water for everyday public use, in agriculture, and in the production, in this case, of bread and electricity can be drawn.	5. Fountain-trough El Pocito; 6. Fountain-trough La Reina.	Research and Documentation Tourism Architecture
Point where water emerges	Vector feature class (point)	[56]				
Land use	Vector feature class (polygon)	[55]				
Hydrography	Vector feature class (line)	[55,56]				
Reservoirs, lagoons and dams	Vector feature class (polygon)	[56]				
Contour lines (10 m)	Vector feature class (line)	[55]				

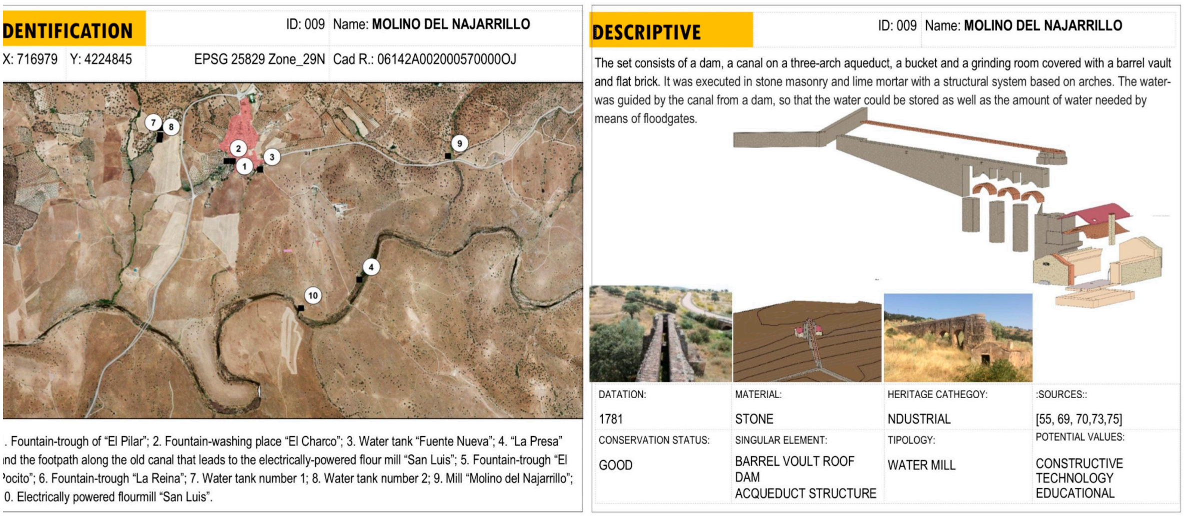

Figure 2. Factsheet corresponding to the "Molino del Najarrillo".

For this case study, it would have been desirable in the design stage of the HIS to expand the team with members from outside the area of research. This was made up for by occasionally consulting specialists and the administration as well as by holding public workshops [68] with the authors participating, and by reading interviews with the local population conducted by anthropologists [69]. The system could be verified in successive phases by presenting the results in meetings and submitting them to debate with the participation of people involved in local development and heritage, in accordance with European guidelines and recommendations [35], ([46] pp. 19–22). In this sense, the HIS has served to suggest themes of interest for local development.

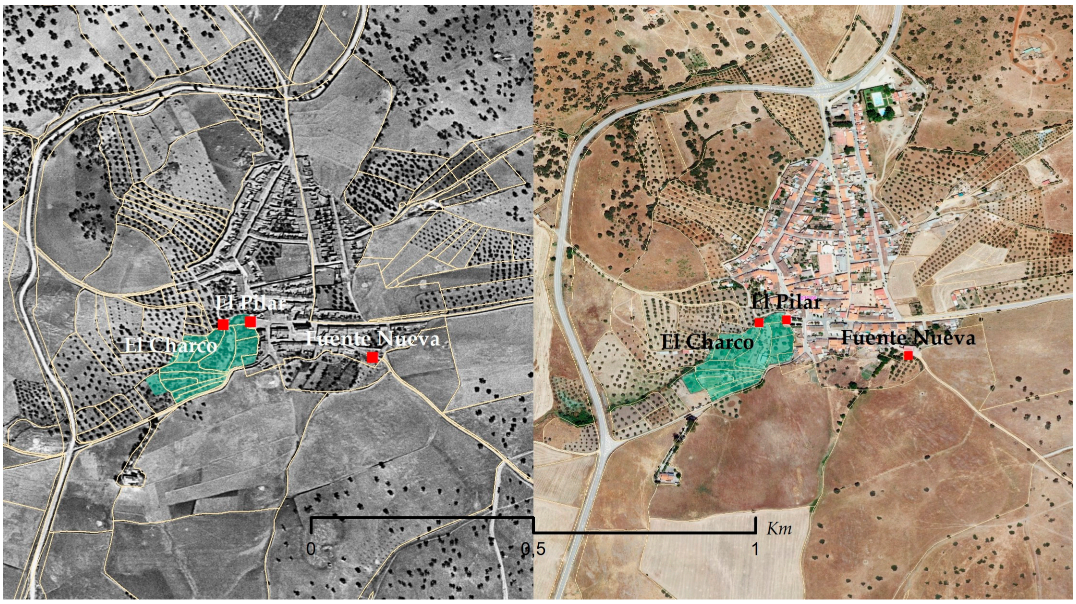

Figure 3. Permanence of the traditional vegetable gardens area between 1945 and today. Graphic made by the authors [58,64].

At the start of the research, the key factors were not identified for the successful implementation of the HIS with the particular conditions described. At the end of the process, two key complementary aspects can be highlighted, coinciding with [41], ([65] pp. 20–30): on one hand, the methodological and technical development for obtaining, adapting, handling, and presenting the data; on the other, the definition and formalization of user needs. In relation to the first, it was not the object of this research to produce the entry data for the elements of "La Cultura del Agua". A thorough search was carried out without much success, which can be considered as having provided an opportunity for the technicians centering their efforts on carrying out a metric and thematic survey, which they would immediately enter into the system. In relation to the second, the user requirements in this article have been centered on having cartography and some factsheets available that bring together and organize the existing information about the case study. Due to limitations of time and other resources, the linking of the HIS to an online platform where the results can be published has not been completed. However, the technology employed means that in a later phase, the HIS can be transferred to a Web–GIS architecture with minimal administrative effort.

6. Conclusions

The main findings are listed below:

- Interdisciplinarity and functionalities of the HIS. The themes dealt with in the design of the HIS (architectural, environmental, cultural, social) has made interdisciplinarity possible as well as exchange between very diverse forms of knowledge (studies, online projects, scientific articles, guidelines). Similar objectives to that of this research were identified, which marked the selection of functionalities in the HIS. These can be grouped together using the following descriptors: inventory and documentation objectives (related to improving and facilitating the work of the different agents; fomenting scientific and technical investigation; collecting, storing, and codifying the heritage properties); dissemination objectives (to encourage and stimulate the use of these contents as an educational resource and source of information for society, fomenting interaction and access on the part of agents who are not specialized in heritage); and awareness objectives (to increase knowledge of heritage and awareness of the importance of protecting it).
- Different scales of approximation for the understanding of heritage: The creation and uploading of spatial data has made the visualization of each element of "La Cultura del Agua" possible at different scales, according to the area of analysis. This has made it possible to establish ties with other scales of the territory and, then to draw up a global analysis that makes it possible to move toward a macroscale. In this way, the possibility arises of characterizing a broader territory, at the same time as diachrony or a time reference is incorporated (the study of the genesis and the evolution of landscapes, as in the evolution of building techniques.
- Interoperability between managed formats allows for an extendable system: The data presented reflects perfect interoperability between the different information sources, producing valid and appropriate results after the application of various cartographical processes and procedures.
- Opportunity to contribute to integrated knowledge: Traditionally, GIS applications that tackle questions of heritage have involved themselves in other areas of knowledge such as archaeology, town planning, and environmental sciences. The HIS has contributed to the knowledge that stems from the geographic–cultural sphere of the project. The possibility of consulting these auxiliary cartographic elements (irrigation canals, vegetable gardens, etc.) that have been incorporated from written descriptions, field trips, working with photographs from the area, and collaboration with the disciplines of anthropology and agro-ecology has increased the understanding of this hydraulic ensemble and the productive landscape. Its graphic versatility and visual potential as well as its potential for dissemination, gives an added value to traditional systems of analysis and decision-making in the field of heritage. Related to this, we have added new fields to the system containing specific thematic information that has not been previously considered in the area (such as local knowledge, the evolution of ground use in the plots studied, functional types, closeness to areas of environmental protection, distances from historic centers that they served, etc.). With the HIS, the maps have made it possible to know each element and, at the same time, understand them as a single group, which is vital for this type of architecture that forms part of a greater, more extensive system, used for the control and exploitation of a particular territory. The designed factsheets have provided information related to history, landscape, ethnology, and technology, among other areas of knowledge to be collected in the thematic field.

- Future lines of research: A smaller scale strategy is required that deals with the lack of protection tools and the high level of empiricism that exists in the processes of documentation. The inclusion of the tool that has been designed—called HIS in this study—in the generation of heritage knowledge, planning, and management has resulted in it being given value in greater visibility of the programmed actions, in the reactivation of these cultural elements, in social participation, and in its harmony with the territory in which it is inserted. These actions would achieve sustainable development in terms of effectiveness. The systems of monuments (all publicly managed) are good recorders of heritage elements that have official protection. However, there are various reasons why the systems are not flexible. The enormous quantity of records in too wide a territorial framework detracts from the flexibility of information processing and does not allow for the in depth investigation of many areas of interest. On the other hand, incomplete or badly thought out design of the information fields can sometimes lead to failed queries, as they do not meet the needs of users who are different from those who usually make use of them. Another problem is that the system takes a long time to be built and is subjected to changes in government and changes in interests, so the continuity of its use cannot be guaranteed or the updating of its data. Privately started systems, in contrast, appear spontaneously or are connected to a local interest and are often one of the best ways to make the first steps in discovering a property with official protection. In addition, for local government at a basic level, a HIS could be a good way to begin a heritage reactivation project when there is not much support from the main administrative body. Normally, they are very easy to manage, but there is not a complex or well-defined strategy. For their part, specific digital inventories for heritage research are not generally easily accessible. This article supposes an improvement, by making public European recommendations and scientific studies of methodologies that have been verified and by implementing these studies in a real case of heritage that needed a helping hand to find new life.

Author Contributions: The main idea of this paper was proposed by V.D.-R. The editing process was carried out by J.R.-P. The three authors collaborated to produce this paper contributed to the data analysis and the writing of the final manuscript. Funding acquisition, V.D.-R. All the authors read and approved the final manuscript.

Funding: This research was funded by Programa Estatal de Investigación, Desarrollo e Innovación Orientada a los Retos de la Sociedad, Spain, of the 2016 RDI Project Call (Convocatoria 2016 de Proyectos de I+D+I) grant number HAR2016-78113-R and The APC was funded by the Research Group TEP-130 of PAIDI. In addition, the English revision and edition of this text was funded through the Research Group TEP-130 of PAIDI and the Internationalization Grant by the Instituto Universitario de Arquitectura y Ciencias de la Construcción in the framework of the Sixth Research and Transfer Plan of the Universidad de Sevilla.

Acknowledgments: We would like to thank the students of the University of Seville, who have deepened our knowledge by means of academic projects on the cultural heritage of Valverde de Burguillos, on its urban and construction characterization in the traditional small village at the center of the municipality; experimenting with BIM, GIS, and TIC information models for heritage management; or reflecting on the immaterial values associated with the collective memory of this place. In addition, we would like to highlight the valuable contribution of the head of the research group *SEJ377: Cultura, Ecología y Desarrollo de Pequeños Territorios,* as an advisor to and active researcher in these projects.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Corneliussen, H.G.; Herman, C.; Gajjala, R. ICT changes everything! But who changes ICT? In *IFIP Advances in Information and Communication Technology, Proceedings of the 13th IFIP TC 9 International Conference on Human Choice and Computers, HCC 2018 Held at the 24th IFIP World Computer Congress, WCC 2018, Poznan, Poland, 19–21 September 2018*; Kimppa, K., Ess, C., Leenen, L., Kreps, D., Eds.; Springer: New York, NY, USA, 2018; Volume 537, pp. 250–257, doi:10.1007/978-3-319-99605-9_18.
2. Häyrinen-Alestalo, M. Is knowledge-based society a relevant strategy for civil society? *Curr. Sociol.* **2001**, *49*, 203–218, doi:10.1177/0011392101049004011.

3. Pinto Puerto, F. TUTSOSMOD Project. Tutela Sostenible del Patrimonio Cultural a Través de Modelos Digitales BIM y SIG. Contribución al Conocimiento e Innovación Social (ref. HAR2016-78113-R). 2019. Available online: http://grupo.us.es/tutsosmodhum/?page_id=79 (accessed on 30 September 2019).
4. Veldpaus, L.; Roders, A.P. Learning from a legacy: Venice to Valletta. *Chang. Over Time* **2014**, *4*, 244–263, doi:10.1353/cot.2014.0022.
5. Pereira Roders, A.; van Oers, R. Bridging cultural heritage and sustainable development. *J. Cult. Herit. Manag. Sustain. Dev.* **2011**, *1*, 5–14, doi:10.1108/20441261111129898.
6. Rey-Pérez, J. Del patrimonio como objeto arquitectónico hacia la patrimonialización del paisaje: Un recorrido por las Cartas y Textos internacionales del Patrimonio Cultural. *ESTOA. Revista de la Facultad de arquitectura y Urbanismo de la Universidad de Cuenca* **2017**, *6*, 33–46, doi:10.18537/est.v006.n010.04.
7. Bindé, J. *Towards Knowledge Societies: UNESCO World Report*; UNESCO Publishing: Paris, France, 2005. Available online: https://unesdoc.unesco.org/ark:/48223/pf0000141843 (accessed on 30 September 2019).
8. Sharma, R.S.; Samuel, E.M.; Ng, E.W. Beyond the digital divide: Policy analysis for knowledge societies. *J. Knowl. Manag.* **2009**, *13*, 373–386, doi:10.1108/13673270910988178.
9. Torres, J.C.; López, L.; Romo, C.; Soler, F. An Information System to Analize Cultural Heritage Information. In *Progress in Cultural Heritage Preservation. EuroMed 2012. Lecture Notes in Computer Science*; Ioannides, M., Fritsch, D., Leissner, J., Davies, R., Remondino, F., Caffo, R., Eds.; Springer: Berlin/Heidelberg, Germany, 2012; Volume 7616, pp. 809–816, doi:10.1007/978-3-642-34234-9_86.
10. Pinto Puerto, F.S. La tutela sostenible del patrimonio cultural a través de modelos digitales BIM y SIG como contribución al conocimiento e innovación social. *PH: Boletín del Instituto Andaluz del Patrimonio Histórico* **2009**, *93*, 27–29, doi:10.33349/2018.0.4125.
11. Biehl, M. Success factors for implementing global information systems. *Commun. ACM* **2007**, *50*, 52–58, doi:10.1145/1188913.1188917.
12. Oxoli, D.; Cannata, M.; Terza, V.; Brovelli, M.A. Natural heritage management and promotion through free and open source software: A preliminary system design for the Insubriparks Project. In *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, XLII-4/W14, Proceedings of the FOSS4G 2019, Bucharest, Romania, 26–30 August 2019*; ISPRS: Sydney, Australia, 2019; pp. 179–183, doi:10.5194/isprs-archives-XLII-4-W14-179-2019.
13. Han, J.; Wu, F.; Tian, M.; Li, W. From Geopark to Sustainable Development: Heritage Conservation and Geotourism Promotion in the Huangshan UNESCO Global Geopark. *Geoheritage* **2018**, *10*, 79–91, doi:10.1007/s12371-017-0227-2.
14. Statuto, D.; Cillis, G.; Picuno, P. GIS-based Analysis of Temporal Evolution of Rural Landscape: A Case Study in Southern Italy. *Nat. Resour. Res.* **2019**, *28* (Suppl. 1), 61–75, doi:10.1007/s11053-018-9402-7.
15. Siguencia Avila, M.E.; Rey Pérez, J. Heritage values protection, from the monument to the urban dimension. Case study: The historic centre of Santa Ana de los Ríos de Cuenca, Ecuador. *Hist. Environ. Policy Pract.* **2016**, *7*, 164–176, doi:10.1080/17567505.2016.1172785.
16. Cassatella, C.; Carlone, G. GIS-based visual analysis for planning and designing historic urban landscapes. In *Digital Heritage, Proceedings of the 2013 Digital Heritage International Congress, Marseille, France, 28 October – 1 November 2019*; IEEE/Institute of Electrical and Electronics Engineers: Danvers, MA, USA, 2013; Volume 2, pp. 45–52. Available online: http://porto.polito.it/2519009/ (accessed on 30 December 2019).
17. García-Hernández, M.; Calle-Vaquero, M.; Yubero, C. Cultural Heritage and Urban Tourism: Historic City Centres under Pressure. *Sustainability* **2017**, *9*, 1346, doi:10.3390/su9081346.
18. The DigiCULT Report. Available online: https://www.digicult.info/downloads/html/6/6.html (accessed on 30 December 2019).
19. PH: Boletín del Instituto Andaluz del Patrimonio Histórico 2003. Special issue on Heritage and ITCs. Available online: http://www.iaph.es/revistaph/index.php/revistaph/issue/view/45 (accessed on 15 June 2019).
20. Colorado Castellary, A. Nuevos lenguajes para la difusión del patrimonio cultural. *PH: Boletín del Instituto Andaluz del Patrimonio Histórico* **2003**, *46*, 42–48, doi:10.33349/2003.46.1628.
21. Uriarte González, A.; Parcero Oubiña, C.; Fraguas Bravo, A.; Álvarez, F.; Vicent García, J.M.; Pérez Asensio, E.; Fernández Freire, C.; de Bosque González, I.; Verhagen, P.; Earl, G. Cultural Heritage Application Schema: A SDI Framework within the Protected Sites INSPIRE Spatial Data Theme. In *Archaeology in the Digital Era, Proceedings of the 40th Annual Conference of Computer Applications and Quantitative Methods in*

Archaeology (CAA), Southampton, England, 26–29 March 2012; Philip, V., Graeme, E., Eds.; Amsterdam University Press: Amsterdam, The Netherlands, 2014; pp. 279–290, doi:10.1515/9789048519590-030.

22. Colorado Castellary, A. Perspectivas de la cultura digital. *Zer: Revista de Estudios de Comunicación* **2010**, *15*, 103–115.
23. Ferreira Lopes, P. Achieving the state of research pertaining to gis applications for cultural heritage by a systematic literature review. *Int. Arch. Photogramm. Remote Sens. Spat. Inf. Sci.* **2018**, *42*, 169–175, doi:10.5194/isprs-archives-XLII-4-169-2018.
24. Riveiro, B.; Arias, P.; Armesto, J.; Ordóñez, C. A Methodology for the Inventory of Historical Infrastructures: Documentation, Current State, and Influencing Factors. *Int. J. Archit. Herit.* **2011**, *5*, 629–646, doi:10.1080/15583051003792880.
25. Dore, C.; Murphy, M. Integration of Historic Building Information Modeling (HBIM) and 3D GIS for recording and managing cultural heritage sites. In Proceedings of the 2012 18th International Conference on Virtual Systems and Multimedia, Milan, Italy, 2–5 September 2012; pp. 369–376, doi:10.1109/VSMM.2012.6365947.
26. Miele, F. La conservazione della memoria materiale e immateriale. Sistemi informativi di catalogo e territoriali in Campania. *Archeologia e Calcolatori* **2011**, *22*, 7–34. Available online: http://www.archcalc.cnr.it//indice/PDF22/AC_22_Miele.pdf (accessed on 15 June 2019).
27. Koroso Arriaga, I.; Muñoz Lozano, O. 12 años de registro digital de datos arqueológicos en la catedral de Santa María de Vitoria-Gasteiz (1997–2009). *Cuadernos de Prehistoria y Arqueología de la Universidad de Granada* **2010**, *20*, 163–176. Available online: https://revistaseug.ugr.es/index.php/cpag/article/view/130/115 (accessed on 15 June 2019).
28. Franco, D.; Franco, D.; Mannino, I.; Zanetto, G. The impact of agroforestry networks on scenic beauty estimation: The role of a landscape ecological network on a socio-cultural process. *Landsc. Urban Plan.* **2003**, *62*, 119–138, doi:10.1016/ S0169-2046(02)00127-5..
29. Wang TAO. Interdisciplinary urban GIS for smart cities: Advancements and opportunities. *Geo-Sp. Inf. Sci.* **2013**, *16*, 25–34, doi:10.1080/10095020.2013.774108.
30. Vermont Center for Geographic Information. Available online: https://vcgi.vermont.gov/maps (accessed on 2 January 2020).
31. Fusco Girard, L.; De Toro, P. Integrated spatial assessment: A multicriteria approach to sustainable development of cultural and environmental heritage in San Marco dei Cavoti, Italy. *Cent. Eur. J. Oper. Res.* **2007**, *15*, 281–299, doi:10.1007/s10100-007-0031-1.
32. Ruoss, E.; Alfare, L.; Vallone, R.; Moscatelli, M.; Zumaglini, M.; Grünner, R.; Klementschitz, R. *Sustainable Tourism as Driving Force for Cultural Heritage Sites Development. Planning, Managing and Monitoring Cultural Heritage Sites in South East Europe*; Cherplan: EU, South East Europe, 2013.
33. Pinto Puerto, F.S.; Castellano Román, M.; Ortiz Calderón, M.P.; Cano Díaz, E. Technoheritage: Ciencia, tecnología y empresa al servicio del patrimonio cultural. *PH: Boletín del Instituto Andaluz del Patrimonio Histórico* **2019**, *96*, 2–3, doi:10.33349/2019.96.4254.
34. Fernández-Freire, C.; Del Bosque González, I.; Vicent, J.; Pérez Asensio, E.; Fraguas-Bravo, A.; González, A.; Fábrega-Álvarez, P.; Parcero-Oubiña, C. A Cultural Heritage Application Schema: Achieving Interoperability of Cultural Heritage Data in INSPIRE. *Int. J. Spat. Data Infrastr. Res.* **2013**, *8*, 74–97, doi:10.2902/1725-0463.2013.08.art4.
35. UNESCO. Recommendation on the Historic Urban Landscape, Including a Glossary of Definitions. 2011. Available online: http://portal.unesco.org/en/ev.php-URL_ID=48857&URL_DO=DO_TOPIC&URL_SECTION=201.html (accessed on 23 April 2019).
36. Rey-Pérez, J.; Siguencia Ávila, M.E. Historic urban landscape: An approach for sustainable management in Cuenca (Ecuador). *J. Cult. Herit. Manag. Sustain. Dev.* **2017**, *7*, 308–327, doi:10.1108/JCHMSD-12-2016-0064.
37. Rey-Pérez, J.; González Martínez, P. Lights and shadows over the Recommendation on the Historic Urban Landscape: 'managing change' in Ballarat and Cuenca through a radical approach focused on values and authenticity. *Int. J. Herit. Stud.* **2018**, *24*, 101–116. doi:10.1080/13527258.2017.1362572.
38. Nedović-Budić, Z.; Pinto, J.K. Interorganizational GIS: Issues and prospects. *Ann. Reg. Sci.* **1999**, *33*, 183–195, doi:10.1007/s001680050100.
39. Humanes, A. La necesidad de un plan para el Patrimonio Industrial. *Bienes culturales: Revista del Instituto del Patrimonio Histórico Español* **2007**, *7*, 43–49.

40. Ulied, A.; Biosca, O.; Rodrigo, R. *Urban and Rural Narratives and Spatial Development Trends in Europe: The State of the Question*; Mcrit: Barcelona, Spain, 2010; pp. 92–95.
41. Tulla, A.F. Los sistemas de información geográfica de ámbito local en las áreas rurales. *Documents d'anàlisi geogràfica* **1993**, *23*, 111–127.
42. Boers, B.; Cottrell, S. Sustainable Tourism Infrastructure Planning: A GIS-Supported Approach. *Tour. Geogr.* **2007**, *9*, 1–21, doi:10.1080/14616680601092824.
43. Chang, G.; Caneday, L. Web-based GIS in tourism information search: Perceptions, tasks, and trip attributes. *Tour. Manag.* **2011**, *32*, 1435–1437, doi:10.1016/j.tourman.2011.01.006.
44. Azkarate, A.; Barreiro, D.; Criado, F.; García Camino, I.; Gutiérrez Lloret, S.; Quirós, J.A.; Salvatierra, V. La Arqueología hoy. In *Medio siglo de arqueología en el Cantábrico Oriental y su Entorno, Proceedings of the Congreso Internacional Medio siglo de Arqueología en el Cantábrico Oriental y su entorno, Vitoria-Gasteiz, Spain, 27–30 November 2007*; A. Llanos Ortiz de Landaluze, Coord.; Instituto Alavés de Arqueología and Diputación foral de Álava: Vitoria-Gasteiz, Spain, 2009; pp. 599–615.
45. Trees, K.; Turk, A. Community, Participation and Cultural Heritage: The Ieramugadu Cultural Heritage Information System (ICIS). *Crit. Arts* **1998**, *12*, 78–91, doi:10.1080/02560049885310061.
46. Council of Europe Conference of Ministers responsible for Spatial/Regional Planning (CEMAT). Guía Europea de Observación del Patrimonio Rural–CEMAT (CEMAT-CHF 80 (2003) 19). Budapest (Hungary) on 28 March 2003. Available online: https://www.mapa.gob.es/es/desarrollo-rural/planes-y-estrategias/desarrollo-territorial/09047122800071c4_tcm30-421564.pdf (accessed on 15 June 2019).
47. World Rural Landscapes Classification. Available online: http://www.worldrurallandscapes.org/home/wrl-results/atlas-and-rl-classification/ (accessed on 10 October 2019).
48. ICOMOS. ICOMOS-IFLA Principles Concerning Rural Landscapes as Heritage. 2017. pp. 1–7. Available online: https://www.icomos.org/images/DOCUMENTS/General_Assemblies/19th_Delhi_2017/Working_Documents-First_Batch-August_2017/GA2017_6-3-1_RuralLandscapesPrinciples_EN_final20170730.pdf (accessed on 5 June 2020).
49. España, Ley 14/2007, de 26 de noviembre, del Patrimonio Histórico de Andalucía. Boletín Oficial del Estado, núm. 38, de 13 de febrero de 2008. Referencia BOE-A-2008-2494. 2007. Available online: https://www.boe.es/buscar/pdf/2008/BOE-A-2008-2494-consolidado.pdf (accessed on 2 March 2019).
50. The International Committee for the Conservation of the Industrial Heritage (TICCIH). The Nizhny Tagil Charter for the Industrial Heritage; In Proceedings of the TICCIH XII International Congress, Moscow, Russia, 17 July 2003. Available online: https://www.icomos.org/18thapril/2006/nizhny-tagil-charter-e.pdf (accessed on 15 January 2017).
51. España, Ley 2/1999, de 29 de marzo, de Patrimonio Histórico y Cultural de Extremadura. Boletín Oficial del Estado, núm. 139, de 11 de junio de 1999. Referencia BOE-A-1999-13022. 1999. Available online: https://www.boe.es/buscar/pdf/1999/BOE-A-1999-13022-consolidado.pdf (accessed on 2 March 2019).
52. Río Bodión Community. Office of Urban Management, Housing, Architecture and Territory. Municipal Masterplan Valverde de Burguillos "Documento de Avance Memoria Informativa. pp. 62–63. Available online: http://extremambiente.juntaex.es/files/Memoria%20Informativa%20PGM%20Valverde%20de%20Burguillos.pdf (accessed on 2 March 2019).
53. Resolution of 22 March, of Regional Ministry of Culture and Equality Initiating a New File, for the Declaration of Property of Cultural Interest Regarding "La Cultura del Agua" in Valverde de Burguillos, in the Category of Properties of Ethnological Interest. Available online: https://www.boe.es/diario_boe/txt.php?id=BOE-A-2019-9510 (accessed on 2 July 2018).
54. Ministry of Culture and Sport, Government of Spain. General Administration of Fine Arts and Cultural Assets. Available online: http://www.culturaydeporte.gob.es/bienes/cargarFiltroBienesInmuebles.do;jsessionid=67AEB77C67D84052B11A0C67%203519351949E?layout=bienesInmuebles&cache=init&language=es (accessed on 20 May 2019).
55. Centro de Descargas. Sistema de Información Territorial de Extremadura SITEX. Available online: http://sitex.gobex.es/SITEX/centrodescargas (accessed on 23 April 2018).

56. Centro de Descargas. Centro Nacional de Información Geográfica. Available online: http://centrodedescargas.cnig.es/CentroDescargas/index.jsp (accessed on 23 April 2018).
57. Sede Electrónica del Catastro. Available online: https://www1.sedecatastro.gob.es/ (accessed on 23 April 2018).
58. WMS Ortofoto PNOA del Instituto Geográfico Nacional. Available online: http://www.juntadeandalucia.es/medioambiente/site/rediam/menuitem.04dc44281e5d53cf8ca78ca731525ea0/?vgnextoid=2d0c5997c8de5410VgnVCM2000000624e50aRCRD&vgnextchannel=867122ad8470f210VgnVCM1000001325e50aRCRD&vgnextfmt=rediam&lr=lang_en (accessed on 23 April 2018).
59. Raveaux, R.; Burie, J.C.; Ogier, J.M. A Colour Document Interpretation: Application to Ancient Cadastral Maps. In Proceedings of the Name of the Ninth International Conference on Document Analysis and Recognition, Parana, Brazil, 23–26 September 2007, doi:10.1109/ICDAR.2007.4377091.
60. Summerby-Murray, R. Analysing Heritage Landscapes with Historical GIS: Contributions from problem-based inquiry and constructivist pedagogy. *J. Geogr. High. Educ.* **2001**, *25*, 37–52, doi:10.1080/03098260020026624.
61. CIDOC: Conceptual Reference Model, Version 6.2.7. Available online: http://www.cidoc-crm.org/sites/default/files/2018-10-26%23CIDOC%20CRM_v6.2.4_esIP.pdf (accessed on 10 June 2019).
62. Babette Wehrmann, B.; Glavina, J. *Geographic Information Systems (GIS)-The Spatial Dimension to Developmen Cooperation*; GTZ, Federal Ministry for Economic Cooperation and Development: Eschborn, Germany, 2009.
63. Sistema Geográfico Nacional de Parcelas Agrícolas SIGPAC. Available online: http://sigpac.mapama.gob.es/fega/visor (accessed on 23 April 2018).
64. Ortofotografía del vuelo americano de 1945 Serie A 1m. Hojas 853, 854, 875, 876. Centro de Información Cartográfica y Territorial de Extremadura (CICTEX). Available online: http://sitex.gobex.es/SITEX/centrodescargas/viewsubcategoria/43 (accessed on 23 April 2018).
65. Gallardo, J.A. *Apuntes para la Historia de Valverde de Burguillos*; Diputación de Badajoz: Badajoz, Spain, 2014.
66. I Taller de Iniciativas Vernáculas. *Patrimonio y Sostenibilidad Para Una Nueva Ruralidad*; Domínguez-Ruiz, V., Rivero-Lamela, G., Eds.; III Plan Propio de Docencia de la Universidad de Sevilla: Sevilla, Spain, 2018.
67. Sesma Álvarez, T. Aplicación de las Nuevas Tecnologías al Patrimonio Rural Construido. Análisis del Estado Actual y Propuesta de uso del "Molino del Najarrillo" Valverde de Burguillos, Badajoz. Master's Thesis, University of Seville, Spain, 4 February 2018.
68. Domínguez-Ruiz, V.; Rivero-Lamela, G. I Taller de Iniciativas Vernáculas. patrimonio y sostenibilidad para una nueva ruralidad. *Crónica del Bodión* **2018**, *1*, 19.
69. Blasco Martín, E. Situación Actual y Potencial del Desarrollo Agroecológico del río Bodión Para Valverde de Burguillos (Badajoz). Master's Thesis, University of Seville, Spain, 10 December 2017.