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Open Source Tools, Landscape and Cartography: Studies on the Cultural Heritage at a Territorial Scale

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Additional information is available at the end of the chapter

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1. Introduction

The Task Group 2 “Open Source in use for the cultural heritage communication process” [1] is hosted by CIPA, the International Committee for Architectural Photogrammetry, one of the international committees of ICOMOS (International Council on Monuments and Sites). The main targets of the Task Group are related to the study and dissemination of the Cultural Heritage, considered from a wide perspective according to UNESCO’s definition [2], and the current EU legal framework.

This scope includes “the entire corpus of material signs –either artistic or symbolic- handed on by the past to each culture and, therefore, to the whole of humankind” [3]. Thus, Cultural Heritage consists of more than *monuments* (architectural works, sculpture and painting elements, archaeological structures, ancient books, manuscripts, maps and charts), but of *groups of buildings* (historical towns, industrial heritage, historical infrastructures), and *sites* (cultural landscapes, natural values). Physical artifacts and intangible attributes inherited from past generations must be maintained for the future generations, and accordingly, their knowledge must be widely disseminated.

Due to the different particular types of cultural objects, different approaches, tools and techniques must be developed to get an accurate knowledge of them. Aspects and disciplines concomitant with the preservation and conservation of tangible and intangible culture include archival science, art and architectural conservation, audio recording, digital data collection, storage and management, and architectural, urban and landscape drawing, among others. From a multidisciplinary approach, the Task Group 2 aims to develop an intensive promotion of Open Source software as free alternate tools for all researches on Cultural Heritage, which are useful in every stage involved in the processes of knowledge, documentation, management, and dissemination of cultural heritage.

In a first epoch the Task Group 2 initiative was successfully chaired by Markus Jobst, of Research Group Cartography at Vienna University of Technology (Austria). Currently we are starting a new era chaired by Prof. Pilar Chias, at the University of Alcalá (Spain).

2. Main targets of the task group

Researches on Cultural Heritage have wide connotations related to the characteristics of the cultural objects that are considered, as well as to the particular targets and methodologies that can be applied in each case.

As a first stage, a deep knowledge of the cultural objects is needed, and adequate documentation processes become essential. But depending on the kind of cultural object that is being studied, it is necessary to collect and store a high amount of datasets in various formats, to draw accurate maps and sketches, to take pictures, and to write detailed descriptions (or transcriptions). Thus, useful software for writing, drawing, image manipulation and mapping is needed.

An easy and efficient data recording and archiving, as well as a quick access to all these digital materials become fundamental in the processes of documentation and storage of the cultural heritage. The other aim is to get high quality information from them. The later analysis processes must lay the foundations to propose the right conclusions, and to make the appropriate decisions. In this stage, GIS become a useful tool.

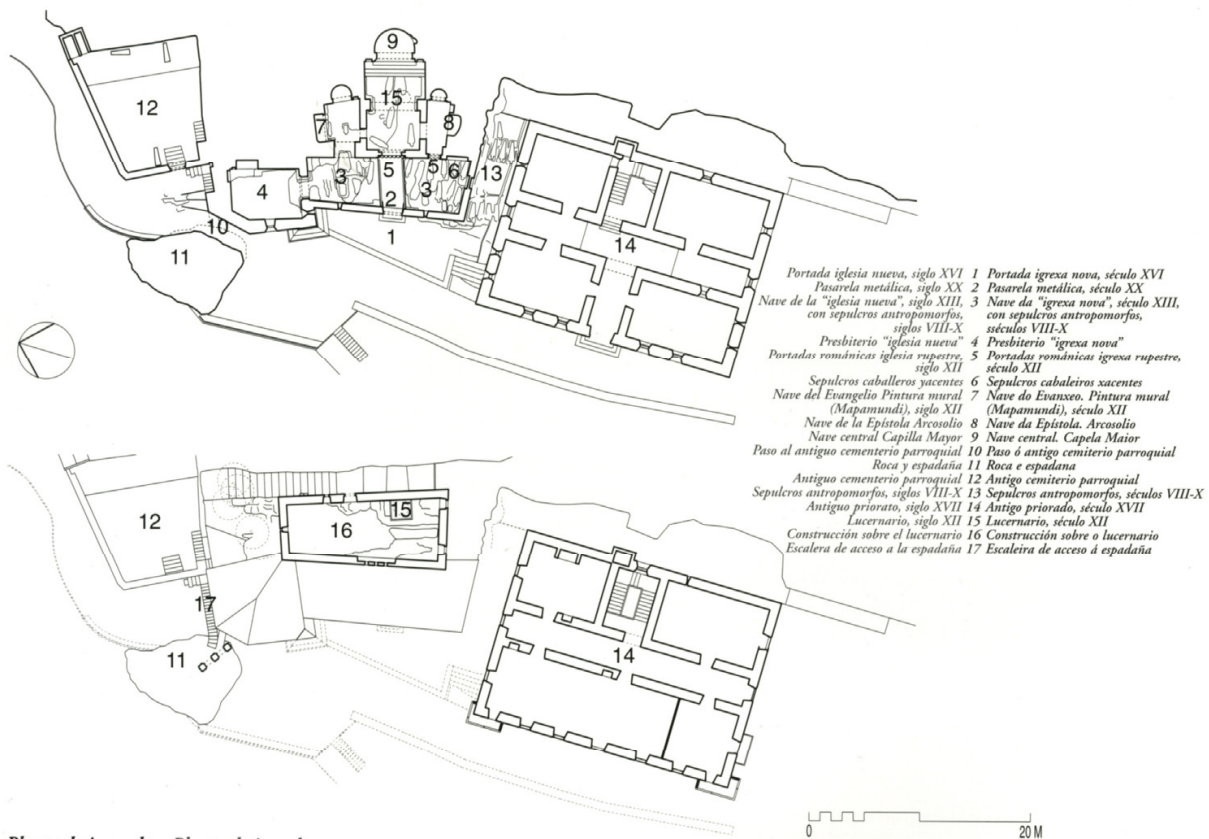
Finally, an efficient prospective plan must include management and preservation actions, as well as wide realist communication and dissemination programmes, including online platforms.

All these tasks and their related activities can be successfully approached and developed by using Open Source software. It provides the necessary office and prepress tools, multimedia and graphic editors (both vector and raster formats), friendly computer aided design (CAD) and 3D modelling software, as well as geographic information systems (GIS) and other publishing products.

According to it, the Task Group's strategies will correspond to two main objectives:

1. Related to the cultural heritage:
 - Improved knowledge and understanding of the cultural heritage, covering the different 'cultural properties' [4].
 - Improved methodologies in order to get a deep knowledge and an accurate documentation of each cultural object, encouraging an integrated interdisciplinary approach.
 - Collaboration between involved research groups and other related initiatives.
 - More effective preservation and management.
2. Related to the Open Source tools to be used to accomplish these targets:
 - Dissemination of Open Source software capabilities in order to fulfill objective no. 1.
 - Greater accessibility to the public via the Task Group web site, but also through courses, conferences and online materials, as well as other cultural actions.
 - Wide offer of academic courses at the Universities involved.

San Pedro de Rocas



Plantas baixa e alta · Plantas baja y alta

A planta baixa recolle a igrexa rupestre do século XII escavada na roca, coa "igrexa nova" románica do século XIII situada diante transversalmente. A dereita, antigo priorato do século XVII.

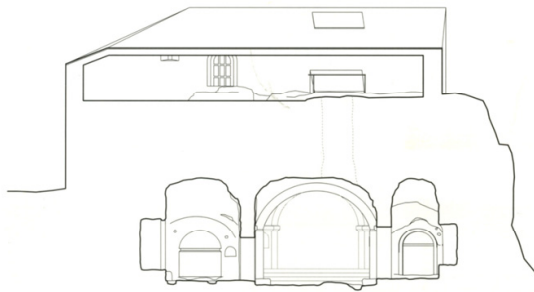
La planta baja recoge la iglesia rupestre del siglo XII excavada en la roca, con la "iglesia nueva" románica del siglo XIII situada delante transversalmente. A la derecha, antiguo priorato del siglo XVII.

Ground and first floor plans: the ground floor plan depicts the 12th century rock church, with the Romanesque 13th century 'new church' which is placed in front and transversely. The old 17th century priory is on the right side of the plans. Legend:

1. New church's 16th century façade.
2. Metallic footbridge, 20th century.
3. Nave of the 'new church', 13th century; with anthropomorphic tombs dated to the 8th-10th centuries.
4. New church's presbytery.
5. Romanesque façades of the rock church, 12th century.
6. Tombs of the recumbent knights.
7. Wall map (world map) in the gospel aisle, 12th century.
8. Epistle aisle's arcosolium.
9. Main chancel in the nave.
10. Access to the old graveyard.
11. Rock and belfry.
12. Old graveyard.
13. Anthropomorphic tombs, 8th-10th centuries.
14. Old priory, 17th century.
15. Skylight, 12th century.
16. Structure over the skylight.
17. Stairs to the belfry.

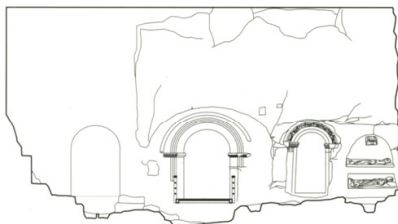
(a)

San Pedro de Rocas



Sección transversal da igrexa rupestre · Sección transversal de la iglesia rupestre

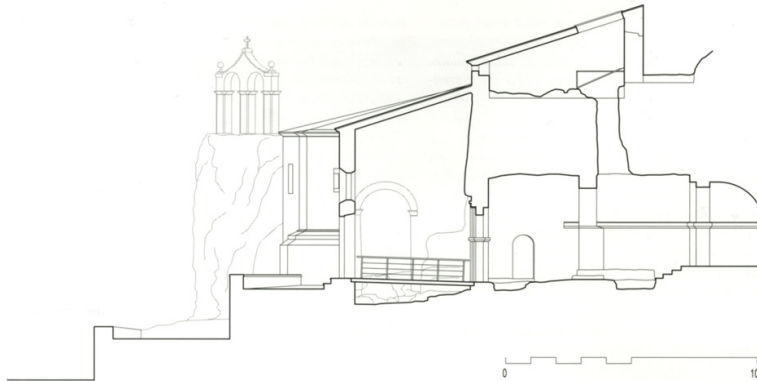
As tres capelas hipoxeas, comunicadas entre si, ventilaban a través dunha claraboia excavada na roca (a trazos), hoxe protexida por unha construción superior. Las tres capillas hipogeeas, comunicadas entre si, ventilaban a través de un lucernario excavado en la roca (a trazos), hoy protegido por una construcción superior.



Sección-alzado da fachada románica · Sección-alzado de la fachada románica

Esta sección lonxitudinal sen a "iglesia nova" mostra a fachada da antiga igrexa rupestre coas dúas portadas románicas do século XII, a central e a da dereita, e o nicho cos sepulcros de dous cabaleiros xacentes.

Esta sección longitudinal sin la "iglesia nueva" muestra la fachada de la antigua iglesia rupestre con las dos portadas románicas del siglo XII, la central y la de la derecha, y el nicho con dos sepulcros de dos caballeros yacentes.



Sección lonxitudinal da igrexa · Sección longitudinal de la iglesia

Nesta sección pode apreciarse á esquerda a espadana sobre a roca, no centro a sección transversal da "iglesia nova" do século XIII coa pasarela metálica de acceso á igrexa rupestre. Encima pode observarse a claraboia superior excavada na roca e a nova construción superior que a protexe.

En esta sección puede apreciarse a la izquierda la espadana sobre la roca, en el centro la sección transversal de la "iglesia nueva" del siglo XIII con la pasarela metálica de acceso a la iglesia rupestre. Encima puede observarse el lucernario superior excavado en la roca y la nueva construcción superior que lo protege.

On top: Cross section of the rock church. The three hypogeal chancels, which are connected, ventilated through a skylight dug in the rock (broken lines) that nowadays is protected by an upper building.

Centre: Cross-elevation of the Romanesque façade. This longitudinal section omitting the 'new church', shows the old rock church with its two 12th century Romanesque façades –the central and the right ones-, and the niche with the tombs of the two recumbent knights.

Below: Longitudinal section of the church. It depicts the bellfry on the rock at the right side; in the middle, the cross section of the 13th century 'new church' can be seen, with the metallic footbridge that leads to the rock church. The old skylight is placed over the rock church, currently protected with a modern upper structure.

(b)

Figure 1. a) Combined techniques in use for subterranean heritage mapping. San Pedro de Rocas, Esgos, Spain (Task Group's Partner: GIRAP Research Team, University of La Coruña, Spain).

b) Combined techniques in use for subterranean heritage mapping. San Pedro de Rocas, Esgos, Spain (Task Group's Partner: GIRAP Research Team, University of La Coruña, Spain).

3. Open Source tools in the methodologies applied to the study of territories and landscapes

Researches on cultural heritage at a territorial scale involve several stages, according to the different methodologies applied in each case. They can be structured into three main groups of tasks: documentation, analysis, and management and dissemination processes.

3.1. Documentation processes

A deep knowledge of the cultural objects requires previous and accurate measurements, reports and drawings.

Measurements of angles, areas, lengths and distances must be managed to some level of quality (in terms of accuracy, availability, usability, and resilience). Apart from the traditional direct measuring methods, datasets and georeferencing can be achieved nowadays by means of several techniques and electronic devices. They can be lately transferred to a computer, and manipulated through CAD or GIS software, or by graphic or sound editors [5].

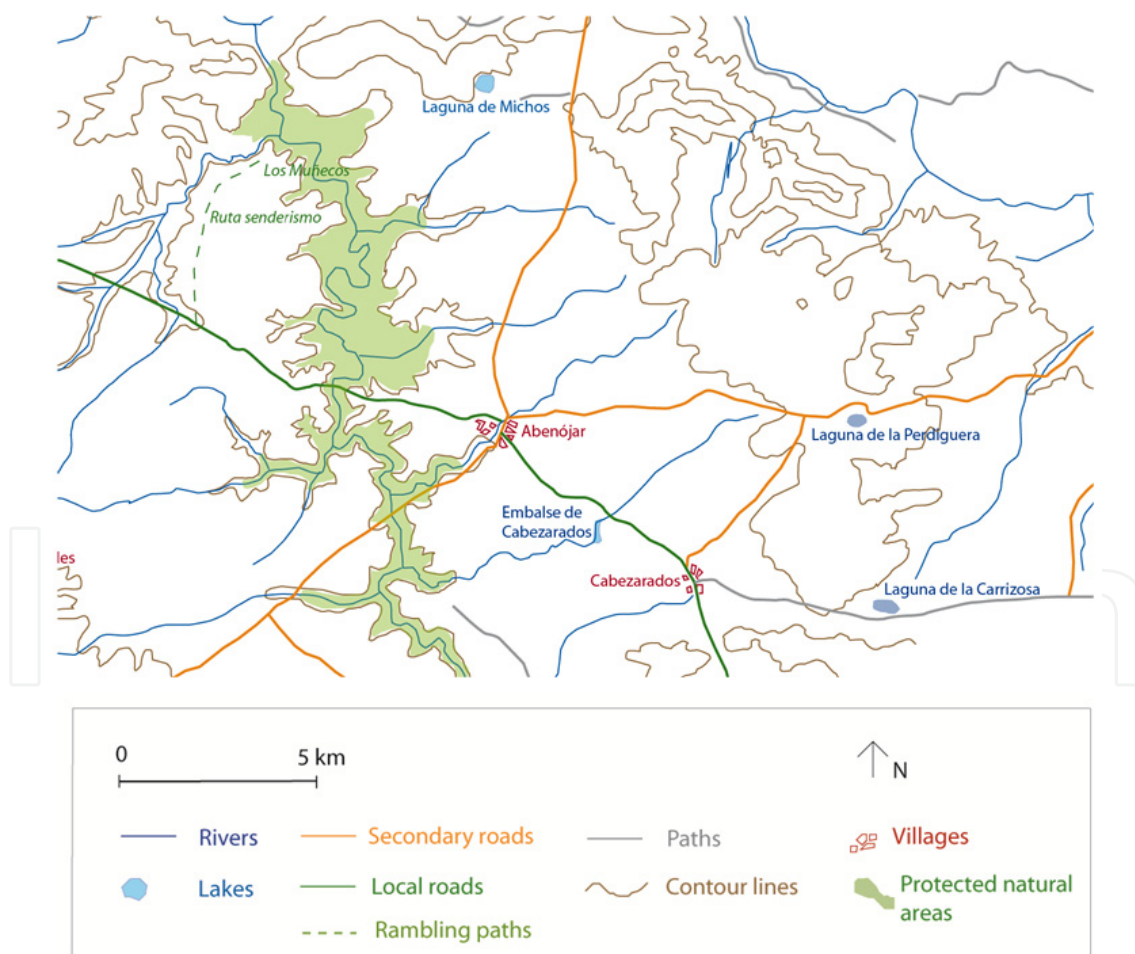


Figure 2. Abenójar, Ciudad Real. Natural resources as an essential part of the Cultural Heritage. Original scale 1:50.000 (Task Group's Partner: Cultural Heritage and sustainable architecture Research Team, University of Alcalá, Spain).

Thus, photogrammetry, angle and distance measuring with distance meters and GPS, or total stations, become useful tools with the adequate standalone or plugin software. Free software as Angle Meter, Distance Meter and GeoDistance provide easy to use tools to collect all these datasets [6].

Afterwards digital maps and plans can be drawn with free vector graphics editing programs as AutoCAD or Inkscape, which can easily integrate the measures and georeferences that were previously collected.

Depending on the type of heritage and the working scale, 2D and 3D designs as well as landscape drawings, can be produced in order to show their main characteristics and features with the required precision.

There are free specific tools for cartography and landscape as Cross GL Draw and Terragen. The first one is a general purpose 2D raster and vector graphics library. As a full featured vector graphics editor, it covers a wide range of utilization domains as business graphics, web graphics, DTP, cartography, printing, user interface graphics, serverside rendering, and many more. It is a useful tool to draw digital cartography and available for Windows platforms.

Terragen is a powerful solution for rendering and animating realistic landscapes and natural environments. It is useful in researches on landscape as a cultural heritage, and works both on Mac OS and Windows operating systems. Ancient maps are useful tools to study the historical features at a territorial scale. They provide interesting information about the history of the territory and the landscape, as they depict their main features, their topologic relationships, and the toponimy [7].



Figure 3. The *Via Augusta* near the Roman colony of *Hasta Regia*, Cádiz. Hypothetical reconstruction by means of aerial photographs (Task Group's Partner: *Cultural Heritage and sustainable architecture Research Team*, University of Alcalá, Spain).

Terrestrial and aerial photographs can also be edited and manipulated with free programs as GIMP, Photoshop, or Image Analyzer, that run on Windows and Mac operating systems. They provide an array of useful features such as bitmap image viewing, management, comparison, resizing, cropping, warping, and colour adjustment.

In terrestrial photogrammetric works GIMP compensates easily perspectives, distortions caused by lens tilt, and eliminates len's *barrel distortion* and vignetting [12].



Figure 5. Accurate drawing of the 16th century façade of the Colegio de San Ildefonso (Alcalá de Henares, Spain), using photogrammetrical techniques (Task Group's Partner: *Cultural Heritage and sustainable architecture Research Team*, University of Alcalá, Spain).

Simultaneously, some researches require to collect other kind of data, which are related to perception. These relevant attributes of the cultural object must be also recorded, stored and drawn. Specific software and techniques are needed for studying some qualities as colour or textures [13], and there is also free image and photo open source software available to do it, as Photoshop and GIMPShop.

When tools for live video and sound recording are needed, Adapter free video and audio converter, and the audio editor Audacity, become useful free tools for studying soundscapes.

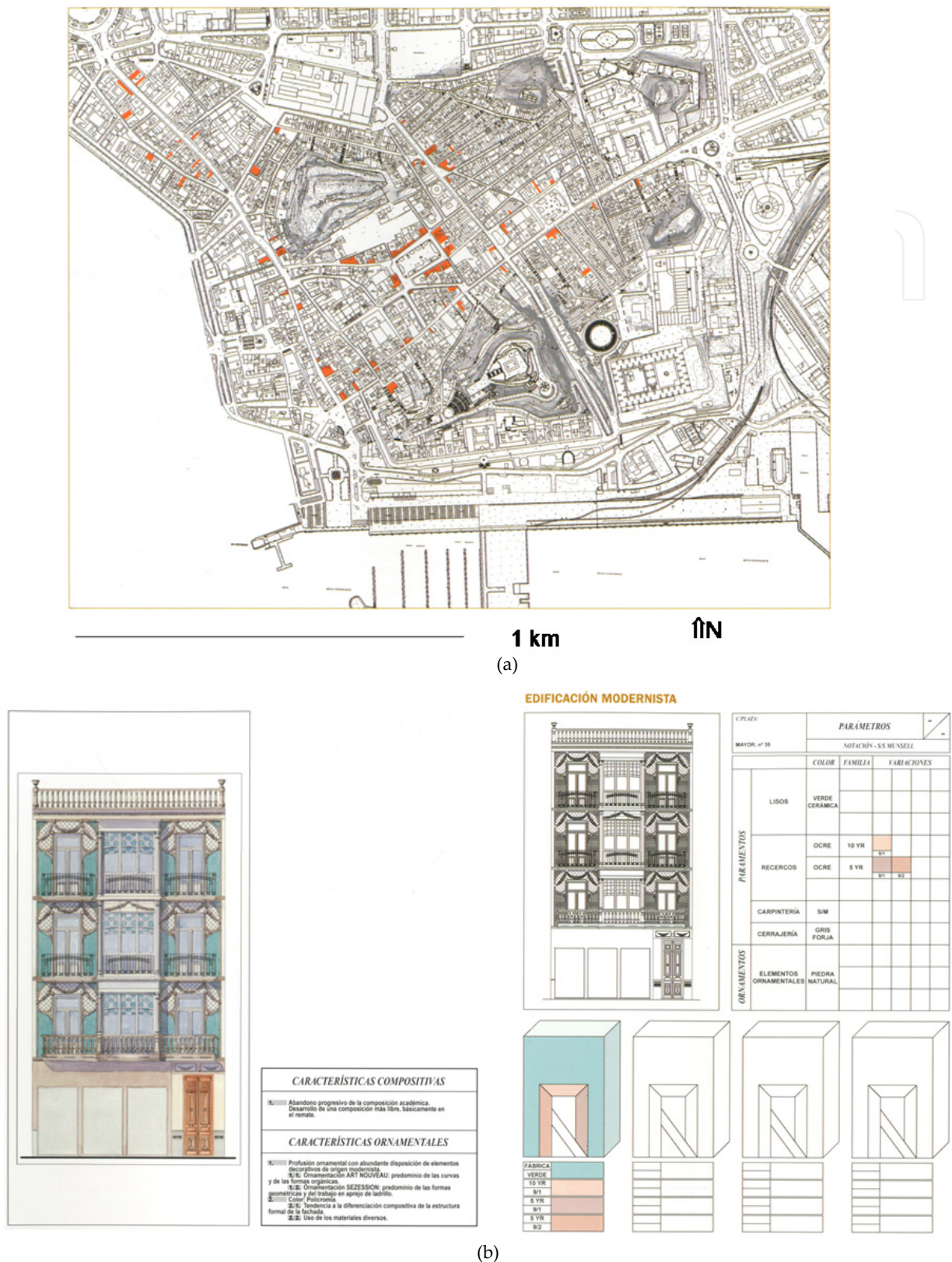


Figure 6. a) Plan of Cartagena, Murcia (Spain). Study of Cartagena's urban landscape colours (Task Group's Partner: *Cultural Heritage's Colour Research Team*, University of Valencia, Spain). In orange: Case studies in the city centre. b) Study of Cartagena urban landscape colours (Task Group's Partner: *Cultural Heritage's Colour Research Team*, University of Valencia, Spain).

Legend (right drawing):

Structuring features
1. Continuous abandonment of the academic traditional arrangement. Development of a free composition, particularly on ornamental tops.
Ornamental features
1. Wealth of details, mainly Modernist. 1.1 ART NOUVEAU adornment: curves and organic shapes prevail. 1.2 SEZESSION adornment: geometric shapes and brick bonding prevail.
2. Colour: polychromatic. 2.1 Tendency to distinguish the features in the structure of the façade. 2.2 Use of diverse materials.

Legend (left drawing):

Modernist building

Street / Square Mayor, no. 35	Parameters	-
	<i>S/S Munsell Notation</i>	

		<i>Colour</i>	<i>Family</i>	<i>Variations</i>			
Faces	Plain	Ceramic Green					
	Frames	Ochre	10 YR	9/1			
		Ochre	5 YR	9/1	9/2		
	Carpentry	S/M					
	Locksmith's Craft	Grey Forge					
	Ornamental Elements	Natural Stone					

All these multiformat datasets previously collected are organized and stored in databases, that imply the use of general-purpose database management system.

As we have seen, databases related to Cultural Heritage involve multimedia contents, that must be processed, stored and disseminated. And there are some interesting and useful free multiformat databases (DBDesigner, Firebird, MySQL, OpenOffice.org BASE) that integrate database design, modeling, creation, and maintenance into a single, seamless environment. Some enable users to meet the database challenges of next generation web, cloud, and communications services with uncompromising scalability, uptime and agility. They are mainly developed for Windows, Unix and Linux.



Figure 7. Texture and colour data of the façade of San Juan de Letran; example of compensated distortions of a photograph (Task Group's Partner: *DAVAP Research Team*, University of Valladolid, Spain).

3.2. Analysis processes

Researches on cultural heritage use to create 3D models, renderings and animations in order to explain and analyze its formal features and qualities, and recreate virtual walks around and inside the object that is being studied.



Figure 8. 3D Modell of Paestum, Italy (Task Group's Partner: *DAVAP Research Team*, University of Valladolid, Spain).

There are also free multiplatform tools available to achieve these targets as 3D Studio Max, Blender, Open FX and SketchUp, which provide powerful, integrated 3D modelling, animation, rendering, and compositing tools. Some include full renderer and raytracing engines, NURBS support, kinematics-based animation, morphing, and extensive plugin APIs. Plugin capabilities include image post processor effects such as lens flare, and depth of field.

For particular illumination effects, Lightsmark provides real time global illumination, colour bleeding, and penumbra shadows.

Useful tools to study the territory and the landscape are GIS, that are used for geospatial data management and analysis, image processing, graphics and maps production, spatial modeling, and visualization. They allow to work with detailed maps in raster, vector, or database format. Among them must be mentioned Quantum GIS, GRASS GIS, GDAL, OpenEV, Thuban, and JUMP.

Virtual Terrain Project fosters the creation of tools for easily constructing any part of the real world in interactive, 3D digital form. For Digital Terrain Models (DTM) can be also used the above mentioned Terragen free software.

Finally, SAGA (System for Automated Geoscientific Analyses) is an open source GIS application with an emphasis on grid and raster functions: digital terrain analysis, geo-statistics, and image processing.

3.3. Management and dissemination processes

Project management can be successfully developed with OpenProj, which is a desktop project management application similar to Microsoft Project with a familiar user interface, and even opens existing MS Project files. It is interoperable with Project, Gantt Charts, and PERT charts. For Mac OS X.

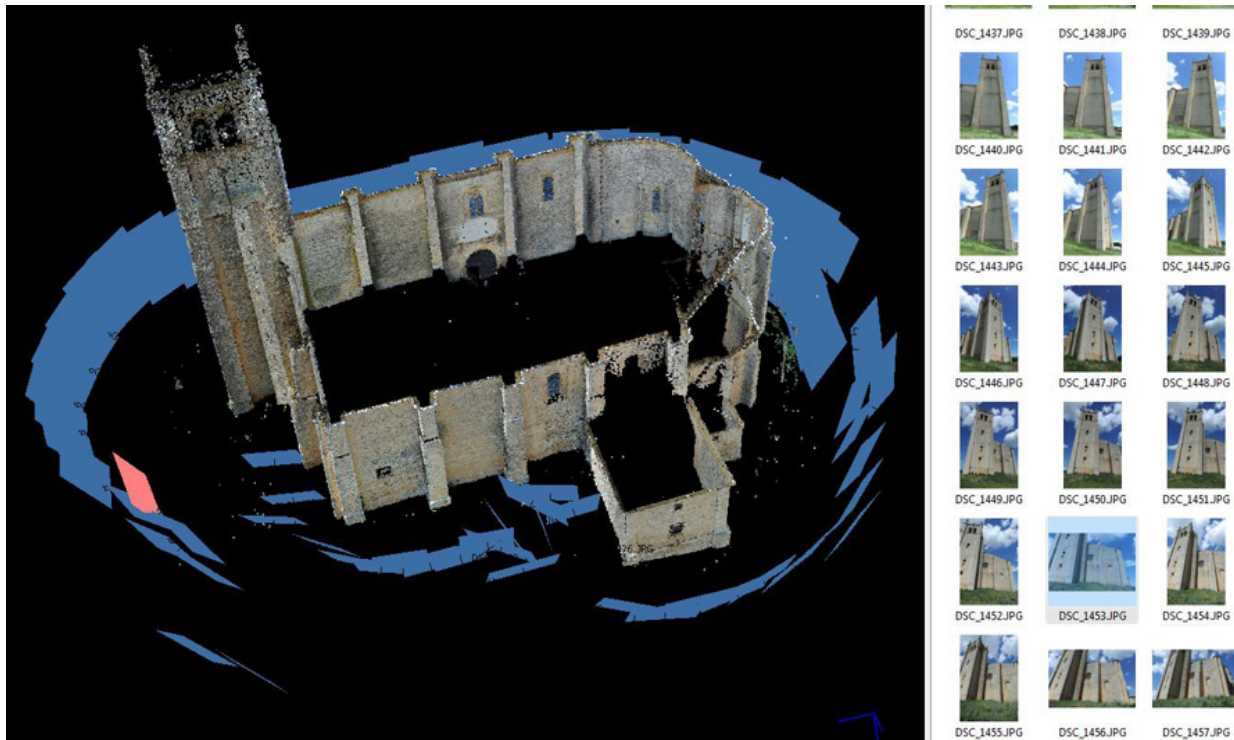


Figure 9. 3D Model of the Church of the Natividad in Villasandino, Spain. It is the cartographic basis of an architectural GIS (Task Group's Partner: *DAVAP Research Team*, University of Valladolid, Spain).

On the other hand, dissemination processes of the Cultural Heritage involve presentation, publishing and prepress, including geoportal design and maintenance. But nowadays dissemination becomes supported by using the Internet and digital storage media [14].

According to Jessop [15], the presence of maps -and other cultural heritage informations- on the web, promotes "heritage material to new audiences, both specialists and general, across many social and cultural groups."

Books' editors as Scribus and SIGIL, as well as other office tools for document production and data processing (OpenOffice, AbiWord, LibreOffice, NeoOffice for Mac, among others) are suitable for a wide variety of word processing tasks, spreadsheets, presentations, graphics, databases and more. They store all the data in an international standard format and can also read and write files from other common office software packages.

There are also free multiplatform web editors, i.e. tools used to create and upgrade documents directly on the web. Browsing features are seamlessly integrated with the editing and remote access features in an uniform environment. Some combine web file management and easy-to-use WYSIWYG web page editing, and have been designed to be extremely easy to use, making them ideal for non-technical computer users who want to create an attractive, professional-looking web site without needing to know HTML or web coding. Thus, the web becomes a space for collaboration, and not just a one-way publishing medium.

The offer of free software is wide (Amaya, Aptana, Kompozer, and Nvu can be mentioned), but MapServer is a specific program for publishing spatial data and interactive mapping applications to the web, running on all major platforms (Windows, Linux, Mac OS X).

4. Members, partners, and initiatives

4.1. Members

The Task Group is currently hosted by the University of Alcalá (Spain), and is composed by the following international teams of researchers:

- University of Alcalá (Spain), Department of Architecture, Technical School of Architecture and Geodesy: Research Group 'Cultural Heritage and sustainable architecture' (http://www2.uah.es/cipa_opensource_taskgroup). Director: Prof. Dr. Arch. Pilar Chias (pilar.chias@uah.es). Researchers: Master in Civil Engineering Tomás Abad, Prof. Dr. Ing. León González Sotos, Dr. Arch. Ernesto Echeverría, Dr. Arch. Enrique Castaño, Dr. Arch. Fernando Da Casa, Ph. D. Ángeles Layuno, Dr. Ing. Raúl Fernández del Castillo, Dr. Ing. Francisco Maza, Arch. Manuel de Miguel, Arch. Paz Llorente.

Their main research subjects are focused on cultural heritage documentation and dissemination, mainly at architectural, urban and territorial scales, including landscape studies. They lead and participate in many national and international research projects, and develop different methodologies to be applied to the documentation and dissemination of the cultural heritage at territorial, urban and architectural scales. They also collaborate with other Universities as the University of Grenoble (France), the CUJAE in Havana and the University of Oriente (Santiago de Cuba).

These methodologies use free open-source CAD software for cultural heritage documentation, as well as databases, digital cartography, terrestrial and aerial photogrammetry, and GIS for cultural heritage management.

They are also leading an important effort in order to disseminate all data and informations related to cultural heritage via Internet. As an example can be cited the Ancient Spanish Cartography e-Library (<http://www.ielat.es/>).

- University of Valladolid (Spain), Technical School of Architecture: 'LFA-DAVAP Laboratory of Photogrammetry' (<http://www.uav.es/davap/>). Director: Dr. Arch. Juan José Fernández Martín (juanjo@ega.uva.es); Coordinator: Dr. Arch. Jesús San José Alonso (lfa@ega.uva.es); Research director: Dr. Math. Javier Finat (jfinat@agt.uva.es).

Since 1995, this team is leading an important documentation and dissemination programme about the cultural heritage mainly in the Comunidad de Castilla y León (Spain), but also in Italy. They currently use both terrestrial and aerial photogrammetry.

- Politechnical University of Valencia, Technical School of Architecture: 'Colour' and 'Photogrammetry' research groups. Research directors: Prof. Ph. D. Ángela García Codoñer (angarcia@ega.upv.es) and Prof. Dr. Arch. Pablo Navarro (pnavarro@ega.upv.es). Researchers: Dr. Arch. Jorge Llopis, Dr. Arch. Ana Torres, Dr. Arch. Juan Serra.

They all are members of the Assoziazione Internazionale dei Design.

The team is developing some experiences on drawing and documenting the cultural heritage of the Comunidad Valenciana (Spain) by means of different techniques, including colour charts, architectural design, terrestrial photogrammetry, and CAD.

- Politecnico di Milano (Italy), II School of Architecture: 'Management and Urban Cultural Politics' research group. Director: Ph. D. Alessandro De Masi (alessandro.demasi@unina.it). As a member of UNESCO Forum, he is on the international research team for the 'Rural Vernacular Heritage 2007-2012' created by UNESCO World Heritage Centre (France).
The team participates in international research projects with the Universities of Naples and Florence (Italy), the Simmons College of Boston (USA), and the West University of 'Neofit Rilisky' (Bulgaria).
- Università di Chieti-Pescara, Facoltà di Architettura: 'Theory and Practice in Conservation'. Director: Prof. Dr. Arch. Claudio Varagnoli (cvaragnoli@tiscali.it).
They work mainly on architectural and urban restoration, as well as on industrial heritage, focusing on the materials and their qualities.
- University of A Coruña (Spain), Technical School of Architecture: 'GIRAP Group for the Representation of the Architectural Heritage'. Director: Prof. Dr. Arch. Jose Antonio Franco Taboada (jafranco@udc.es). Researchers: Dr. Arch. Antonio Amado, Dr. Arch. Juan Manuel Franco, Dr. Arch. Antonia Pérez, Dr. Arch. Santiago Tarrio.
The team focuses mainly on the documentation and analysis of the architecture and the archaeology using combined techniques (photogrammetry, direct measuring, radar). They are currently collaborating with the University of Puerto Rico.
- University of Málaga (Spain), Technical School of Architecture Research Group. Director: Dr. Arch. Guido Cimadomo (cimadomo@uma.es). Researchers: Arch. Javier Castellano, Arch. Antonio Álvarez, Arch. Jonathan Ruiz, and Arch. Dolores Goyanes.
They usually collaborate with the School of Architecture of Rabat (Morocco) and the University of Bologna (Italy), leading projects about sustainable tourism, cultural landscapes, and databases of the architectural heritage in Andalusia (Spain) and the valley of Mgoun (Morocco), and about the European colonialism in Granada (Nicaragua).
- University Antonio de Nebrija (Madrid, Spain), Technical School of Architecture: 'Sustainable Architecture and Civil Engineering' research group. Director: Dr. Arch. Carlos González-Bravo (cgonzabr@nebrija.es). Team: Arch. Loreto Barrios, Arch. Emilio Mitre.
Their main contributions are on the field of the sustainable rehabilitation of the cultural heritage, and the researches on green construction solutions.
- IADE, Institución Artística de Enseñanza (Madrid, Spain). Director: Diego García de Castro (IADE@IADE.ES) (Website: <http://www.iade.es/>).
The Institute is a centre with a long-established tradition in teaching interiors' design, fashion design, graphic and industrial design. According to their targets, they educate on the benefits of using open source software.

New members and collaborations are always welcome.

4.2. Partners

There are some international teams of researchers that use to collaborate with the Task Group activities. Among them, the

- ICA Commission on Maps and the Internet (<http://maps.unomaha.edu/ica/>): chaired by Rex Cammack (rcammack@unomaha.edu), works on cartographic presentation, communication and processing methods.

4.3. Initiatives

Among the Open Source software dissemination initiatives that provide information and access to different tools and demos concerning to geospatial data are:

- Arc-Team Community (<http://www.arc-team.com/>): provides archaeological documentation and processing methods. Virtual Archaeology & 3D modelling.
- Cultural Heritage Computing (CHC) Salzburg, (https://www.sbg.ac.at/chc/chc_site_en/chc_ziele.html): located at the University of Salzburg, the team aims at the documentation and procurement of contents concerned with cultural heritage using modern computer technologies.
- FreeGIS Project (<http://freegis.org/>).
- The Open Source Geospatial Foundation (<http://www.osgeo.org/>).
- OpenGIS Consortium (<http://www.opengeospatial.org/>).

Other useful related initiatives and websites are:

- François Letellier's web site (<http://www.flet.fr/>) and blog.
- Open Source Initiative (<http://www.opensource.org/>).
- Opensource.com (<http://opensource.com/>).
- Opensource CMS (<http://www.opensourcecms.com/>).
- Free Open Source Software Mac User Group (<http://www.freesmug.org/>).
- The OSSwin Project: Open Source for Windows (<http://osswin.sourceforge.net/>).

5. Conclusions and prospective

The above mentioned Open Source software, though not and exhaustive list, is regularly checked by the Task Group, and tools are tested and used in different research projects and experiences. We aim to compare their results and to disseminate them worldwide.

We invite all communities and professionals, that are currently involved in researches or management of the cultural heritage, to share their experiences with Open Source software products.

We include not only professional works, but other initiatives as courses, conferences, congresses, publications, related blogs and websites, and other materials which contribute to the dissemination of both the cultural heritage and the free Open Source software.

All of them will be included in the Task Group's web page, as Information and Communication Technologies provide powerful media for education, research and the dissemination to a wider audience than ever before.

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