Quality assessment criteria for cartographic heritage dissemination: a preliminary analysis of 300 websites.

Keywords: User acceptance, Usefulness, Historical Cartography, Digital Historical Map Libraries

Summary: This research reviews a sample of around 300 websites providing access to historical cartography to give insights on the quality of those web portals. The criteria applied are the quality of the visualization; the flexibility for exploring the images; the availability of georeference and overlay tools; and additional options such as downloading and georeferencing. The key result is that map galleries are no significant different to their counterparts designed for images or books, in spite of high quality scanning resolution and provision of metadata due to lack of specialized tools. In addition the way on in which search engines such as Google work makes it difficult to differentiate low quality pages from properly built digital map collections. Exploring the best sites reveals the potential of web-based historical portals. It is concluded that, even in the best cases, the capacities online are not yet ready to substitute those available in GIS systems or hard copy library retrieval systems.

Introduction

Historical cartographic artefacts are valuable for their cultural and historical qualities. However, to achieve their potential as elements of cartographic heritage, they have to be known, observed and studied. As a result, the institutional owners of historical map collections have created websites for their dissemination. On the other hand, Roth et al. (2017) remark that in general geovisualization applications developed by academic institutions in contrast to those developed by private companies with commercial purposes, are affected by low rates of visits. Therefore it is relevant to study the factors that make users accept and use such a system. Human Computer Interaction (HCI) approaches analyse the interaction of humans with computer technologies including acceptability issues. As a first phase for a more detailed usability study, this research aims to provide a general vision of digital historical map libraries from the perspective of usefulness, reviewing the functionality that those systems offer. First, the basic functions required for a website to be considered as a map library are defined. Then, starting from an exploration of several websites including historical cartography among their items, an analysis was carried out to explore different functions. Finally, it is concluded that a minimum number of sites accomplished the characteristics required for the proper display of the historical cartographic material.
Cartographic heritage and dissemination

Historical cartography encompasses cartographic artefacts from the past. This includes elements such as maps, atlases, plan spheres (Bitelli et al., 2014), earth globes (Hruby et al., 2006), panoramic drawings, relief models (Jenny and Hurni, 2011), images and text (Livieratos, 2008), or even aerial photos and updates to topographic databases (Radovan and Šolar, 2010). However as the vast majority of historical cartography are historical maps Livieratos (2008) simply calls them maps. Along this document this simplification will be also used.

Historical maps are valuable for their artistic qualities and for the geographic information about the past that they depict (Bitelli et al., 2014). As a consequence can be considered as cartographic heritage, a part of the broader cultural heritage (Bitelli et al., 2014) and (Hruby et al., 2006). UNESCO (2017) states elements of cultural heritage present a legacy of the past times, which helps humans to discover and understand their history. Furthermore, other cultures also easier to grasp and understand and potentially even foster ideas around tolerance peace (D’Orville, 2003). Therefore, to achieve the status of cartographic heritage, active efforts are required for protecting historical cartographic items for future generations and for analysing and sharing them with the public. Such work has been principally made by institutions that manage the cartographic material. For centuries historical maps has been collected and administered by libraries or private collectors. Livieratos (2008) explains that the tasks of administration are related with the following characteristics of maps:

- Materiality: the physical support of the artefact which requires conservation.
- Contents: the geometric and thematic elements depicted in the map. This requires study.
- Communication ability: the capacity of the item for communicating information. This requires dissemination.

Through the hard and persistent work of librarians and other custodians, conservation of a large number of cartographic items has been possible. But, the physical copies of those maps in libraries remain less used than books or similar materials (Radovan and Šolar, 2010) because of their limited audience, principally individual enthusiasts or professionals. In the past, historical maps were objects of interest only for historians, and not for cartographic sciences, as they were considered outdated passive documents without relevant information (Balletti, 2006).

Digital historical map libraries

Accessibility to historical cartography beyond conservation is also fundamental as it is related to a wide audience: the public in general (Hruby et al., 2006; Livieratos, 2008). However, granting access to the materials is not enough: dissemination is only really achieved if people are attracted by the materials and use them. Such an interest also attracts more investment in projects related to historical cartography (Fleet, 2007). Therefore, there is a constant need to create mechanisms for the diffusion of the collections to the public without undermining previous efforts made for conservation.

Indeed, underuse of original copies of historical maps is related to the restrictions of manual handling derived from their material fragility. As a result, efforts were made throughout the twentieth century for permitting conservation and better access to the maps through the creation of facsimiles as alternatives to hard copies. Technologies such as microfilms emerged for the creation of duplicates of the maps (Cartwright, 2010). The development of computational technologies in the 1960s encouraged museums and map libraries to scan their maps and create
digital map collections accessible through systems available internally in those institutions. Since the 1990s the widespread of internet allowed a wide diffusion of digital libraries supported by web portals. This shift to the digital world supported the efforts for the conservation of historical maps and stimulated the study of their geographical information. In turn this increased the potential for research based in historical cartography. At the present time, historical maps support historic, artistic, sociological and literary studies (Balletti, 2006) education, linguistics and other fields (Radovan and Šolar, 2010). However, when maps are georeferenced and geo data is obtained from them, additional research areas are opened in topics like human perception, art, ideology, geography, geometry, science, technology and power (Livieratos, 2008), genealogy, property studies, and toponymy (Radovan and Šolar, 2010). The study of geographic elements of historical maps for those potential areas of research is carried out in GIS environments (Jenny and Hurni, 2011) therefore digital map libraries are repositories of potential materials for those studies.

Since dissemination is the main objective of map-based digital libraries, it is necessary to create systems that a user can accept and wishes to engage with. However Roth et al. (2017) states that the low use of many systems created for the visualization of geographic information is still an open topic for analysis. Geovisualization applications include a vast range of software products including GISystems and online sites for interactive maps. Some commercial examples such as ArcGIS and Google Maps are very popular whereas many others remain unused. Cartography scholars and professionals are still investigating the factors involved in the success of applications. Therefore, it is relevant to find procedures for assessing the quality of the systems delivering historical cartography as part of the drive towards increasing the diffusion of the materials. In pursuing that objective, the following considerations are a necessary starting point:

First there are differences among digital map libraries that stem from variations between institutions creating these systems. Academic institutions focused on research have incorporated GISystems into the analysis of historical maps. As a result they have georeferenced their maps but frequently these remain internal to the institution. On the other hand national libraries more focused on providing access to their cultural contents have created public systems that are accessible online with standard options for search and visualization. However, without GISystems their maps are frequently not georeferenced (Radovan and Šolar, 2010).

Second historical cartography has geographic elements as spatial location, scale, projection, or distance. This makes the maps different from simple images or text. Visualization of mapping should therefore emphasize that geographic nature. In addition Radovan and Šolar (2010) suggest that diffusion of historical materials as the process of putting them online is not necessarily a guarantee of successful dissemination. Instead, the organization of the maps and their visualization should be based on their geographic properties. As for example, it should be possible to search maps through coordinates or toponyms instead of a time consuming visual exploration. Additionally a degree of interactivity is necessary in their exploration with options such as magnification and panning.

Third digitized historical maps lose their material characteristics. For example, a digitized map has lost the original paper where it was printed or the impression the original colours could have produced in the observer. In addition, the website displaying the map becomes a novel
means of supporting access to the item. Therefore, the impression that the digitized map generates is partly a result of the quality of visualization offered by the system.

Fourth maps in some cases also lose their context. For example, maps embedded in books would lose contextual information or descriptions when scanned. In addition, deformations due to the scanning process could be introduced to the digital copy. As for example, hard copies present waves in the paper surface. Along digitization, they could produce deformations in the digital copy. As a result, the quality of the scanned documents is also part of the quality of a digital library.

With all these considerations, it is possible to find a framework for the evaluation of the functionality offered by digital map libraries and therefore, the extent to which users will accept their designs.

*Usability and usefulness*

Accepting an information system depends upon the extent to which potential users are willing to use that system. With the expansion of computational technology, computer science and HCI need to determine the reasons people accept to use computational systems and thus, increase the level of acceptability in existing and future applications. The Technology Acceptance Model (TAM) proposed by Davis (1986) has been widely used for understanding acceptance of information systems (Surendran, 2012; Park et al., 2009).

TAM (Davis, 1986) states that acceptance is influenced by several factors. The most relevant are how users perceive both usefulness and usability. Usefulness or utility is the perception of how much the system would increase the user’s performance in pursuing its goals. On the other hand usability or the ease of use corresponds to the user’s belief in how easy it will be to physically and mentally use the system. Both aspects are necessary in the examination of acceptability, although systems that are easy to use are perceived as more useful.

However, MacDonald and Atwood (2014) recognise that usefulness has been less explored in HCI research in spite of its importance. They claim that expectations of users go beyond how easy it is to use the system. Therefore usability alone is not enough for validating a system. In the same way Roth et al. (2017) suggest that users can interact with a system that is hard to use providing it allows them to achieve their goals. Therefore, for determining the acceptability of a system, it becomes necessary to assess the extent to which it supports the expected activities of the user.

In fact, usefulness can give insights about problems related to acceptability. In a revision of geovisualization systems by Andrienko and Andrienko (2006) it was concluded that failures in usefulness is often produced by an excess of functions which makes systems too complex for the user. Instead geovisualization systems should reduce the set of available tools and therefore their complexity.

In the case of digital libraries Matusiak (2012) finds that, in spite of the efforts of libraries and academic institutions creating digital collections, students still use these systems largely for research with textual resources. In contrast, they prefer commercial search engines for researching visual materials. This is the result of a negative perception of the usefulness and usability of digital libraries.

In addition, only limited research has to date investigated acceptability in digital map libraries and it is this gap that is partly addressed by the research reported in this paper. The objective of this study is determining how useful online websites relating to historical cartography
actually are. In this case usefulness is expressed as the degree to which the site can accomplish the tasks and fulfill the goals expected from a digital map library for historical cartography. This research has been focused on usefulness and has been carried out solely with the participation of the researcher of this study. However, this the first phase of a broader analysis of acceptability in digital map libraries. Insights about usefulness obtained at this stage will support a subsequent usability study with the participation of a number of potential users of historical cartography. There, much more detail will be obtained about the quality of the web sites analysed and the perception of the participants.

Methods

The evaluation was divided in three stages:

1. Definition of criteria of evaluation. This included the creation of:
   - A functional definition of a digital map library. This is a list of functionalities that are expected on sites including historical cartography.
   - Categories of authorship. Four categories were created for classifying the websites according to the institution that developed them.
   - Evaluation scores. A sixfold index was designed for assigning a quantitative value to the sites according to their compliance with the expected functionality.
   - Sample definition. The sample of websites was built in base to some restrictions for limiting the scope of sites to be reviewed.

2. Execution of the evaluation.
   - Exploration on the Internet. This corresponds to the search for sites depicting historical maps fulfilling the conditions set for the sample.
   - Usefulness study. For each site, the contents and functionality of the site were compared against the functional definition of a digital map library. Then, the site was scored in base on the extent to which it fulfilled the functional requirements. Finally, the site was classified according its institution.
   - Analysis of the results. Once the revision of the sites was concluded, the results were grouped by score for a descriptive analysis.

3. Selection of sites with the highest usefulness. Finally, from the sites with the highest score, a subset of five sites was selected and described as an example of the results.

All these steps of the process are described in detail below.

Definition of criteria of evaluation

Functional definition of a digital map library

Map libraries are a particular case of geographic visualization and their functions should be focused on the representation of historical maps. On the other hand, mapmaking or the analytic functions as those are available in GISystems are not mandatory in this kind of system. Therefore, from the definitions of map libraries described above and including the functions described by Fernández Wyttnebach et al. (2008) this analysis defines the follow functions for a digital historical map library:
Remote access to the material: the user should not have to go to the institution to access materials.

The contents of the website should at least in part comprise historical cartographic materials.

Searching for spatial information: cartographic materials should be searchable either from coordinates or from other non-spatial descriptive metadata.

Visualization: the display of the map on screen.

Exploration: magnification and panning options.

Areas of interest: the user should be able to define a section of interest over the map as a work area.

Comparison of items: generally done by overlaying maps and using transparency or similar tools.

Georeferencing tool: with a modern map as guide, this ought to allow the user to create reference points and georeference the map.

Download functions: high resolution and diverse file formats are desirable.

Categories of authorship
Understanding authorship and commissioning of a digital map library is helpful as it underpins the origin and objectives of the site. From the institutions and expertise behind the creation of web sites for Historical Cartography, it is possible to establish categories even if sites subsequently pursue different objectives. As for example, a private initiative for the dissemination of digital copies of maps could also include options for selling printed facsimiles.

However, for simplicity this research has created the follow categories:

- Commercial sites. A web website whose main aim is to sell copies of the maps.
- Libraries and educational institutions. Institutions oriented to cultural or educational objectives and therefore looking to make their cartographic contents public.
- Private initiatives. Owners of cartographic collections with the will of sharing their collections with the public.
- Surveys or other administrative bodies. Creators of maps, these institutions want to publish their archives.

Evaluation scores
A quantitative scale of scores was created for establishing the level of usefulness in the websites explored. As functionality is the focus of this analysis it excluded other aspects of the systems as their quality of implementation, their performance or the satisfaction of their users which are relate to usability. A usability evaluation of digital map libraries is expected be carried out in a subsequent investigation.

This exclusion is due to the fact that, through a proper design, a site might fit to the purpose it was created, driving a positive experience to the user. In addition, the objectives of an institution or the needs of the immediate users would not always want or need the full set of tools described in this research. In those cases, sites that have scored 5 would be inadequate and sites with a lower score could cope with the requirements. However those sites are missing functionality, a fact that limits their usefulness. As a result, some sites which are perceived as good or advanced by the users could have received a low score due to the perspective adopted in this review.

For the creation of the scale of scores, it was assumed that certain functionality precedes another. As for example, it is expected that the basic steps in a digital library are search and
visualization. Equally, georeferencing and overlaying are considered more advanced and thus graded with a higher score. The levels were also created as an attempt to encompass the most frequent cases of websites presenting historical cartography. Therefore, it is possible that sites presenting a particular set of functions but missing others could not perfectly fit in the proposed scale. As for example, a site with overlaying and transparency options could lack a search tool. However, due to the high diversity of sites online, the scale was a necessary restriction for such heterogeneity in favour of simplicity for the analysis.

The scale includes six degrees of usefulness or scores. Values go from -1 for the lowest value of usefulness to 5 for the highest. To each level there were assigned set of characteristics of a web site as follows:

Score -1 or fake site: It is the lowest score and is used for false web sites, or pages with many keywords designed to promote their ranking in a results page, but which lacked any real functionality.

Score 0: It corresponds to a site without historical maps in its contents. As there is no cartographic content, any function could be evaluated.

Score 1: It describes a catalogue of digitized historical maps and metadata including search and visualization options but lacking either functions to explore the images or their georeferencing. This level aims to include a large number of digital libraries with limited usefulness for cartography where maps are managed equal as the rest of the images. The website of the University of Manchester Library\(^1\) depicted in Figure 1 is an example. There, maps include metadata but not geographic coordinates.

Score 2: It includes the same options of score 1 but also the sites present georeferenced images and additional functionality for their exploration as magnification and panning. This group encompass all sites that provide maps with a geographical reference and options for their exploration on screen. An example is the site Cartomundi\(^2\) developed in France by the Maison Méditerranéenne des Sciences de l’Homme, in Figure 2. The exploration of the map is possible in the main section and a grid shows the location of the map over the earth.

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\(^1\) https://luna.manchester.ac.uk/luna/servlet/maps002~1~1

\(^2\) http://www.cartomundi.fr/site/
Score 3: Includes the same options of score 2 and the option to overlay a modern map. This comparison tool is not common in digital map galleries despite its relevance for the visualization of maps using a geographic reference. An example is the National Library of Scotland (NLS) in Figure 3. There, a modern map is the background layer, showing the differences between it and the historical map. This site offers Ordnance Survey series of individual maps, depicted together as a single map. However, it is possible to visualize only one historical map at a time. Therefore, despite the option of visualization of composed maps, the overlay of different items is not available, limiting this site to a score of 3.

Score 4: Websites in this category have developed all the functions in score 3 but they also permit to overlay multiple historical maps at the same time. In addition, changes to the transparency of the maps are allowed, facilitating the comparison of the items on screen. An example is the National Library of Scotland (NLS) available at [https://maps.nls.uk/](https://maps.nls.uk/).
example is The British Library site4 presented on Figure 4. In this case, it is possible to visualize two items at the same time over a modern map. Even if this site includes series of maps composed of individual sheets, the visualization is limited to two elements. Therefore, it is not possible to visualize all the pages at the same time, limiting this site to a score of 4.

![Figure 4. The British library example of a site with a score of 4.](image)

Score 5: The highest score is for the sites with the same options of score 4 that additionally visualize different sheets of a map in a single view. Additional options as tools for georeferencing maps are included in this category. Figure 5 presents an example of this kind of sites, the David Rumsey collection5. There, several maps can overlay at the same time. Therefore, several sheets of the same map can be visualized together. In addition, other maps can be displayed for comparison.

![Figure 5. - The David Rumsey collection - example of a site with a score of 5.](image)

4 http://www.bl.uk/georeferencer/georeferencingmap.html
5 https://www.davidrumsey.com/
Sample definition
The usefulness evaluation rests upon a sample size that is as large as possible subject to time constraints and the definitions described below. The aim of the study was to explore a large number of websites however the scope has to be reduced for the following practical reasons:

- **Language**: due to language knowledge of the evaluator, only sites built in English or Spanish or with a version in those languages were included.
- **Time**: A time frame of 6 weeks was allocated for the exploration, categorization and evaluation of the sites.
- **Keywords**: The diversity of origins and contents online is wide. The internet deploys a plethora of keywords for making reference to historical cartography. Adjectives for maps include old, antique, ancient, archaic, classic, obsolete, etc. As a search on the internet could be done for each one of the results with a large set of results, many of them repeated, only the term historical map was selected as a keyword for the research.

**Execution of the evaluation**

Exploration on the Internet
The potential sites were accessed using the Google search engine. In an initial phase the search was done manually, and their addresses where obtained one by one from the list of results. In addition, other strategies were attempted, such as the exploration of websites of administrative offices. This includes as city councils or cadastral organizations. As for example, a number of sites belonging to British councils where explored are possible sources of historical cartography. However, this process gave few results.

In a second phase, it was decided to automate the process. This was done using a harvesting tool for automatic extraction of links from a Google search list of results. For this purpose, there where used the following extensions for the Google Chrome browser:

- **GInfinity**: Extends the list of results of a search to 100 in the same page.
- **Linkklipper**: Extracts the links of the results page as a list.

The selection of those tools was based only in their immediate availability and other similar tools available could return the same results. In addition, even if their use simplified the exploration, inevitably included links to false websites, created only for advertisements, common in Google’s results. Those were categorized as fake sites.

Usefulness study
Usefulness of each site was analysed exploring the website and answering the usability questionnaire presented in Table 1. Questions are grouped by their related score. If the exploration gave positive answers for a section, the site reached that score and the exploration moved forward to the next section.
Questions | Score
--- | ---
Does the site only include misleading content or links to external pages? | -1
Which is the institution creator of the site? | General data
What is the title or name of the site? |
Which is the country of the institution? |
Which languages are available? |
Do contents in the site not include historical cartography? | 0
Does the site include historical cartography as a part or all of its contents? | 1
Is metadata related to the contents? |
Does the site allow the search of items by their metadata? |
Does the site permit users to visualize the items on screen? | 2
Is possible to explore the items using magnifier and panning tools? |
Can maps be downloaded? | 3
Are items georeferenced? |
Is it possible to overlay an historical map over a modern one? | 4
Is it possible to overlay multiple maps? |
Is it possible to adjust the transparency of the maps? | 5
Are maps originally composed of different sheets depicted together and thus visualized as a single image? |
Does the site include a Georeferencing tool? | 6

Table 1. Usefulness questions used for assessing digital map libraries

Due to the variability of the quality of the images in terms of scanning, resolution and format even in the same website, this characteristic was not used for assessing the portals. In addition, the option of download was excluded from the evaluation as it was not clear in some cases. For example, some sites do not have an explicit option for downloading contents but the image on screen could be copied or obtained in another way from the browser. On the other hand, some sites block explicitly this option.

Analysis of the results
The process included a total of 469 different web links and the total of sites by score is presented in Table 2. The links extraction tool helped to obtain 241 new websites for analysis; some of them were of good quality. However 90 of those links were a score of -1 as it was found those were not real websites, reducing the total of valid sites to 379. In addition, the group of score 0 corresponds to pages not related to historical cartography but including the text historical map or even some images of maps among their contents. Those sites were excluded from the revision and it was carried out for the remaining sites.

Websites with historical cartography were given a score from 1 to 5. The number of sites by score grouped by institution is presented in Table 3 which shows a large prevalence of sites belonging to Libraries and educational institutions.
### Table 2. Web sites by score category

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<th>Score</th>
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<td>-1</td>
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<td>0</td>
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<td>19</td>
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<td>5</td>
<td>10</td>
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</table>

Sites with a score of 1 comprise more than two thirds of the valid websites of this review. This shows that a majority of map digital galleries do not manage maps differently to another digitized material. Sites including higher levels of functionality received a score from 2 to 4. Those groups show absence of sites created purely for selling maps and in the other hand they include examples of the rest of categories. Sites that reached a score of 5 include the most sophisticated set of options like visualization of maps composed of several sheets and georeferencing tools and show higher numbers in private initiatives. As the aim was to assess functionality the quality or the amount of the contents was not evaluated. As a result some sites in the highest categories could have only few sets of maps for display.

### Selection of sites with the highest usefulness

A final review of sites allocated a score of 5 reduced this list to 5 sites. This number was considered as a descriptive sample of sites that fulfil in the best way the requirements of usefulness of a digital historical map library. They comprise:

**David Rumsey map collection**
Institution: David Rumsey.
Description: A large collection of 150,000 physical maps and other cartographic material of which almost 87,000 digitized items are on the website. The site includes many tools for georeferencing,

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8 https://www.davidrumsey.com/
overlaying and searching maps. Born as a private collection, the originals of the maps have been donated to the Stanford University.
Category: private initiatives.

USGS Historical Topographic Map Explorer ⁹
Description: powered by ESRI the site depicts its items using a time line. Presents a simple interface but includes options for overlay and setting of transparency.
Category: Surveys or other administrative bodies.

PRONI Historical Maps ¹⁰
Institution: The Public Record Office of Northern Ireland (PRONI) - Land and Property Services (Ordnance Survey and Spatial NI).
Description: Geoportal of the PRONI. It includes a range of historic maps of the Ordnance Survey some composed by different sheets. In those cases the sheets are visualized together.
Category: Surveys or other administrative bodies.

MAPIRE - The Historical Map Portal ¹¹
Institution: The developer and operator of the project is Arcanum Database Ltd., in collaboration with several national archives of Europe.
Description: Web site including historical military surveys, national maps and thematic maps of Europe in the 19th century. Series of historical maps has been assembled covering territories of France and the Austro-Hungarian Empire.
Category: Private initiatives.

GEOPORTAL.LU ¹²
Institution: The Luxembourg land registry and topography authority.
Description: Geoportal of the Administration of the Cadastre and Topography of Luxemburg. The portal includes a set of layers of Historical Topographical maps that can be combined with the modern layers of information.
Category: Surveys or other administrative bodies.

Conclusions

Search engines like Google present their results as textual keywords. Thus, it is not possible yet to access data from map libraries according to their geographic content from those search platforms. Instead, map libraries are listed among other websites not related with cartography, commercial sites selling maps or ancient Image galleries offering contents and functionality on interfaces now obsolete.
A majority of the digital libraries that host historical maps among their contents do not offer tools for their exploration. Instead, they are managed in the same way as tools for accessing other visual

⁹ http://historicalmaps.arcgis.com/usgs/
¹¹ https://mapire.eu/en/
contents. Thus, those map galleries are not significantly different to their counterparts designed for images or books.

In many cases, map libraries have created digital content in high resolution and linked to metadata. However, this content is only rarely georeferenced so they remain isolated as images without a geographic context.

The analysis of usefulness shows that the sites of libraries and educational institutions and surveys and other administrative bodies have a higher number of digital map galleries than the other categories created. However, private initiatives have developed sites in smaller numbers but including advanced tools.

There is a lack of homogeneity in the administration of historical cartography inside many institutions. It is the case that digital libraries do not necessarily include the same functionality for all their items. Thus, while some maps are depicted in high resolution or include geographic coordinates, other items could be presented in low resolution or even only as a textual reference to the physical item in the institution.

The analysis of sites with the best functionality reveals that map libraries are far from implementing the functionalities that GISystems offer. Therefore, their main objective should remain focused on achieving an effective dissemination of the cartographic heritage.

References


[154]
Hellenic National Centre for Maps and Cartographic Heritage, 1(2) pp. 88–98.


