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Maps, Libraries and the "GIS Librarian": an Informal Review of International Cartographic Libraries

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Abstract

A significant research potential in South Africa is recognized by the researcher for the intersection of map services, geospatial data, libraries and education. This paper acknowledges that together, cartographic technology and map collections have the potential to unlock cartographic related research. Based on research conducted in 2010 for the Postgraduate Diploma in Library and Information Science at the University of Cape Town, this paper presents an overview of current literature and investigates what cartographic services are provided by a selection of national and international academic libraries.

The methodology employed was to use the Shanghai Ranking Consultancy (2010) system to identify and choose top ranked universities. The libraries of eight universities were informally compared by reviewing their respective websites. Three cartographic related aspects were the focus of this review: (1) technology, (2) map related services, and (3) legislation.

The findings identify cartographic services and also highlight differences, especially between the libraries in South Africa and those in international countries. The results indicate that while South African libraries are known to have map collections, online services, in the form of digital maps and geospatial data, are not readily accessible. Furthermore, the researcher suggests that there is a need for research that focuses on Geographic Information Librarianship and the GIS Librarian in SA.

1. Introduction and Motivation

Not only has there been a shift from print to digital formats but this shift has "resulted in new ways that society views, understands, and employs maps. Maps are now incorporated into processes where geographic and topical data can be transformed into information that addresses real world issues and research questions" (Weimer and Reehling, 2006:292). It therefore follows that maps have the potential to play an important role in academic research.

This research project was conceptualised as a result of fieldwork at the African Studies Library (ASL) at the University of Cape Town (UCT), South Africa (SA). During the researcher's fieldwork, she was introduced to the map collection at ASL as well as a collaborative project between UCT Libraries and Stanford University Libraries, USA. This project focused on the cataloging and digitization of maps and introduced the researcher to the profession of a *Geographical Information Systems Librarian (GIS Librarian)*.

While completing field work, the researcher realized that in SA, there is significant research potential and need for GIS services, geospatial data, and the digitization and geo-referencing of

maps. This research potential is not limited to within Humanity and the Social Science disciplines, but can be applied in virtually all disciplines. In light of this research potential, the researcher embarked on an investigation of what cartographic services libraries presently provide. It reviews what map and GIS related services are provided in a selection of international and national academic libraries.

Further motivation for such an investigation was fueled by the American bias in such studies, discussed below. These studies investigated the implementation of GIS services within the context of American map libraries, academic universities, and geospatial data centers. Given this bias, it was decided to broaden the geographical sample selection by including universities from various countries. This meant choosing the top four international countries and the top four African universities from those listed in the *Shanghai Ranking Consultancy (2010) system*. The variables that were used had to satisfy the study's aim: *what are the present cartographic library services?* The following variables were thus selected: technology, services and legislation (i.e. standards and policy).

In the sections below the relevant literature is reviewed and the methods employed are explained. The results are discussed and the paper concludes with reflections and recommendations.

2. Review of Literature

2.1 Concepts: GIS, the GIS Librarian and Geographic Information Librarianship (GIL)

According to Aufmuth (2006: 341), GIS is defined as "the infrastructure (i.e. hardware, software and personnel), spatial data, and application used to inventory, manage and analyse [special data]" while Todd (2008: 15) states that "GISs combine maps with tables of information… [which allows one to] analyze natural, behavioral, and social science data with visual evidence". Goodchild (2010: 377) offers an explanation of what sets GIS apart from other information systems or databases: "At the core of a GIS is a geo-referenced database. Such databases are distinguished from all other kinds by the fact that all of their records are given a location on the Earth's surface, usually in the form of coordinates, such as latitude and longitude." It is therefore argued that GIS has ushered in a new era of spatial information management.

Weimer and Reehling (2006) state that libraries are information centers that can no longer afford to solely exist as map repositories where librarians organize, store, and provide services associated with printed maps and associated cartographic materials. The following list of common requests for assistance at University of Kansas (KU) Libraries, United States of America (USA) provides an indication of what type of services a GIS Librarian and the appropriate GIS infrastructure can provide beyond the confines of the map repository 'model':

- finding specific datasets;
- generating a map or image from spatial data;
- converting data among various formats, such as open source or proprietary;
- subsetting data or clipping data layers;
- creating data, such as point, line, or polygon features and editing associated (attribute) information;
- mapping tabular data using geographic coordinates for point locations, or collected with a global positioning system (GPS);
- mapping tabular data by linking (joining) to a GIS layer with the same geographic variables;
- integrating an image, such as a scanned map, into a GIS using geographic coordinates (geo-referencing); and
- spatial data analysis.

Source: adapted from Houser (2006).

Weimer and Reehling (2006: 291) define the GIS Librarian as "the librarian who knows the community and serves the clientele with appropriate maps as well as appropriate technologies" and Geographic Information Librarianship (GIL) as the "profession of providing geographic information resources and services in a library setting". The definition has three areas of expertise, namely (1) cartographic materials cataloging, (2) print map librarianship, and (3) GIS Librarianship.

Both definitions infer the management of geographic information which Vardakosta and Kapidakis (2013: 797) state usually have two components, namely "1) contributing in the development of interactive geo-services in their libraries, [i.e. faculty, liaison, and/or subject librarians], and 2) using the proper descriptive standards, [i.e. cataloguers and/or metadata specialists]".

Furthermore, Vardakosta and Kapidakis (2013) state that the demand for such specialists is growing as the number of requests for and range of cartographic resources used has increased during the last ten years.

2.2 Infrastructure: Technology, Data, and Models

a) Technology - Reference has been made to the infrastructure needed in order to provide the above stated services. Groot (1990, cited in Groot and Sharifi 1994: 1274) defines infrastructure as the "structures and services to make access to and use of geographic information efficiently possible, i.e. accessible, affordable and available". It is noted by Groot and Sharifi (1994) that a selection of computer, communication and visualization technologies is required for the use of geographic information. Similarly, *ESRI's Online GIS Dictionary* (n.d.) defines GIS as "a collection of computer hardware, software, and geographic data for capturing, managing, analyzing, and displaying all forms of geographically referenced information". It also describes geospatial technology as a *"set of technological approaches, such as GIS, photogrammetry, and remote sensing, for acquiring and manipulating geographic data"* (ESRI, n.d.).

b) Data - Since almost any data can be given a physical location, maps, data, government information and statistics are possible resources for a GIS. Houser (2006) discusses such data management. The importance of surveying library-owned spatial data, as well as federal depository

items, commercial data, and internally generated data is noted. Creating an inventory of such available data in one's library is a good starting point. Such an inventory is ongoing through data requests, coincidental discovery, collection development, and monitoring of new resources. Before datasets are purchased, spatial and tabular data should be located online and from government agencies. Casey, Smith and Keck (1999) supports this by stating that much spatial data is available from government agencies, units and departments, especially if they have a local government repository library. Furthermore, due to staff skill sets, easy manipulation of present datasets reduces the need for purchasing commercial datasets.

While commercial data incurs a high financial cost, its advantage is that although it probably originated from government sources, it would have been improved in order to increase its relevance and usability by means of standardizing information or linking it with other useful datasets (Casey, Smith and Keck, 1999).

Other factors that need to be taken into account and impact the acquisition of geospatial data are "user demands, budgets, license restrictions, availability, data formats, and staffing resources" (Florance, 2006:226). It can be argued that acquiring data can be considered as a service that is provided to GIS users. Therefore, knowing what map services are possible and how these services are generated is important. It is important to understand how such services and systems work within the larger context of the library as well as the tertiary institution.

c) Models – Star and Ruhleder (1996, cited in Sigh, 2005: 236) point out that one rarely starts with a clean slate and that there usually is an existing system that requires enhancements to "link the old and new in an interoperable way". This means that implementation takes time in a variety of areas (i.e. hardware, software, data formats, staffing, etc.).

Aufmuth (2006) identifies three models that are used to deliver information services and data. The *centralised system* provides series and data through a single individual or departmental unit. *Distributed systems* rely on many interconnected individuals or units to supply services and data. The advantages and disadvantages of both models may culminate in a *hybrid* of both models or result in a movement from one to the other.

Should an established network of GIS services exist, libraries can identify a niche in such services and/or provide the stakeholders of such a network with GIS related services, namely faculty, staff and students. Furthermore, libraries can serve as a neutral space for highly competitive research and educational centers to collaborate together and even unite under one roof or banner. Regardless, it is important to note that the library GIS service and data delivery may include the following functions listed in Table 1.

Table 1: Library GIS service and data delivery
Source: Aufmuth (2006)

GIS function	**Additional information**
consulting	
data acquisition	creation, download, or purchase
data archiving	institutional repositories
data distribution	
data maintenance	
data processing and analysis	
GIS applications	development and/or implementation
hardware support	
research	
software	purchasing, licensing, distribution, and installation
teaching	

2.3 Standards, Policy and Legislation

Due to copyright and various license agreements, an academic library usually has documented policy about the way its resources can be used. In light of this, a geographical data dissemination system designed by Shawa (2006) is used as an example of the some of the standards, policy and legislative features such a system would require.

a) Resolution and compression standards - For this system a distinction was made between scanning a map as artwork and preserving map information for GIS use. The latter was the objective and after much research and in house testing, the resolution for paper map scanning was established as 400dpi optical resolution with 256 colours. A 10:1 compression ratio was used when encoding the TIFF file into a JPG file format.

b) Metadata standards - Metadata for the system was created for every digital map. The International Organisation for Standardisation (ISO) 19115 metadata standards were used to individually catalogue all scanned and digital maps. Such metadata were important for making the digital maps available for browsing and searching purposes. These user functions are depicted in the figure below, which shows how the maps were displayed online.

c) Legislation: copyright - Copyrighted maps were scanned for archival purposes and to provide a user with an idea of what the map looks like. The metadata records included thumbnail pictures of the scanned maps, as depicted in the figure below. Such a thumbnail helps users decide if a map will be useful for their research. Since the scanned map takes the form of a thumbnail, it is a small image of poor quality and would not be readily used for other purposes.

2.4 Previous Studies

Martindale (2004) explains the context behind numerous GIS and library related literature published in the 1990s. Furthermore, he identifies that while such literature is presently published, it appears to be thinner and that library students interested in GIS library services need to look beyond the context of libraries for literature.

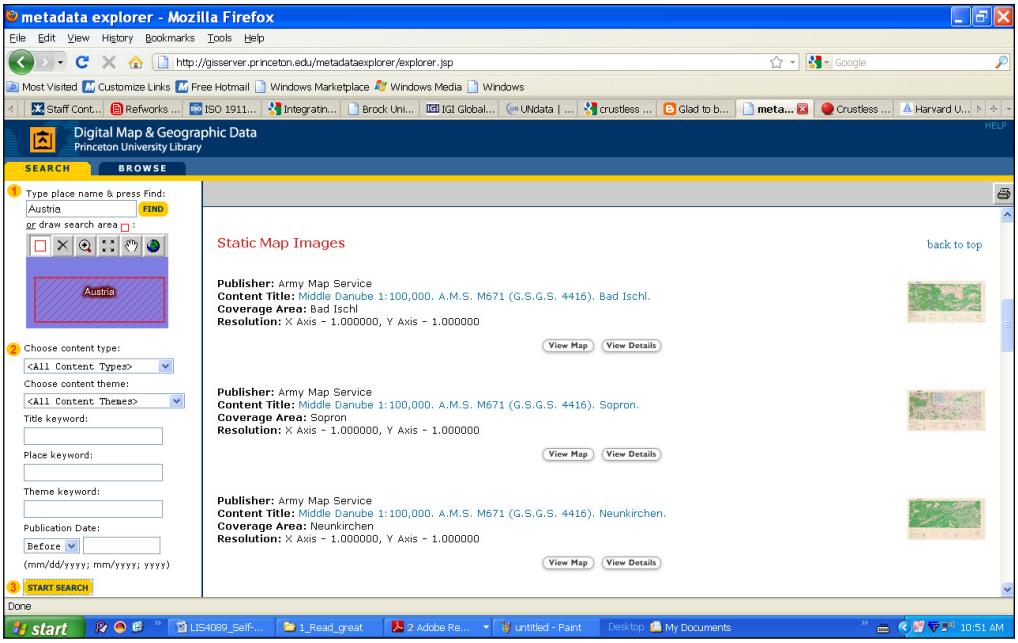


Figure 1: Using metadata to make online browsing and searching of digital maps possible
Source: Digital Map and Geographic Data - Princeton University Library (2010)

During the 1990s, the concept of incorporating GIS services in libraries was novel and popular. The Association of Research Libraries (ARL) GIS Literacy Project also fueled implementation and associated literature in 1992. Librarians whose institutions participated in the ARL project authored articles which focused on staffing, hardware, software, and building geospatial data collections. These articles aided the initial implementation of GIS in the academic library, especially within the USA. The ARL surveyed all 121 GIS Literacy Project participants during 1997. The objective was to identify how GIS initiatives were supported in the library. The survey report was published in 1999 and indicated that 89% of the respondents offered some kind of GIS service.

Research similar to this study has taken place in USA. One recent study by Kinikin and Hench (2005a) and the follow-up thereof (Kinikin and Hench, 2005b) are discussed in this paper. According to Kinikin and Hench (2005a), few studies had examined GIS implementation at multiple libraries. This motivated the researchers to undertake a survey of the implementation and use of GIS in smaller academic libraries. The premise was that if smaller libraries undertook to provide GIS services, lessons could be learnt from this and that there was a growing need for such services. The objectives and results of the study are summarised in Table 2.

Table 2: Summarised objectives and results of the Kinikin and Hench (2005b) study

No.	**Objectives of the study**	**Results of the study** *(138 surveys returned from 268 libraries surveyed)*	
1	Institutions that have implemented GIS	Libraries that supported GIS: 22	Libraries that do not use GIS and did not plan to implement such services: 119
2	Institutions that have plans to implement GIS	Libraries that do not currently use GIS but plan to do so in the future: 27	
3	How institutions have implemented GIS focusing on the areas of hardware/software, staffing, levels of service, training, monetary support, and use.		

Given these statistics, it was predicted that the number of libraries with GIS at smaller institutions would almost double by 2012. The paper continued by concentrating on the twenty-two library institutions that provided GIS services. In terms of hardware it was established that at least one computer was used to support GIS services and that a majority (15) indicated the use of a printer. The use of a scanner (6), server (4), digitizer (3), Global Positioning System (GPS) unit (2), and plotter (1) were also indicated. For GIS software, the majority of the respondents (21) indicated that they used ESRI ArcView, a proprietary software programme. Data were sourced from various places and the top three were (a) the Government Printing Office Depository program (18), (b) via state agencies (9), and (c) through purchase (10). The majority of surveys (10) indicated that there was "one full-time employee who assists with GIS along with other duties" (Kinikin and Hench 2005a). In addition to this, five institutions also marked "students with some knowledge of GIS" (Kinikin and Hench, 2005a).

Kowal (2002) describes in detail the different levels of GIS services that libraries can offer which are summarised in Table 3. This gives an indication of the types of queries asked and the level of service required to support these queries.

Table 3: Levels of GIS Services Adapted from Kowal (2002)

GIS service level	Example of Query	Summarised Definition
high-level	"I want to make a map of outdoor camping facilities in Minnesota by country using this table of data I collected."	full GIS set-up
mid-level	"I'm researching the socioeconomic makeup of a region across the country and would like to look at a map showing demographic features of an area."	GIS applications available via the Web which require user input
low-level	"I need maps of China, both current and from other points in the twentieth century."	static maps available through the Web

Table 4: Service Levels from Kinikin and Hench (2005a) case study

Library		Non-Library	
Service Level	**Count**		**Count**
Provides a clearinghouse for geospatial information.	6	Users with some knowledge of GIS are given open access to a computer loaded with GIS software.	15
Library employee creates map at user's request.	6	Library does not support GIS Lab. GIS Lab is only used for discipline-specific courses.	1
User may consult with library employee for help, if needed.	6		
Users can make an appointment with staff or students for help with projects.	11		
Note: Values represent actual count(s) on returned surveys indicating GIS use (22) and are not mutually exclusive.			

The service levels in the Kinikin and Hench (2005a) study were determined and these are summarised in Table 4. The majority of respondents (15) indicated that "users with some knowledge of GIS are given open access to a computer loaded with GIS software" (Kinikin and Hench, 2005a).

The majority of respondents (19) indicated that the main users of GIS were the geography and geology departments and natural resources (11). However, other academic departments were included: business, engineering, sociology, political science, environmental science, biology, landscape architecture, city & regional planning, history, and nursing.

A follow-up survey was conducted with the 22 libraries by Kinikin and Hench (2005b). Only 11 surveys were returned and nine continued offering GIS services. The remaining two indicated that such services were discontinued due to lack of use and funding. Lack of use was attributed to the focused use of GIS services in Geographical and Geological disciplines and not multi-disciplines.

2.5 Summary

Šolar and Radovan (2008: 53) state that…

"*…recent developments in information and communication technologies, especially the internet and web, have brought significant changes in the ways we generate, distribute, access and use information. This new era, the digital era, is changing the paradigms of librarianship.*"

Given such developments, as well as the powerful analytical capabilities of GIS, this study aims to gain a better understanding of what map services are presently available in academic libraries. This was done by comparing the libraries at top internationally ranked universities.

3. Methods

As discussed above, most of the articles reviewed were published during the 1990s due to the ARL GIS Literacy Project. The author focused on the most recent of these publications and included those that provided an historical background of GIS services in libraries. The American bias in similar studies called for a wider geographical comparison. The use of an international ranking system or international library statistics would provide this wider comparison. The best suited ranking system for this study would be one that ranked international academic libraries.

However, research by Ellis, Heaney, Meunier, and Poll (2009) explains that such 'robust' data were not available. Given this, it was evident that global library statistics relevant for this study was outdated and both geographically and thematically insufficient. For this research, it was therefore decided to use the Academic Ranking of World Universities (ARWU), an internationally accredited ranking system for academic institutions.

The ARWU website (Shanghai Ranking Consultancy 2010) describes its formation in 2003 and its uses. It was first published by the Center for World-Class Universities and the Institute of Higher Education of Shanghai Jiao Tong University, China. The need to rank Chinese tertiary institutes according to international standards motivated its conception. *The Economist* (Wooldridge 2005) published a survey on higher education and stated that ARWU is the most widely used annual ranking of the world's research universities. Furthermore, it has been used to identify national strengths and weaknesses in order to facilitate reform and set new initiatives. Since 2003, the data has been updated and published on an annual basis.

ARWU annually ranks over 1000 universities and the top 500 are published on the web. The initial five academic libraries were identified by selecting the top university from each of the top five countries. Due to a collaborative map project between Stanford and UCT, the researcher's home institution, the researcher decided to include both of these universities. The top African universities were also included to gain a better understanding of what is presently taking place in Africa. Interestingly, only three African universities made the top 500 list and all were SA universities. This sample of universities would allow for both international and national comparisons. In total nine universities were identified. However, the website for the University of Tokyo was not in English and therefore removed from the review reducing the initial five universities to four. The eight universities included in this study are listed in the table below.

Table 5: Sample size - top universities per country including Stanford University and Africa
Source: Adapted from Shanghai Ranking Consultancy (2010)

List	World Rank	Institution	Region	Regional Rank	National Rank
1	1	Harvard University	America	1	100.0
2	3	Stanford University	America	3	40.2
3	5	University of Cambridge	Europe	1	88.5
4	23	Swiss Federal Institute of Technology Zurich (SFITZ)	Europe	4	34.1
5	27	University of Toronto	America	20	23.8
6	256	University of Cape Town	Africa	1	21.3
7	391	University of the Witwatersrand	Africa	2	21.3
8	461	University of KwaZulu-Natal	Africa	3	0.0

In light of the case studies already discussed, the libraries of these eight universities were compared by reviewing their respective websites and focused on certain aspects, namely (1) technology (i.e. hardware and software), (2) map related services, and (3) legislation (i.e. standards, policy and copyright).

Data collected from each library is presented and discussed in the following section. The literature has indicated that libraries may not be the only provider of map and/or GIS services and that a centre or a GIS lab/department on campus may also facilitate such services. Therefore, each university website was searched for such services located outside the management of the campus libraries and termed *non-library*.

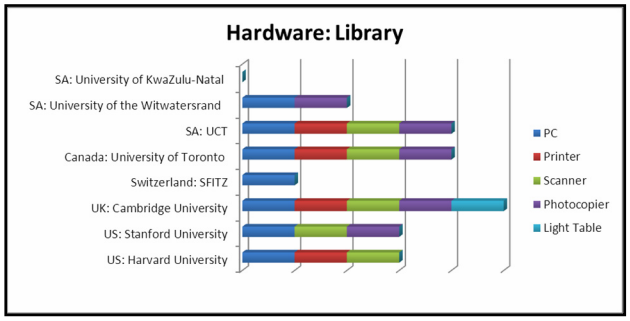
4. Results and discussion

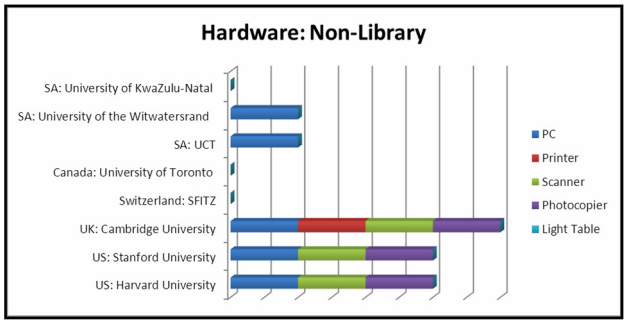
The results are discussed under the sub-headings technology, map related services and legislation.

4.1 Technology: Hardware and Software

Figures 2 and 3 indicate the types of library and non-library (i.e. outside library management) hardware available at the universities. Two SA universities, either did not fully specify the types of hardware or their websites did not display this data in detail.

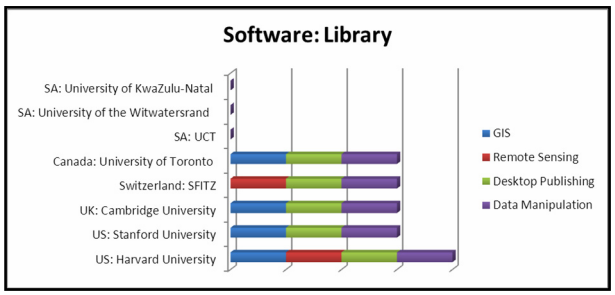
Most universities indicated that computers (PC), printers, scanners and photocopiers or a combination of these tools were available in the library. Non-library hardware for the US and UK universities included printers, computers and scanners. The rest only indicated computers.

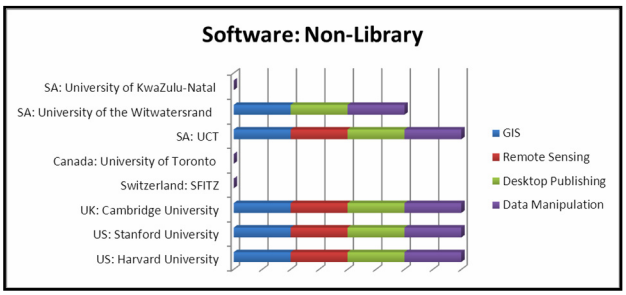




Figures 2 and 3: Accessible library and non-library hardware

Figures 4 and 5 indicate the range of software available in the library and non-library university locations. Most international university libraries indicated that a combination of GIS, remote sensing, desktop publishing and data manipuation were available both within and outside the library. The SA universities did not indicate library access to any of these software packages. It appears that for UCT and the University of the Witwatersrand, such access was only accessible outside the library.



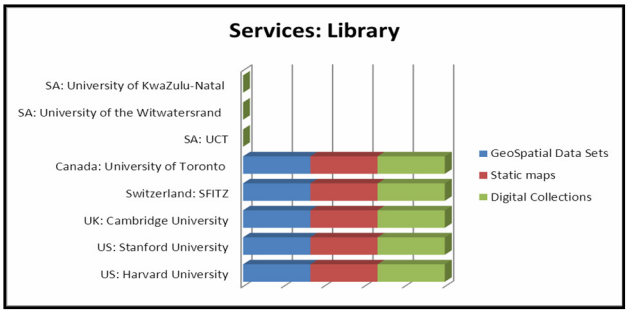


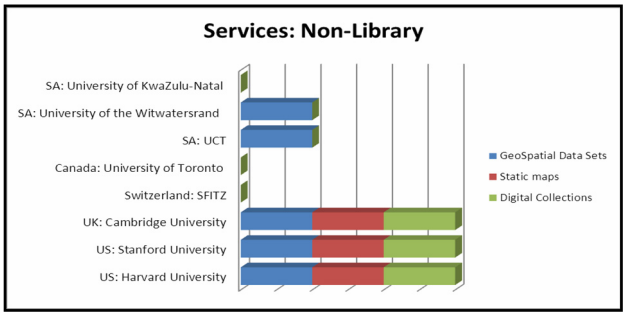
Figures 4 and 5: Accessible library and non-library software

4.2 Map Related Services

Figures 6 and 7 show that geospatial data sets (i.e. data that can be used in a GIS), static maps (i.e. images of maps), and digital collections (i.e. interactive map images similar to dynamic maps) are available both within and outside all the international libraries. For the SA universities, none of these services are available within the library. However, for UCT and the University of the Witwatersrand, there is access to geo-spatial datasets and digital collections outside the library.

The five international libraries offered the highest number of services. However, the figures show that for 60% (3 of 5) of the international institutions, all these services are also available outside the library. For two of the SA universities, these services were only available outside the library while one had no such services available either within and outside the library.





Figures 6 and 7: Accessible library and non-library services

4.3 Legislation: Map Related Policy

While most universities provided policies related to their collections and services, these did not directly pertain to maps or cartographic data. It would appear that SA libraries are on a par with international libraries with regard to policy, i.e. they adhere to and uphold similar copyright and license agreements. However, it is proposed that a better understanding of and access to documented standards and policy associated with maps, GIS and cartographic data is needed in a library setting.

4.4 Comparative Summary

This section has presented and compared the technology, services and legislation of each library. It was indicated that while the SA libraries do have map collections, these are not marketed or accessible as online collections, nor are they as readily available as most of the international libraries reviewed. Furthermore, GIS and related map services do not appear to be readily provided within the SA Libraries.

Most of the international libraries examined indicated that they have digital online images of their map collections, which are used for searching and browsing. In addition, GIS and map related services are provided by means of online datasets, website bibliographies, online map programs, etc.

Although similar copyright and license related policies were noted, explicit reference to maps and map related services were not as readily available. Further research into map, GIS and cartographic data standards and policy is proposed.

Since completing this research and at the time of writing this paper, UCT Libraries together with Stanford University Libraries, have made online static maps available via the UCT Libraries' website. This was done through the "William and Yvonne Jacobson Digital Africana Program at UCT". These maps are from the UCT Libraries' Special Collections and display the *Cape Town Street Plans* and *African Historical Maps* collections. Included is the *Maps of Africa* collection of Stanford University. This highlights the potential of collaborations and use of online access to showcase various collections.

Data for this project were collected in 2010 and it is important to note that other universities may have initiated similar map related projects since then.

5. Reflections and Conclusion

The results indicate that SA academic libraries or collections do not provide the same range of map related technology and services as international ones. Ascertaining reasons for this was beyond the scope of this study. Speculations include lack of funding, technology, awareness, training, and subsequent difficulty making use of GIS data in research. It is recommended that these issues should be the focus of future research studies in order to validate the tentative conclusions of this study. A better understanding is needed of how cartographic services are supported at SA tertiary institutions and the role that the academic library can play in this endeavor. In light of the literature reviewed, this should be done with the profession of the GIS Librarian as well as the context of Geographic Information Librarianship in mind.

This informal study has indicated that SA libraries 'lag behind' the map technology and services that constitute international academic map libraries and centres. Such services would provide researchers with the resources and tools to conduct research that may not be readily possible in an African context at present. Such services should be introduced in SA academic libraries in order for researchers to tap into a presently limited research niche and tool, i.e. GIS, map and library related research.

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