Books for SDI Education and Training in South Africa

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Abstract. The objective of the South African Spatial Data Infrastructure (SASDI) is to facilitate the capture, management, maintenance, integration, distribution and use of spatial information in South Africa. To realize this objective, SASDI stakeholders have to understand the purpose and benefits of participating in SASDI and its activities. Target audiences and knowledge areas for education and training within SASDI were identified. The goal of the paper is to present the results of a survey of books for potential use in SDI education and training in South Africa. The surveyed books were classified based on their content and matched to the identified knowledge areas. The results show that educational books on SDIs are available. A more in-depth study of books is necessary to establish whether they meet the needs of the specific target audiences identified for SDI education and training in South Africa.

Keywords: spatial data infrastructure, SDI, SDI awareness, education, training, books, South Africa

1. Introduction

In the early 1980s national spatial data infrastructure (SDI) initiatives emerged in countries such as the United States of America and Australia. An SDI facilitates and coordinates the access and exchange of spatial data for users and providers within all levels of government, industry, non-profit, academia, and citizens (GSDI 2004, Rajabifard et al. 2002). The focus of an SDI is data interoperability in order to share and make data available to a wide audience for their economic and societal benefit. An SDI is a collection of technologies, systems (hardware and software), standards, policies, agreements, human and economic resources, institutions and organisational aspects that have to be orchestrated to make it possible for users to access data (Coetzee 2012).

The South African Committee for Spatial Information (CSI) was established in 2010 by the South African Spatial Data Infrastructure Act of 2003. The CSI members are mandated with the responsibility of guiding the development of the South African Spatial Data Infrastructure (SASDI) as specified in the Act. Makanga and Smit (2010) stated that the lack of SDI expertise in South Africa will negatively affect the development of SASDI; this concern was confirmed at the first CSI meeting (CSI 2010). The CSI sub-committee for Education and Training was established to address this concern. The sub-committee is assigned with the task to provide forums for sharing experiences and discussing issues related to data, metadata, standards and systems; determine the education and training needs for the various stakeholders in the CSI and the SASDI; develop an overall framework of these needs; and develop a plan for funding the actual preparation of education and training materials, getting formal accreditation and the presentation of courses (CSI 2011).

Education has been identified as an essential component in the successful development and maintenance of a national SDI (World Bank 2011, Fernández et al. 2005). Education and training programs for GIS professionals and other individuals involved in the development of an SDI are essential, and academia should contribute through SDI education and research. Globally a lot of effort has gone into understanding and implementing SDIs and other types of data infrastructures. From these efforts a collection of education and training material has been produced. The European Commission (INSPIRE), the Federal Geographic Data Council (FGDC) in the United States of America, the Canadian Geospatial Data Infrastructure (CGDI), the European Strategy Forum on Research Infrastructures (ESFRI) and the Global Spatial Data Infrastructure Association (GSDI) are examples of initiatives and organisations that have published material on SDIs. In South Africa we need to leverage the international knowledge on SDIs and their implementation to ensure the success of SASDI.

The objective of the paper is to present the results of a survey of books for potential use in SDI education and training in South Africa. The rest of the paper is structured as follows: section 2 provides a description of the methodology; in section 3 the SDI education and training needs identified for the implementation of SASDI are described; in section 4 the book survey results are presented; in section 5 the survey results are matched to the identified needs; and conclusions are presented in section 6.

2. Methodology

To achieve the objective of identifying existing SDI education and training material, the needs for SDI education and training were identified, available material was surveyed and finally available material was matched to the identified needs.

SDI education and training needs for South Africa were identified as follows: first, the different *target audiences* were identified, next the response sought (learning objectives) and *message* (knowledge area) were described, and finally, a suitable *medium* (including the level of specialisation) was selected to convey the relevant messages to respective target audiences. Two workshops with individuals from academia, research institutes, government and industry were held in November 2011 and July 2012 respectively. Workshop participants identified, described and agreed upon target audiences to be engaged and the media and messages most suitable to reach those audiences (Rautenbach et al. 2012).

The survey of SDI education and training material was performed on two sources: 1) search for books on Amazon.com (http://www.amazon.com); and 2) sending a request for education and training material to a number of mailing lists in the geospatial community.

A search for books on Amazon.com with the keyword 'spatial data infrastructure' (without quotes) returned 572 books: 505 English, 11 German, 2 French, 1 Spanish, and 53 unclassified books. For each book, the following was recorded: title, authors, publisher, year of publication, format in which the book is available (electronic, hardback or paperback) and the lowest price and format in which the book can be ordered through Amazon.com. In the email requests for SDI education and training material contributors were asked to provide the following information: title, authors, publisher, URL, access (open, free, cost, copyright), description, and contact details. 28 responses were received, 9 of these included information about a book.

The 581 books were surveyed in three phases, refer to Figure 1. In the first phase, the following books were removed: duplicates, earlier editions (only the latest edition of a book was considered), research articles, and books that are irrelevant at first glance, for example, books that focus on a specific GIS application. After completing the first phase, 124 books remained to be surveyed in the next phase.

During phase two, each book was categorised to indicate its relevance to SDI and to describe its contents. Refer to Tables 3 and 4 for the relevant category descriptions.
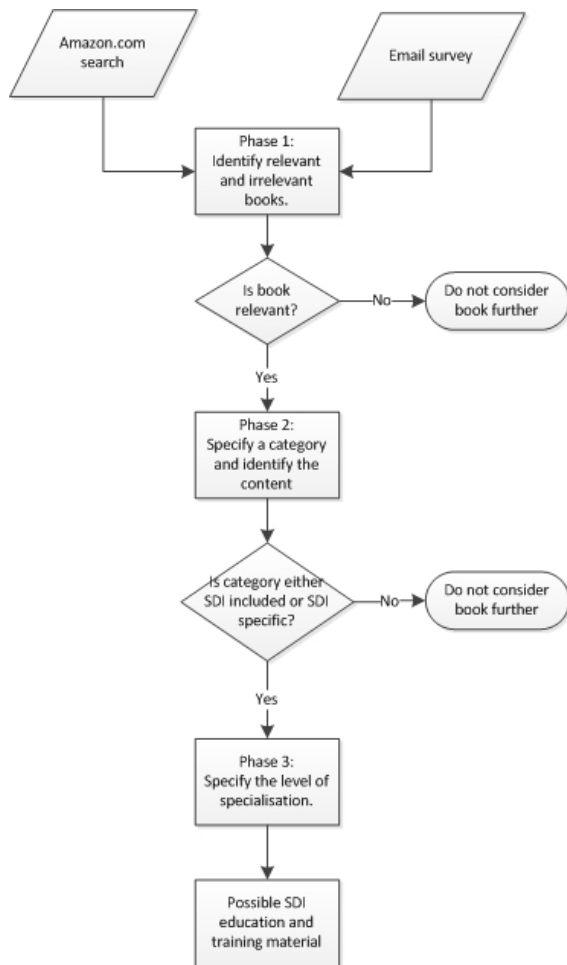
Figure 1. Flow diagram of the methodology.

SDI relevance	Description
Related	The book does not have a specific focus on SDI but is relevant because it includes material related to an SDI. Books on GIS, GISc or geomatics are included in this category.
SDI included	The book includes material on SDIs. For example, one or more chapters on SDI or the book description refers to SDI content in the book.
SDI specific	The book has a specific focus on one or more aspects of an SDI, i.e. SDI, spatial information infrastructure (SII), or geoinformation infrastructure are included in the title of the book.

Table 1. SDI relevance categories assigned to the books in phase 2.

Content Category	Description
GISc	The book includes topics related to GIS or GISc, but not SDI specifically.
Data or information	Data, information and SDI related issues such as data quality and information systems.
Standards	Standards, interoperability and harmonisation of data, information and services.
Technical	Hardware, software, web services and other SDI related technical issues.
Policies and legislation	Policies and/or legislation, including license agreements, relevant to SDIs.
People	Content related to the people aspect of SDIs, such as organisational issues, capacity building, marketing, awareness and community support.
Economics	Economic studies about SDIs and spatial information.
Combination	The book description refers to SDI in general and a specific content category (listed above) cannot be identified.

Table 2. Content categories assigned to the books in phase 2.

During the third phase a level of specialisation was assigned to the books categorised as 'SDI included' and 'SDI specific' to distinguish between books presenting research results and books aiming to convey understanding and ability.

Level of specialisation	Description
Understanding and ability	The book presents content with the objective of improving the reader's SDI-related understanding and/or abilities. Textbooks, amongst others, fall in this category.
Research	The book presents SDI research results that contribute to the knowledge and understanding of SDIs. Conference proceedings, products from workshops, and case studies were categorised as research books.

Table 3. Levels of specialisation assigned to books in phase 3.

3. SDI education and training needs

The following groups of SASDI stakeholders were identified as target audiences (Rautenbach et al. 2012):

- CSI members
- Decision makers, funders, and policy makers
- Custodians of SASDI identified base data sets
- Producers of SASDI non-base data sets
- Producers of SASDI services
- Providers of SASDI base data sets and services
- End users and consumers

The *CSI members* range from GISc technical experts to GISc managers and are appointed by their organisations to represent their interests in CSI. *Decision makers, funders and policy makers* do not necessarily use SASDI data and services on a day-to-day basis, but influence decisions related to SASDI. *Custodians* are defined by the Act as organisations or individuals responsible to capture, maintain, manage, integrate, distribute or use spatial information. Custodians (or their employees) typically have a strong GISc background. *Producers* of non-base data sets are experts from various disciplines who produce secondary or ancillary data sets derived from base data sets. *Producers* of services develop geoportal and associated services and have a background in information and communication technology (ICT). *Providers* provide access to the SASDI base and non-base data sets (as-is or with value-add) and associated services to end users and consumers. Representatives of this group do not necessarily have a GISc background. *End users and consumers* (GISc experts and non-experts) are citizens in general who access and use SASDI data sets and services through a provider.

Each of the target audiences' roles were examined and the following 18 knowledge areas were identified (Rautenbach et al. 2012):

- the value of spatial information for their respective purpose or job in SASDI
- spatial data and the principles of geographic information systems (GIS)
- overview of SDI, SDI principles and its benefits
- SDI component: data and metadata
- SDI component: standards and specifications
- SDI component: web services
- SDI component: institutional agreements
- laws other than the SDI Act related to SASDI, e.g. copyright and intellectual property right laws

- relevant knowledge areas in the South African GISc academic model[1,2]
- SASDI and its providers
- SASDI and the benefits to their respective purposes of participating
- SASDI base data and associated services
- SASDI policy and legal issues
- legislative responsibilities inferred on participants by the SDI Act
- information and/or training that providers have to pass on to users
- design and use of SASDI tools (e.g. a geoportal or clearinghouse)
- service implementation according to SASDI guidelines
- SASDI prescribed tools and technologies

All target audiences do not have to be experts in all knowledge areas and thus the required level of specialisation for a stakeholder group in each knowledge area was identified. Refer to Figure 2 for the different levels of specialisation. The triangle represents the relative number of people in a target audience whom a message should reach at that level of specialisation. For example, awareness is aimed at a large group, while at the research level a smaller number of individuals are involved.

Level of specialisation	Media	Example
Research: Contribution to knowledge	Postgraduate degree or research project	PhD / MSc Geomatics Research project by CSIR
Design solution: Independent problem solving by using own research and ideas	Four year degree or certificate course at appropriate level	BSc (Hons) Geoinformatics Registered GISc Practitioner
Select solution: Formulation of solutions to problems	Three year degree or certificate course at appropriate level	BSc Geoinformatics B Tech Geomatics Registered GISc Technologist
Apply solution: Apply predefined solution or method to a problem, i.e. solve familiar problems	Diploma or certificate course at appropriate level	Diploma in Cartography CE at UP Intro GIS-certificate Registered GISc Technician
Skills (how?)	Attendance course, workshop, material	CE at UP 3-day QGIS hands-on training
Knowledge (what?)	Attendance course, workshop, material	Presentations at the SDI workshop
Awareness	One-on-one discussion, presentation, material	PositionIT article NSIF brochure

**Figure 2.** Levels of specialisation and corresponding education and training media (Rautenbach et al. 2012).

[1] PLATO is the South African statutory body for GISc professional registration, http://www.plato.org.za/

[2] For more information on the PLATO academic model, http://www.gissa.org.za/plato-registration/academic-model

Table 4 shows target audiences and the corresponding level of specialisation required in the knowledge area, 'Design and use of SASDI tools'. Figure 3 shows how relevant messages are delivered through different media to the respective target audience.

Target audience	Level of specialisation
CSI members	Apply solution
Decision makers, funders, and policy makers	n/a
Custodians of SASDI identified base data sets	Skills
Producers of SASDI non-base data sets	Skills
Producers of SASDI services	Skills
Providers of SASDI base datasets and services	Design solution
End users and consumers	Awareness

Table 4. Target audiences, level of specialisation and corresponding media for the knowledge area 'Design and use of SASDI tools' (Rautenbach et al. 2012).
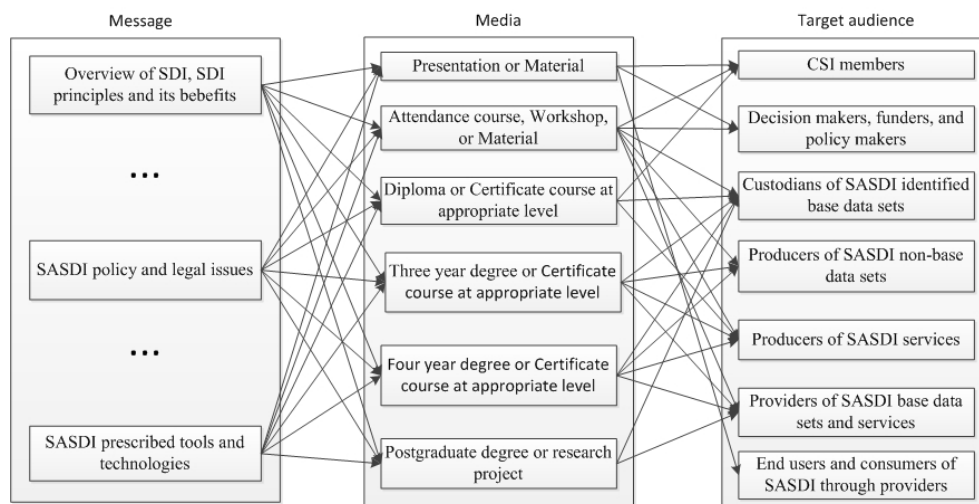
Figure 3. Delivering SDI education and training message through different media to identified target audiences (Rautenbach et al. 2012).

4. Survey of available education and training material

This section provides an overview of the 124 books from 31 publishers that were classified after irrelevant books had been removed. Only five publishers have published seven or more of the surveyed books. Refer to Table 5. The books spanned a period of 19 years, from 1993 to 2012 with no books published in 1995, 1997 and 1999. The year with the most book publications was 2010 (26 books).
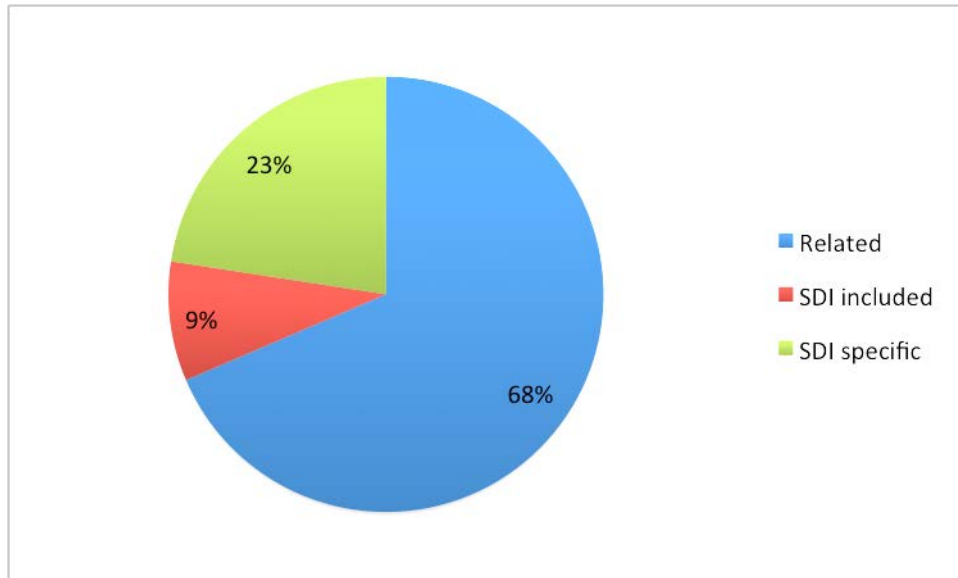
Publisher	Number of books	% of all books surveyed
Springer	45	34%
CRC Press	15	11%
Elsevier	10	8%
ESRI Press	8	6%
Wiley	7	5%
Other (31 publishers)	55	36%

Table 5. Publishers of the 124 surveyed books.

Figure 4 shows that for most books the cheapest option is paperback (43%), with electronic format a close second (38%).
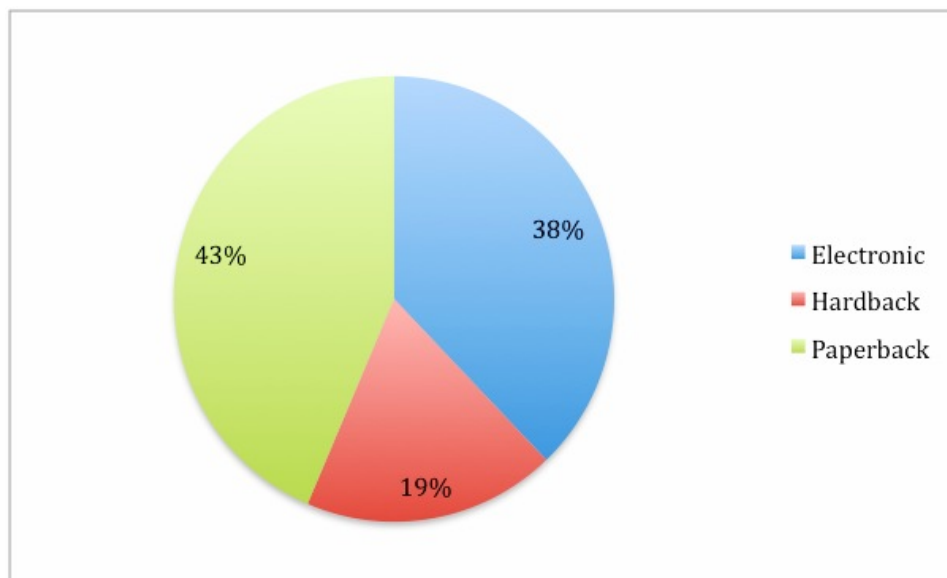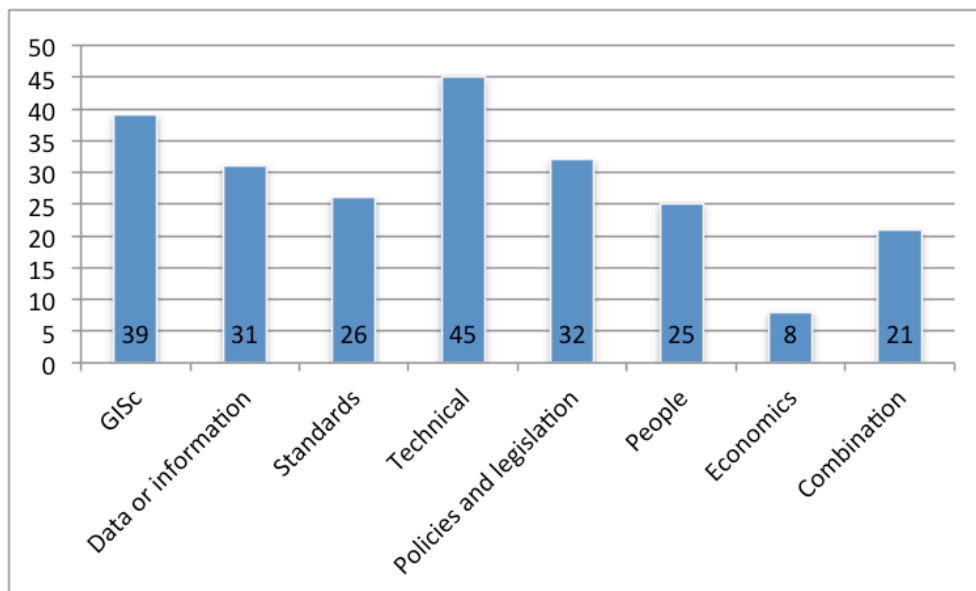

Figure 4. Available book formats.

Figure 5. SDI relevance of surveyed books.

Figures 5 and 6 show the SDI relevance and content categories of surveyed books. The majority of books are relevant to SDI, but do not include any SDI specific content ('Related'). The next biggest category of books has a specific focus on one or more aspects of an SDI ('SDI specific').

Figure 6. Surveyed books categorised by content.

5. Matching Book Survey Results to Identified Knowledge Areas

In this section we compare the identified knowledge areas and their required levels of specialisation to the book survey results. SASDI specific knowledge areas are excluded because books on SASDI will not yet exist.

Table 6 shows a cross matching of the identified knowledge areas and the level of specialisation required for all target audiences. This provides an overview of the level of specialisation required for each knowledge area.

For each of the knowledge areas, the relevant content category was assigned. Refer to table 7. In figure 7 the breakdown between 'Research' and 'Understanding and ability' per content category is shown. The highest number of books in a content category is 20 for the 'Combination' category.

Knowledge area	Awareness	Knowledge	Skills	Apply solution	Select solution	Design solution	Research
	Level of specialisation						
1. The value of spatial information for their respective purpose or job in SASDI	X	X					
2. Spatial data and the principles of geographic information systems (GIS)	X	X		X			
3. Overview of SDI, SDI principles and its benefits	X	X	X			X	
4. SDI component: data and metadata		X	X			X	
5. SDI component: standards and specifications		X			X		X
6. SDI component: web services		X				X	X
7. SDI component: institutional agreements					X	X	X

Table 6. Levels of specialisation required for different knowledge areas.

Knowledge area	Matching content category from the survey
1. The value of spatial information for their respective purpose or job in SASDI	GISc Economics
2. Spatial data and the principles of geographic information systems (GIS)	GISc Technical
3. Overview of SDI, SDI principles and its benefits	Combination
4. SDI component: data and metadata	Data and information
5. SDI component: standards and specifications	Standards
6. SDI component: web services	Technical
7. SDI component: institutional agreements	Policies and legislation

Table 7. Matching identified knowledge areas to book content and level of specialisation.
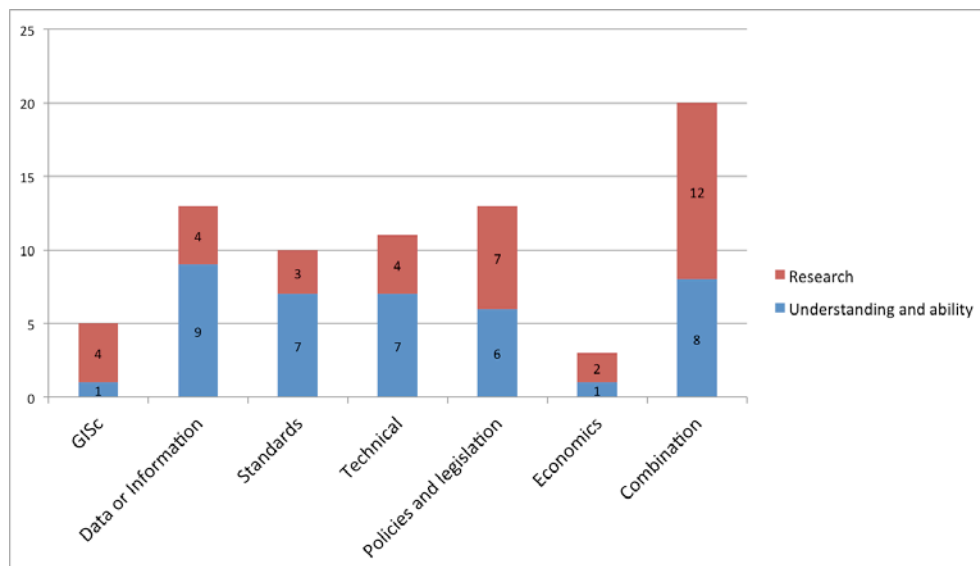
Figure 7. 'Research' vs 'Understanding and ability' per content category.

For the first two knowledge areas, the number of books shown in Table 7 is low, because only 'SDI included' or 'SDI specific' books are included. However, the level of specialisation required for these knowledge areas is low and relevant material should be available in most GIS textbooks. The initial

methodology included an 'Introductory' level in addition to the 'Understanding & Ability' and 'Research' levels. Introductory books would be appropriate where low levels of specialisation are required. However, it was difficult to distinguish introductory books from others due to the limited information available in the book description. For example, many GISc books include a short section on SDI (Harvey 2008, Kresse & Danko 2012), which is not mentioned in the book description.

For knowledge areas 3 to 7 books with education and training material are readily available. The question is whether less than ten books are 'enough'? One way to evaluate this could be to compare it with the number of books available on a different topic, such as GIS or cartography. However, SDI is a new and specialised field and can thus not be compared to the number of books available on GIS or cartography. Also, educational material for knowledge areas, such as data, web services and standards, are commonly embedded in books covering GIS and distributed systems in general.

A worrying figure is the low number of books relating to Economics, such as return on investment and financing models for SDIs. At the two workshops by the CSI sub-committee on Education and Training, the need to educate decision makers about the possible return on investment and cost benefits of spending money on spatial data and SDIs was raised repeatedly.

The question also arises whether these books are appropriate for the target audiences identified in SASDI: does a book's expectation of the readers existing knowledge match that of the identified target audiences? For example, if the authors of a book on geospatial web services assume that the readers have background knowledge in GIS, the book is not appropriate for IT professionals. The results of this survey cannot answer these questions. More in-depth book reviews are required,

6.   Conclusion

The survey shows that educational books on SDIs are available, but a more in-depth study of books is necessary to establish whether they meet the needs of the specific target audiences identified for SDI education and training in South Africa.

The survey results further show that numerous SDI publications are available in a variety of formats, including books, white papers, research articles, and reports. This material is full of relevant information, but needs to be synthesized into material that is useful for education and training purposes: the focus needs to move from research finding to knowledge for practical application.

In future work we plan to review the 39 books identified in this survey in more detail to evaluate their appropriateness for the specific target audiences identified in South Africa (a list of these books can be found at www.up.ac.za/cgis, click on Research > Projects > Developing a framework for South African SDI education and training). Gaps between the available books and identified needs will be easier to identify with the in-depth review. Such a review will assist with the identification of education and training material that needs to be developed for SASDI specifically. We also plan to analyse SDI content in curricula at universities and institutions outside South Africa, which will aid in the development of SDI content for the South African educational model.

Acknowledgements

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