

Lexical knowledge sources for cartography and GIS – development, current status and outlook

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Abstract. Lexical knowledge sources are indispensable for research, education and general information. The transition of the reference works to the digital world has been a gradual one. This paper discusses the basic principles and structure of knowledge presentation, as well as user access and knowledge acquisition with specific consideration of contributions in German. The ideal reference works of the future should be interactive, optimally adapted to the user, reliable, current and quotable.

Keywords: knowledge documentation, knowledge acquisition, specialized encyclopaedia, lexicology, terminology, cartography, GIS

1. Introduction

The aim of scientific research is to acquire new knowledge. It should always be in touch with current knowledge and has no chance of success without an awareness and evaluation of the available knowledge. The same applies to the disciplines of cartography and geoinformatics. As in other sciences, current expert knowledge is documented and published in various forms: as individual articles (papers) about often narrowly defined subjects in periodicals, scientific publication series or other compilations, as independent monographs, systematically subdivided into textbooks for educational purposes and finally also in *specialised encyclopaedias*. These in turn are especially useful for cartography teachers and students as well as for laymen who quickly need to look up technical terms.

In addition to being able to quickly reference terms and definitions and get clarification of other terminological questions, lexical knowledge sources in cartography and geoinformatics should serve the *sophisticated acquisition of knowledge* – as already postulated more generally above. They offer highly efficient knowledge storage under optimum conditions. Finally, they should “stimulate critical

reflection and *further thought*”, as Werner Witt so aptly put it in the preface of his 1979 “Lexikon der Kartographie” (original quote in German).

The terms “Lexikon” and “Enzyklopädie” can be distinguished relatively well in German: a “Lexikon” is “a reference book alphabetically arranged by keyword for all fields of knowledge or for a specific subject area”, while an “Enzyklopädie” is “a clear and comprehensive representation of the whole knowledge of all disciplines or of only one field” (Duden, 2007, pp. 598, 280, original quotes in German). In British and American English, however, the distinction is much more difficult. Smaller reference books are often termed “dictionaries”. More comprehensive works are “encyclopaedias”. An intermediate form is the “encyclopaedic dictionary” (Neumann, 1997; Schlichtmann, 2011). In this context, the German “Lexika” must almost be termed encyclopaedias. Accordingly, the titles of the German “Lexika” have been translated into English using this term.

2. Review, development/history

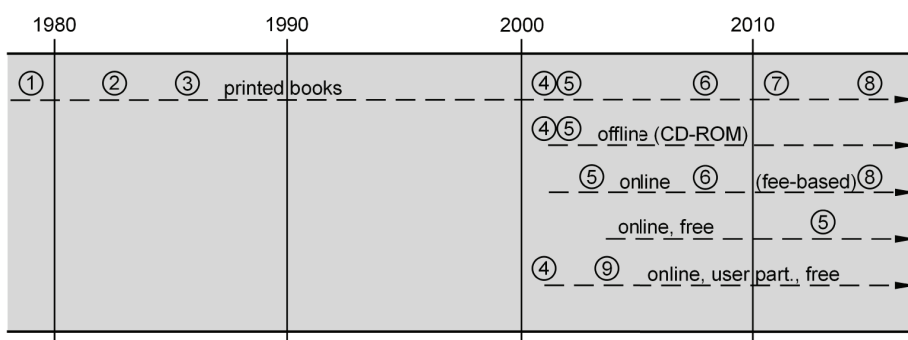
In response to the publication of the “Encyclopaedia of Cartography and Geomatics” (*Lexikon der Kartographie und Geomatik*) (Bollmann and Koch, ed., 2001/2002), Stams compiled a comprehensive “Review and Comparison” (*Rückblick und Vergleich*) of cartographic encyclopaedias (Stams, 2003). In the intervening 12 years, we have witnessed developments in lexical knowledge sources that far surpass those of the past century. The *transition to the digital world* has been a gradual one. The great from subject area universal encyclopaedias, which contain a selection of the main terms from subject areas that include cartography and GIS (cf. Koch, 1998), have been no exception. For example, the 30 volume Brockhaus Encyclopaedia (*Brockhaus Enzyklopädie*) was first published in digital format in 2002, on 2 CD-ROMs and 1 DVD; in 2005, it was published on 2 CD-ROMs and 1 USB stick. A free, ad-funded online portal was planned for 2008, but never implemented. In 2014, this largest German-language encyclopaedia ceased publication, no longer able to withstand the pressure of competition from WIKIPEDIA. The Encyclopaedia Britannica, which was available on CD-ROM as early as 1994, transitioned to an online edition in 2008/09 and gradually opened the door for anyone to participate in composing keyword articles. In so doing, it hoped to adopt the approach first taken with the launch of *Wikipedia* in 2001. The multimedia encyclopaedia “*Microsoft Encarta*” (1993-2009) took a similar route. Encarta also contained keywords for cartography and introduced feedback functions for the texts in 2005. The encyclopaedia was shut down a few years later, in 2009 (Kleinz, 2009). As printed books (30 volumes) the big Polish encyclopedia “*Wielka encyklopedia PWN*” has been published in the years from 2001 to 2005. Also this reference work contains numerous cartographic entries.

Steps in the *development of lexical knowledge sources* for cartography and GIS since 1990:

- Printed version (available to purchase)
- Printed version and eBook (available to purchase), pdf file (free)
- Offline versions: CD-ROM or DVD-ROM versions and USB stick (available to purchase)
- Online version, fee-based (subscription, pay-per-view)
- Online version, free

Online version with possible user participation (desirable), free

It should be noted that not all cartographic encyclopaedias have taken the final step (online, free, participation possible) and are available as combination sales (primarily printed+online).



- ① W. Witt: *Lexikon der Kartographie*, 1979
- ② R. Ogrissek (ed.): *Brockhaus abc Kartenkunde*, 1983
- ③ I. Kretschmer, J. Dörflinger, F. Wawrik (eds.): *Lexikon zur Geschichte der Kartographie*, 1986
- ④ R. Bill, M. L. Zehner: *Lexikon der Geoinformatik*, 2001
- ⑤ J. Bollmann, W. G. Koch (eds.): *Lexikon der Kartographie und Geomatik*, 2001/2002, 2003, 2013
- ⑥ S. Shekhar, H. Xiong (eds.): *Encyclopedia of GIS*, 2008
- ⑦ H. Schlichtmann: *Cartosemiotics: a short dictionary*, 2011
- ⑧ M. Monmonier (ed.): *The History of Cartography*, Vol. 6, 2015
- ⑨ GISWiki, 2003

Fig. 1. The most significant reference works for cartography and geoinformatics 1979-2015 and their publication versions

The actual revolution in specialised encyclopaedias for cartography and GIS began in 2001/02. Whilst the three large encyclopaedias of the late 20th century (Witt, 1979, Ogrissek, ed., 1984; Kretschmer, Dörflinger and Wawrik, ed., 1986), including the *Encyclopaedic Dictionary of the ICA Commission II* (Neumann, 1997), were still only published in print, the two-volume edition of the “*Lexikon der Kartographie und Geomatik*” (“*Encyclopaedia of Cartography and Geomatics*”) was immediately followed by a CD-ROM edition with identical contents, and the “*Lexikon der Geoinformatik*” (“*Encyclopaedia of Geoinformatics*”) (Bill and Zehner, ed., 2001)

was available online shortly after its publication as a printed book (Geoinformatics Service of the University of Rostock). No new edition of either encyclopaedia has since been published, despite the fact that they have long been out of print. On the one hand, this would seem to indicate that a substantial part of the content remains valid despite the lack of updating and on the other, that the transition to the digital world is finally complete. The publication forms of the “*Lexikon der Fernerkundung*” (“Encyclopaedia of Remote Sensing”, Baldenhofen 2004, updated 2015) – in 2004 CD-ROM, in 2005 DVD, in each case also as a web version, free of charge – also confirm this development.

The previously mentioned “Encyclopaedia of Cartography and Geomatics” also provides a typical example of the gradual progression of lexical versions. After sales of the printed and CD-ROM version were suspended, a fee-based online version followed. For the past few years, the encyclopaedia has been available free of charge on the Internet. The publisher has no current plans to update or further develop the encyclopaedia, such as by adding dynamic cartographic illustrations, real 3D maps, etc. Thus the opportunity for development is unfortunately not being exploited. Since 2010, the online edition of the “*Lexikon der Geowissenschaften*” (“Encyclopaedia of Geosciences”) (Landscape 2000-2002), a version with adverts of every sort, has developed a certain kind of competition, having been posted online as a pirate copy by Stolzenberger-Ramirez, University of Jujuy, Argentina (“*GeoDZ-das Lexikon der Erde, Geografie-Geologie-Geowissenschaften-Geodäsie-Topologie*”), albeit without citing the authors.

Among the (few) more recent global encyclopaedias, the “*Encyclopedia of GIS*” from US publisher Shekar and Xion has an entirely different style to that of the Rostock “Encyclopaedia of Geoinformatics”, even though both are available digitally as well as in print. Here, an international team of authors composed detailed essays on 41 problem areas and provided extensive literary references, giving the impression of an alphabetically structured manual. Similar characteristics can be found in Volume 6 of the compiled “*History of Cartography*” – “Cartography in the 20th Century”, published in 2015, currently unavailable online, but available to purchase as an eBook. The genesis of this encyclopaedia is also remarkable. The methodology and practical realisation have been described in detail by the publisher (Monmonier 2014). The “History of Cartography”, Vol. 6, completes the specialised encyclopaedias of cartography that have been produced in Germany and Austria in the 20th century.

Encyclopaedias for special fields of cartography and geoinformatics are very rare, but there are some dictionaries and glossaries, such as those for automation in cartography, topography etc. A special feature from the last few years is the work “*Cartosemiotics: a short dictionary*” by Hansgeorg Schlichtmann (2011). It is “an encyclopaedic dictionary [...], that is, it combines definitions of terms with comments on the matters being discussed” (Schlichtmann, 2011, p. 1). The articles are arranged alphabetically and linked by cross-references.

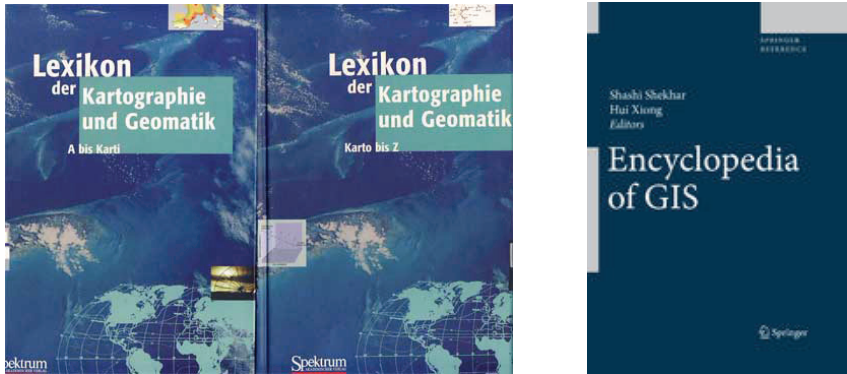


Fig. 2. Two examples of encyclopaedias (German and English), available as printed books and digitally



Fig. 3. Lexikon der Kartographie und Geomatik (Encyclopaedia of Cartography and Geomatics), CD-ROM and accompanying booklet, 2002

3. Basic principles and structure of modern lexical knowledge presentation in cartographic and GIS contexts

For both printed and online encyclopaedias, it is important to convey the scientific and conceptual structure. It goes, as far as possible, a *unified scientific concept* should be applied, which should be based on the foundations of modern science. The explanation of this concept can be carried out in the form of an introductory text, of graphs or as systematic classification (topical table) of terms or key words, in part also linked with the naming of the field editors (if in existence, see “Topical Table of Contents” in “Encyclopedia of GIS”, 2008). From this, the user can also identify the extent to which peripheral areas and disciplines have been included. In the case of the “Lexikon der Kartographie und Geomatik”, the name suggests that, alongside

extensive cartographic knowledge of geodesy, photogrammetry, remote sensing, geoinformatics and geostatistics have also been included.

The *selection of terms and keywords* will always be difficult, even though there are almost no limits to digital storage and presentation. However, the user should not be faced with an endless flood of information, but rather with a well thought-out set of terms and associated texts from which a basic understanding and knowledge of usage can be obtained. Proven terms with wide application must always be included, but rarer terms that are scientifically and practically important should be taken into account as well. This also applies to the terminology of individual scientific schools. It can be useful to differentiate by scope: in addition to keyword texts composed with varying degrees of detail, there should be longer essays that provide a comprehensive inventory of important subtopics and scientific fields.

This is the procedure used in the “Lexikon der Kartographie und Geomatik”, 2002/04, for example. Twenty-eight of the 5,500 articles are detailed essays. If an encyclopaedia is uniquely designed for scientific and academic use, it can also have a detailed, essay-like representation throughout, which dispenses with the use of links. In that case, “Cross References” and extensive reading lists (“Recommended Reading”) are added (see “Encyclopedia of GIS”, 2008). However, even such essays cannot provide a comprehensive description. For this you need handbooks, textbooks and specific monographs.

Obsolete terms must either be omitted or explicitly identified as such using the term “obsolete”. Currently controversial terms should not be neglected. However, their different interpretations according to different scientific viewpoints must be explained.

Biographies, e. g. of eminent scientists, are usually reserved for specialised encyclopaedias. However, the biographical texts should not be too long. It is often better to use biographical databases on the web. The inclusion of *product names* and company names is controversial. The two well-known geoinformatics encyclopaedias – “Lexikon der Geoinformatik” and the “Encyclopedia of GIS” – both contain such terms. The “Lexikon der Kartographie und Geomatik” does not include product names with a commercial background, such as from the hardware and software industry (except in tables).

A largely uniform structure of the texts of keywords facilitates knowledge discovery from the lexicon. A single, clear and concise definition should be based on the keyword and its synonyms and, if appropriate, the term in another language. What follows is a descriptive and explanatory section of text (the main section), with concluding historical remarks where applicable. In many cases it also proves useful to start the descriptive text with the historical background (see “Encyclopedia of GIS”, “Wikipedia”). Long essays are made clearer using *subtitles*. These can be differentiated by subject, for example, or can be largely uniform (“Encyclopedia of GIS”: Term/Synonyms/Definition/Historical Background/Scientific Fundamentals/Key Applications/Future Directions/Cross References). Further reading should be included in a limited way. An alphabetic index (subject index) at the beginning

or the end of the encyclopaedia is very convenient and can enable faster access to the articles.

4. User access, knowledge acquisition and knowledge utilisation

The *knowledge* in an encyclopaedia should be *reliable, quotable and current*; access to knowledge and its exploitation should be as quick and uncomplicated as possible. In addition, ways to broaden and deepen the limited lexicon knowledge must be developed. There must be options for accessing *original sources*, becoming acquainted with more *extensive literature* and accessing closely associated or factually related keyword texts via *links*. These requirements can be met in different ways in the individual lexical formats. While all encyclopaedias with online connectivity provide the best conditions for this, even strictly classical publications can be structured in such a way that terms are easily accessible and the information is sufficiently interlinked by reference keywords. Nevertheless, such encyclopaedias remain static by nature. This is especially true in the worst-case scenario where only a single edition exists. This used to be the case for all hard copy and off-line encyclopaedias on cartography and GIS. But even a static, printed encyclopaedia can be designed to ensure that the keywords are oriented toward three (new) scientific methods and fields of activity in cartography and GIS. An example of this is the aforementioned “Lexikon der Kartographie und Geomatik”, which contains texts on the *acquisition, application and evaluation* of cartographic knowledge (see Figure 4).

In addition, the keyword texts can also be developed in terms of *methodology* and *process levels*. Overall, the structural design of the texts enables an effective mental development by the user as well as comparison thereof. It should not be forgotten that the keyword texts include a significant potential in terms of *implicit knowledge structures*. The user can tap into this knowledge individually (Bollmann, Koch, 2002). The book lexicon mentioned has been developed on the basis of a lexicon database. This technology is common practice today. This meant that rapid and highly effective communication between authors, author groups, editors and publishers was possible. The database was also the basis for the *thematic online forums* proposed by Trier University (Bollmann, 2002) which should concretise, consolidate and develop the collected knowledge. This endowed the project as a whole with a dynamic output. Unfortunately, the forums did not come into being. Nevertheless, this encyclopaedia is now available online, free of charge, and even the most popular search engines (Google, Bing) frequently access this knowledge.

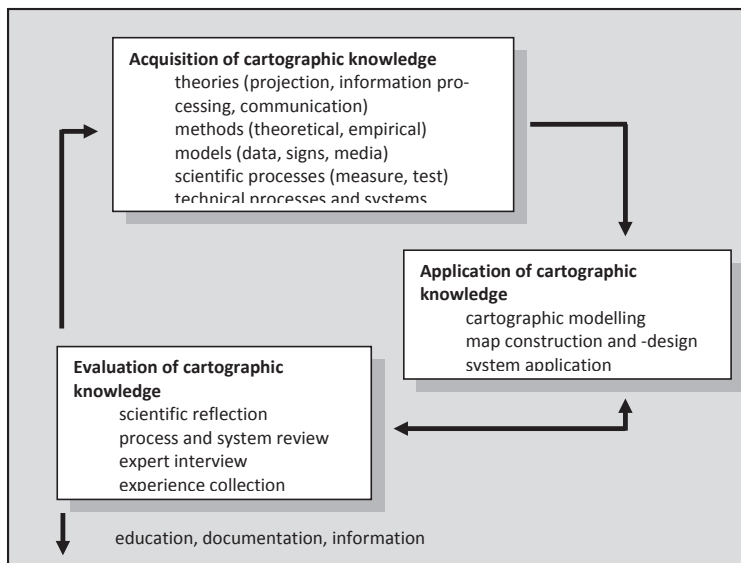


Fig. 4. Process of cartographic knowledge formation using the encyclopaedia “Lexikon der Kartographie und Geomatik” (2001/02, 2003, 2013), source: Bollmann & Koch, 2002

It is noteworthy that, since the 1990s, the extraction of knowledge for the purpose of structuring task and activity fields of map use has increased in importance. In this way, communication and use models of cartographic representations can be constructed (Uthe, 1996).

This path toward a dynamic palette of knowledge, to which anyone can contribute with improvements and updates, has been followed by the “Lexikon der Geoinformatik” of the University of Rostock GI Service since 2002, and by GISWiki, founded in 2003 by H.-J. Lücking in Bremen. Both are non-commercialised, web-based projects dealing exclusively with the conceptual environment of geographic information systems. Core terms of cartography and associated fields are included. These works, which are similar in terms of topic and character, necessarily lead to competition.

Technical access to knowledge, the so-called navigation, works in encyclopaedias of cartography and GIS in the same way as in other than it is in other specialist encyclopaedias. In print encyclopaedias, desired terms can be sought either in a topical index or in an alphabetical index (if available). In this case, it is usually immediately obvious whether the term in question is a regular keyword or a reference keyword. The user then turns to the specified page to find the term. If no term index exists, the keyword must be looked up directly. If you want to go further into the contents of a text, further search actions are needed. Of course, there may still be other reference terms elsewhere in the alphabet that need to be looked up. Online encyclopaedias, in which reference keywords are linked and can be displayed with a click of the mouse, provide a simpler and quicker solution in such cases. Images in online

Search engines provide an alternative to dictionaries and encyclopaedias as a means of acquiring knowledge. Google and Bing are the most widely known and most-used Internet search engines. When a single term, multiple terms or a question is entered, for example, the system returns various types of informative documents, not only encyclopaedia articles. The selection and sequence of the informative documents displayed varies (to some extent) from search engine to search engine. Each search engine has its own relevance criteria. The user's search history (implicit criteria) also plays a role.

So-called *vertical search engines* refer to a limited topic on the web. They capture only specific web documents. Where cartography and GIS are concerned, more research is required here. Undoubtedly, such a vertical search engine, such a portal could be quite useful. In this connection, it should also be mentioned that different online encyclopaedias offer "thematic tours", e.g. the "Lexikon der Geoinformatik" of the Rostock University. Here, only keywords or articles from a selected subject are displayed on the screen.

5. Further development, outlook

In the end, the question remains: does the existence of the "free encyclopaedia" Wikipedia, which has been collectively maintained by volunteer authors since 2001 and contains ever increasing numbers of keyword texts on cartography and GIS, make the maintenance, further development and new development of all types of independent specialised encyclopaedia redundant? *Currently, and for the immediate future, these are not yet obsolete!*

Even though some users continue to enjoy leafing through a printed book and feel a need for the continuous reading of encyclopaedia content, only an online encyclopaedia can provide all-encompassing possibilities. If it is economically feasible to produce a printed version in parallel, then that should be welcomed. It is of fundamental importance that the evident advantages of modern printed encyclopaedias described above be linked with those of digital encyclopaedias. Thus, there should be direct digital access not only to references, illustrations and map examples, but also to sources of information such as basic literature and further reading. All graphical representations should be integrated, with no more isolated "colour charts". The entire range of multimedia processes should be used, such as mouse-over, animation, dynamic time lines and interactive activities.

The *ideal version of an encyclopaedia for cartography and GI sciences* should be dynamic, interactive and optimally adapted to users, thereby facilitating their work in conjunction with a modern editorial environment (content management system). Core content should still be produced by internationally recognised experts (cf. Wirtz and Strohmer, 2014). Whether the collaborative method of producing encyclopaedias has a future remains to be seen.

6. Conclusion

For 4 decades encyclopedias accompany the development of the relatively young scientific discipline cartography. Also in the even younger geoinformatics reference works were gradually compiled since beginning of the 21st century. In the German-speaking world these works, in particular the *Lexikon der Kartographie und Geomatik* the self-concept have moulded of the disciplin. Internationally the *Encyclopedia of GIS* written in English had and still had an ever broader influence.

All newer encyclopedias can be used online. This is a big advantage for the quick information aquisition. However, they must be updated permanently and be modernised further. An adaption to the standards of modern media of information and communication is essential. A dynamic encyclopedia version should be envisaged. Defined subject complexes are compiled by distinguished experts collaboratively, in such an approach. A mutual peer-review-procedure would guarantee a state of information which would be a reliable reference for the discipline.

Thus both main functions of encyclopedias can be fulfilled completely, the documentation of the knowledge and the knowledge acquisition.

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