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TEMAP: a new project of the Czech Republic for accessing map collections (2011-2015)

Keywords: Map collections; *map cataloguing*; digitising of maps; metadata; cartometric analysis.

Summary: Project TEMAP of the Ministry of Culture of the Czech Republic concerning technology for accessing the map collections of the Czech Republic and methodology & software for protection and use of cartography works of national cartographic heritage was created in cooperation with the experts of the Moravian Land Library and Masaryk University in Brno and Charles University in Prague.

Among the expected results of the project are model technology, methodology and other tools for processing, preservation and on-line access of the map collections. A solution is going to be developed combining in an innovative way the area of cartography, the latest web technologies and knowledge of memory institutions. Software development will focus on supporting bibliographic and cartographic processing of collections and subsequent use of data and metadata for new ways of access. The core of the software solution will be the tool Georeferencer enriched with new features. Also, new methodologies will be created for special description of cartographic documents reflecting new international cataloguing rules RDA. Important will be also the support of factual description. These methodologies not only take in consideration Czech cataloguing practice, but will be practically tested in the scientific processing of the parts of the map collections of the participating institutions.

Selected documents from these collections will be digitized and made accessible on-line. The issue of copyright related to digitization will be dealt with. Secondary outcome will be the rescue of the most endangered documents. In the case of the Map collection of the Faculty of Science of Charles University in Prague, one of the largest of its kind in Central Europe both in its content and scope (approx. 130,000 documents), it is expected to process about 40% of the funds. Preference will be given to old prints and manuscripts till 1850 that are in imminent danger of degradation of physical media.

The project will also enable further development of the on-line subject database the Geographical Bibliography of the Czech Republic. Geographical Library of the Faculty of Science, Charles University, has been working on this database since 2008.

Finally, new technological procedures for cartometric analysis of selected cartographic documents will be proposed. Web presentation of the results should be very user friendly. It will be supplemented with e-learning course, which will simply explain how to use the new technologies. The basic methodology for cataloguing old maps was created, formal descriptors for their processing were designed and the issues concerning identification of documents were processed in the first year of the project (2011) at the Charles University, 9500 records were catalogued (3 complete). Digitizing working line was created for the preparation, processing, checking and re-saving of the documents. Scans (TIFF, JJPEG) are saved in two repositories and in another secure storage. 8000 old maps were digitized. Metadata in format METH were designed and tested. Licensing agreements for publication of full-texts of cartographic documents were prepared and copyrights for digitized documents were dealt with.

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About the TEMAP project

The project entitled *TEMAP: Technology for Access to Czech Map Collections: Methodology and Software for Protecting and Utilising National Cartographic Heritage Works*[1], receives financial support from the Czech Ministry of Culture and was established in conjunction with specialists from the Moravian Library in Brno ("MLB"), Masaryk University in Brno ("MU") and Charles University in Prague ("CU"). The project time frame is five years. TEMAP follows up on individual partners' independent research: MLB's research objective *Historical Funds of the Moravian Library in Brno*[2] and the *Early Maps Online* project[3]; UC's project *Bibliography of Czech Geography Online*[4]; and MU's projects focused on the visualisation of spatial data.

The aim of the project is to create new processes, methodologies and software tools for the analytico-synthetic processing and protection of and online access to map collections. A solution will arise which combines the fields of cartography, cutting-edge web technology and the knowledge of memory institutions in an innovative manner. Software development will be primarily focused on support for the bibliographic and cartographic analytico-synthetic processing of map collections at memory institutions, and on the subsequent use of the data and metadata obtained to streamline processes and provide the public and professionals with access to the collections. The core of the software will be the Georeferencer, a tool that will be expanded to include new features (support for cartography design, analytico-synthetic processing of maps, searching maps according to graphic similarity, etc.). New methods that reflect the international cataloguing instructions Resource Description and Access (RDA)[5] will be put in place to describe cartography documents. These methods will take current practice into account and at the same time will be verified when the oldest and rarest sections of the map collections at MLB, UC and MU are studied. Selected documents from these collections will be digitalised and made accessible online. A secondary result will therefore be the saving of priceless documents which are at greatest risk. The project will also make it possible to further develop the Bibliography of Czech Geography Online database, which will be enriched with older records and views of tested Czech cartography. In compliance with the copyrights, relevant full texts will be made accessible online. Technical processes will be designed for carrying out cartometric analysis of selected cartographic documents. The results will be provided online in the form of specialised maps with the most important works from the processed collections. An e-learning course will be added to the collections' website that will explain how to use the new technology effectively.

This article focuses on the part of the project taking place at Charles University in Prague.

Processing at Charles University in Prague

Map Collections at the Faculty of Science of Charles University in Prague

The map collections at Charles University's Faculty of Science[6] were created at the same time as the Geographical Institute at Charles University's Faculty of Arts in 1891. In June 1920, the Institute and the collection were integrated under the new Faculty of Science. In November of that

[1] http://www.temap.cz/
[2] http://www.mzk.cz/o-knihovne/vyzkum-projekty/archiv-projektu/historicke-fondy-mzk-2004-2010
[3] http://www.oldmapsonline.org/
[4] http://www.geobibline.cz/
[5] American Library Association 2010, RDA, Chicago : American Library Association.
[6] https://www.natur.cuni.cz/geografie/mapova-sbirka

year, following intensive preparations by the Academic Board headed by Prof. Václav Švambera, the collection gained the status of the "State Map Collections". It reported directly to the Ministry of Education and obtained large government grants for acquisitions. One of the reasons for establishing the organisation was to obtain large collections from the archives in Vienna. Charles University's Geographical Institute also substantially contributed to the debates and formation of Czechoslovakia's national borders. After World War II, the collection acquired a number of confiscated materials from German universities and castle libraries. The National Museum's and Czech National Library's map collections also became a part of the collection. The State Map Collections maintained its leading position up until 1952, when the communist government "reorganised" the sciences and arts and the collection was integrated into the Czechoslovak Academy of Sciences. There the collection remained from 1953 until 1993. In that year, the Academy of Sciences' Geographical Institute was dissolved and the collection was returned to the original owner. The administrators of the collection had managed to process part of the collection into card catalogues. After the revolution, cartography students entered part of the card catalogue into an Access database. As the collection staff was small, no steps could be made to systematically document and provide access to the collection. There was never enough funding to restore, catalogue and digitise the collection. As a result, it is currently very difficult to navigate the collection. Regrettably, most other Bohemian and Moravian map collections and archives are in a similar state. Now a fundamental change can take place in connection with the TEMAP project. The collection is composed of approximately 130,000 map sheets, around 3,000 atlases and 60 globes. Approximately 50% of the fund is made up of early prints and manuscripts dating before 1850. This scope and content makes the collection unique not only within the Czech Republic, but also throughout Central Europe. Similar university collections are located in the distant cities of Paris and Oslo[7], but not even there do the collections contain such high numbers of early prints and manuscripts. The collection is an essential national cultural landmark, gathering important Central European cartographic documents from many previous generations over the past 500 years.

Bibliography of Czech Geography Online

Many digitised collections have problems in describing, creating metadata and subsequently selecting documents. Bibliographies are a good starting tool for creating a digitised collection. The Bibliography of Czech Geography Online has been in development since 2008. It is published by Geography Library at Charles University's Faculty of Science, the library at Masaryk University's Faculty of Science, and the Department of Geography at the Faculty of Science in Ustí nad Labem. A total of twenty libraries in the Czech Republic, including the Czech National Library and the Library of the Academy of Sciences of the Czech Republic, have joined the project. At the beginning of 2012 it contained 162,000 bibliographic records of all document types, including grey literature. Nearly 12,000 URL addresses of full text and 8,000 PDF and JPG objects (full texts, map views, etc.) were added to the selected records. The database was primarily created to cover the 20th century, but as part of the TEMAP project, it is growing to also include the earliest documents (from 1450 on) – mainly full text and map views. There are also plans to interconnect the bibliographic records with the university repository where digitised cartographic documents are stored.

[7] O. Loiseaux (editor), 2000, World directory of map collections München : K.G. Saur.

Map preparation and cataloguing

It was essential to prepare sample documents to test new methodologies and software. To this day, a method has not been sufficiently developed in the Czech Republic for cataloguing cartographic documents and especially early cartography prints according to current cataloguing rules. At the start of work, research was conducted. The key documents are the ISBD (CM): International Standard Bibliographic Description for Cartographic Materials[8] and Ivana Andresová's Cataloguing of Cartographic Documents[9] which, while beneficial, remains very general in some areas and does not deal with complex issues associated with special cataloguing. Another key document was Terminology in Geodesy and Cartography ČSN 73 0401[10]. Issues regarding map collections and the cataloguing of cartographic materials were discussed in papers by R.V. Tooley[11], a bibliography of Austrian atlases[12], J. Dörlingers Österreichische Kartographie im 18. und zu Beginn de 19. Jahrhunderts[13], I. Nebehay[14] and P. Voit's book *Encyklopedie knihy*[15]. Unpublished methodologies available at the libraries, especially the National Library, were also examined.

It was necessary to study, revise and add to the current available national methodology for cartographic materials and early prints. Furthermore, the differences in the participating libraries' cataloguing policies were harmonised and unified. Libraries use valid international norms and standards, but sometimes various "customary rules" in the analytico-synthetic processing history have an effect that lead to different output.

Differing approaches in the cataloguing process were analysed and options for harmonising the processes were proposed. It was particularly important to set the chronological boundaries for early printed maps. The following options were considered: 1800, when there is an observable difference between illustrations and maps (geometrically); or 1850, based on Military Mapping II (1852) or Military Mapping III. Up until 1850, non-decimal map layouts were used. In the end, 1850 was set as the time boundary for defining "early printed maps".

Close cooperation was forged with the Czech National Library, especially with expert commissions for subject control, early printed books and special materials.

Basic cataloguing and methodology rules were set out and special problems associated with cataloguing early printed maps were addressed. These problems included cataloguing extra additions and overprints, note fields, document formats or the MARC 21 field for scale and geographical coordinates (034 and 255). A rule was also made that the scale will always be converted[16], if possible, so that it can be subsequently georeferenced. E.g.: 255 |a Scale [ca 1:240,000]. 7.9 cm = 2 Böhm. Meilen |c (014°57´28" E --017°03´17" E/050°52´06" N -- 049°59´30" N)

It was also essential that all institutions collaborate in the creation of geographical and name authorities in the National Authority File at the National Library.

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[8] Národní knihovna ČR 1997, *ISBD(CM)*. Praha: Národní knihovna ČR.

[9] Andresová, I. 2005. Katalogizace kartografických dokumentů: příručka pro katalogizátora s příklady ve formátu UNIMARC a MARC 21. Praha: Národní knihovna České republiky.

[10] Český normalizační institut 1989, Názvosloví v geodézii a kartografii, Praha: Český normalizační institut.

[11] R. V. Tooley 1999-, Tooley's dictionary of mapmakers, Tring, Herts : Map Collector Publications.

[12] I. Kretschmer, J. Dörflinger and H. Hühnel (editor), c1995. Atlantes Austriaci , Wien : Böhlau.

[13] J. Dörlinger 1984**,** Die österreichische Kartographie im 18. und zu Beginn des 19. Jahrhunderts, Wien : Österreichische Akademie der Wissenschaften.

J. Dörlinger 1988**,** Österreichische Kartographie im 18. und zu Beginn de 19. Jahrhunderts, Wien : Verlag der Österreichischen Akademie der Wissenschaften.

[14] I. Nebehay 1981-1984**,** Bibliographie altösterreichischer Ansichtenwerke aus fünf Jahrhunderten,. Graz : Akademische Druck- und Verlagsanstalt.

[15] P. Voit 2008**,** Encyklopedie knihy, Praha : Libri.

[16] http://www.jednotky.cz/delka/

The TEMAP cataloguing group was created. Among other areas, the group intensively focused on subject control of the early maps. The issues addressed mainly included the use of MARC 21 fields for topical headings 650 and the field for formal descriptors / genre 655, the scope of the indices, the conspectus field 072 for early maps, and the term "early maps" used by experts as opposed to the historical map terms used at the National Library. Lists of new formal descriptors for the maps were proposed. Colleagues from the Military History Museum also got involved and prepared a list of military maps. In 2011, at a session of the National Library subject control commission, proposals regarding the time boundary for early maps (1850), the use of the term "early maps" and the integration of this term into the National Library conspectus groups were approved. Furthermore, it was agreed to collaborate in creating formal descriptors for cartographic materials.

A Cooperation Agreement was signed with the Union Catalogue[17] of the Czech Republic, where records have been regularly sent. It was necessary to fine-tune issues regarding the receipt of early map and manuscript records that the Union Catalogue originally had not anticipated.

The printed version of the new RDA cataloguing rules (2010) was purchased. The rules also contain a comparison between RDA and the AACR2/R rules. The basic form of these rules is still being fine tuned, however, and has not been completed for special documents and subject control. The planned date for implementing the new cataloguing rules in the Czech Republic is 2013.

Three cataloguers have processed a total of 9,500 records in 2011 (number of units added: 10,600). Of this number, 7,541 were early maps and 393 were manuscripts.

The basic methodology for cataloguing cartographic materials (including early maps) was unified in connection with other activities, such as georeferencing, etc. (e.g. coordinate fields). A total of 10,800 records were sent to the Union Catalogue and 9,000 were accepted. Bibliographic records are accessible at the Centralized Catalogue of Charles University, the GEOBIBLINE database and the Union Catalogue of the Czech Republic.

Figure 1: Joris Hoefnagel's map of Barcelona, cca 1572 (from the Map Collections of Charles University in Prague).

[17] http://www.caslin.cz/

Tag	Field content
*****	Record 1
LDR	-----nem-a22--------4500
001	001360842
003	CZ-PrCU
005	20111120173734.0
007	ay|a|||
008	110606s1572----gw-i------a-----|---lat-d
0340	|d E0020905 |e E0021339 |f N0412509 |g N0412130
0340	|d W0050545 |e W0050358 |f N0373316 |g N0373145
040	|a ABD065 |b cze |c ABD065
072 7	|a 094 |x Staré tisky |2 Konspekt |9 12
072 7	|a 912 |x Mapy. Atlasy |2 Konspekt |9 7
080	|a 094:912.43 |x (460) |2 MRF
1001	|a Hoefnagel, Joris, |d 1542-1601 |7 jn19990003553 |4 aut
24510	|a Barcelona |h [kartografický dokument] ; |b Eciia / |c depingebat Georgius Hoefnagle ; [Franz Hogenberg]
255	|a Měřítko neuvedeno |c (002°09´05” v.d.--002°13´39” v.d./041°25´09” s.š.--041°21´30” s.š.)
255	|a Měřítko neuvedeno |c (005°05´45” z.d.--005°03´58” z.d./037°33´16” s.š.--037°31´45” s.š.)
260	|a [Kolín nad Rýnem : |b s.n., |c 1572]
300	|a 2 pohledové mapy na 1 listu : |b mědiryt, čb. ; |c 32,5 x 46,5 cm na listu 40,5 x 55,5 cm
500	|a Odpovědnost převzata z desek
500	|a Filigrán
500	|a Popisný text v latině na rubu
550	|a Tiskařské privilegium: cum privilegio
561	|a Geographisches Institut der deutschen Universität in Prag |5 CZ-PrUPM
580	|a List z atlasu Civitates orbis terrarum. I, latinská edice
65007	|a plány měst |7 ph217762 |2 czenas
651 7	|a Barcelona (Španělsko) |7 ge128716 |2 czenas
651 4	|a Écija (Španělsko)
655 7	|a staré tisky |7 fd422076 |2 czenas
78718	|i List z atlasu |t Civitates orbis terrarum. I
7001	|a Hogenberg, Franz, |d 1538-1590 |7 ola2009522867 |4 egr
910	|a ABD065

993-1	|1 MAP |2 800 |3 429/31/3 |9 C 557 |6 11/04046 |5 3233269487 |4 Sken 00429_00031_00003 |8 20110606 |f 10 |m OTHER |r 20110606 |w 001360843 |x 000010
SYS	001360842

Table 1: Sample bibliographic record for a map in the MARC 21 format.

Digitisation process

In earlier years, the map collection tested the options for digitisation and the creation of metadata using the Digitool[18] tool at the university repository. Digitisation processes used at MLB in digitising the Moll Collection[19] were examined. European digital map collections were also examined. The following were identified as key resources: *MLB. Early Maps Online*[20]. The main objective of the Early Maps Online project was to develop an application that allows one to gain online access to georeferenced maps. It offers users precise online georeferencing of large-scale models and searching digitised maps connected to a specific site using information related to the geography and time period. The website *Map History / History of Cartography*[21] was also identified as a resource. This website is updated by Tony Campbell, a librarian for the British Library Map Collections. The portal contains over 100 pages and 5,000 annotated references selected according to relevance and arranged into 25 categories. [Campbell, 2008]. The largest private collection, The David Rumsey Historical Map Collection[22], offers 30,000 maps online and is focused on rare 18th and 19th century maps of North and South America and maps of the world. The collection at the University of Texas, the Perry-Castañeda Library Map Collection[23], offers maps of various regions for all countries around the world. It also contains historical maps and town plans. The Library of Congress[24] map collection offers traditional and panoramic maps, maps of explorers' discoveries, transportation, cities and more.

In 2011 a tender for a digitisation service supplier was held. Use of a certified A0-format flatbed scanner was mandatory. It was required that maximum safety be used in processing and protecting the early maps. Additional requirements were scanning in Geo TIFF at 400 DPI, depth: colour depth of 24 bits, ICC profile: RGB profile according to the scanner, white background for scanned models, lossless data compression (LZW) and perfect processing control. The company was also expected to prepare technical metadata in MIX[25] format (according to Library of Congress standards, Version 2.0) and processing, storage and the connection of MD5 hashes.

The company Microna, which met all of the listed requirements, was selected in the tender.

Before the digitisation process, the documents were clearly identified. Call-numbers were reallotted to the documents and scan numbers were also created based on these call numbers. Early maps (pre-1850) from the map fund were given priority. When allotting the call numbers, problems with the map files, editions, duplicates and sections were also addressed. The materials were marked with a bar code, acquisition number, call number, Aleph number and scan number. Most of the identification data later also appears in the metadata.

[18] http://www.exlibrisgroup.com/category/DigiToolOverview
[19] http://mapy.mzk.cz/mollova-sbirka/
[20] http://www.mzk.cz/o-knihovne/vyzkum-projekty/narodni-projekty/stare-mapy-online-2008-2011
[21] http://www.maphistory.info/
[22] http://www.davidrumsey.com/
[23] http://www.lib.utexas.edu/maps/
[24] http://memory.loc.gov/ammem/gmdhtml/
[25] http://www.loc.gov/standards/mix/

The maps were scanned at the company according to an approved schedule. At the set times (monthly), the originals were collected at Charles University's Faculty of Science and the processed batch was returned. One batch contained an average 1,500 maps. The files were submitted on high-capacity discs.

Batch number	**Number of files**
1.	1372
2.	1915
3.	1520
4.	1828
5.	1596
Total	**8,241 files** (of this number, 764 were A0 and 108 A0+)

Table 2: Overview of scanned files, 2011.

The files were loaded onto the server at the Department of Cartography at Charles University's Faculty of Science ("KAGIK") and checked. 100 DPI views were created. IrfanView was used to create views on a mass scale from the rasters delivered (in folders of about 300 files). The degree of image reduction was selected according to the side of the original. The size of the view is 20% of the original size. For large files over 500 MB, the view is 15% of the original size. For the largest files over 1.2 GB, errors are reported and the program does not process the files. On an individual basis, these files are then reduced to 50% size in Adobe Photoshop and subsequently reduced another 30% in IrfanView, i.e. to 15% of the original scan size. Furthermore, the completeness of the view is checked. The period to process a batch of about 1,500 views is approximately 3 to 4 hours.

After checking and generating the views, the files are exported. Good quality scans with generated views are stored online in two storage sites: the KAGIK server and Charles University Computer Centre ("ÚVT UK") server. From here they are processed further. A total of 8,241 early maps from before 1850 have been digitised. The data volume totals 1.58 TB, the average scan size was 202 MB, and the largest file was 1.82 GB while the smallest file was 3.12 MB.

Metadata

As stated earlier, MIX was selected as the basic format for technical metadata for scanning. This format was created at the company that carried out the digitisation. Technical metadata in the MIX standard (Version 2.0) was supplied for the digital GeoTIFF images.

The metadata contained the following mandatory elements and other nested elements:

<ObjectIdentifier> – Unique digital document or image identifier, can be composed of several data (acquisition number, URN, URL etc.)

<FormatDesignation> – Digital document format (e.g. TIFF, GeoTIFF etc.)

<Compression> – Detailed information about the digital image compression

<Fixity> – Information where one can check if the document was changed (e.g. MD5 hashes)

<BasicImageCharacteristic> – Basic information about the digital image (width, length, photometric data)

<PhotometricInterpretation> – Photometric data (e.g. white balance, ICC profiles, etc.)

<ImageColorEncoding> – Contains information about colour coding (e.g. number of colour components per pixel, RGB, etc.)
<BitsPerSample> – Number of bits based on the colour component per pixel values

Technical metadata for the digitised GeoTIFF images were obtained using Exiftool[26], a program that generates a RDF/XML file. An XSLT template then transforms the file into Metadata for Images in XML Standard (MIX Version 2.0). The name of the MIX file is identical to the name of the GeoTIFF digital image file. MD5 hashes are included in the XML metadata file.

Geonetwork metadata catalogue

In the field of digitised historical map administration, interest is targeted at searching, publishing and presenting cartographic materials online via the Internet so that they can be easily accessed by the broader public. At present there are specialised commercial solutions in this area, such as Digitool. The disadvantage of such tools is the purchase price; an advantage is that they are used extensively.
Intensive development in the non-commercial sector is underway in connection with the need for a single, unified infrastructure for spatial data. One of its products is the GeoNetwork opensource metadata catalogue, primarily designated for working with and searching spatial data records and graphically presenting spatial data. Issues regarding the use of spatial data infrastructure tools and their functionality for administrating and visualising historical maps have not been addressed. Initially, algorithms in Points Pattern Matching were researched (Brůha,2011).
GeoNetwork opensource was then connected with PostgreSQL and the original version of GeoNetwork opensource was run on an Apache Tomcat server. Normally the software is connected to McKoiDB and is run on a Jetty server, which is not suitable for servers. The functionality of metadata storage in PostgreSQL was tested by automatically loading (harvesting) bibliographic records to PostgreSQL. Records in the form of metadata published by ÚVT UK in the Dublin Core standard, are imported using the OAI-PMH protocol[27].
At the same time, the functionality of the GeoNetwork opensource connection with the Geoserver map server was verified by publishing a layer with the historical map rasters and representing these in the Openlayers map viewer, which is an integral part of GeoNetwork opensource. Publication of the layers with digitised map sections are in the development phase; the current status requires manual intervention as is not automated.

Access and tools

Repository

Scanned maps are stored in the Charles University repository[28], which has been built since 2006. In the repository, objects can be full text indexed and, using the indices, searched and split into various collections. The user can search digital objects using simple or advanced queries, or search individual documents (tree structure) as if in a catalogue.

[26] http://www.sno.phy.queensu.ca/~phil/exiftool/
[27] L. Brůha 2011, "Metadatový katalog Geonetwork opensource", Výroční zpráva za rok 2011 TEMAP, Praha.
[28] http://digitool.is.cuni.cz

At the University Computer Centre, scanned data are transferred from an FTP, checked and the integrity of the data is verified (using MD5 hashes). In the repository, data is generated to jpeg 2000, marked with a dynamic watermark, and user copies in the view and jpeg 2000 are issued. The full archived copy is stored out of reach of the users and is protected against abuse.
Online access allows access in three forms: brief, brief table and full view. Full metadata and view and user copy are also available. There are problems with map zooming as a red line appears. This problem is being addressed with the Ex Libris company.

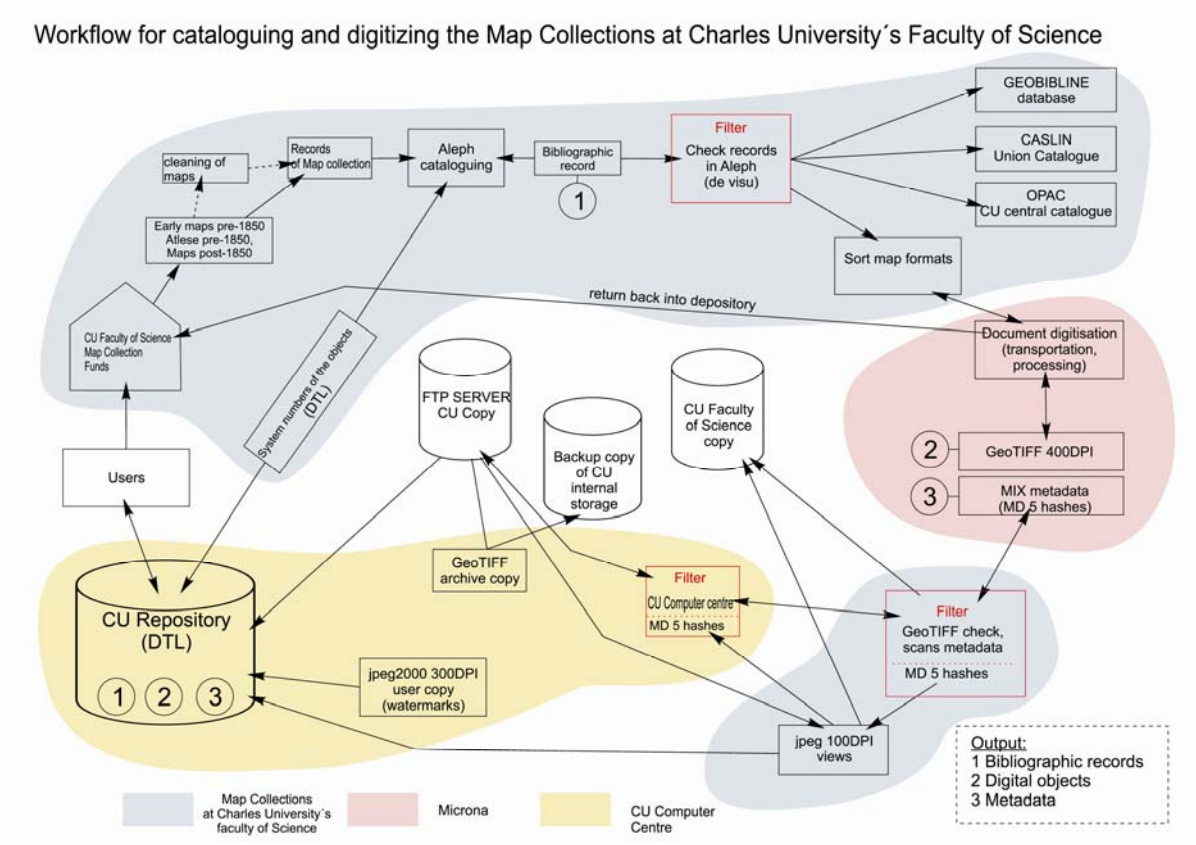

Figure 2: The process for cartographic material processing in Charles University's Map Collections.

Protecting and archiving digital objects

The files are stored in two safe storage sites on servers at Charles University's Faculty of Science and ÚVT UK. In terms of geography, these are located at two different sites in Prague. Data backups and preservation of the university repository in case of a natural disaster are completely secured. Data in the repository are stored on backup tapes for at least one month. Furthermore, primary data (data that have been scanned and are in various phases of processing) are stored for at least five weeks. Operational data and backups are in different locations. These locations are approximately six kilometres air distance away from each other.

Cartographic program extensions

The problem of automatically detecting unknown cartographic images from maps has not been addressed in the cartography community. The publication represents one of the few relevant inter-

national sources[29]. The detection method is based on an analysis of the transformation key between the reference (current) map and the analysed map (the early map). The author of this publication has also created MapAnalyst, a software program that implemented the detection of cartographic images in beta version 1.4.

Bayer (2007)[30] cites the issue ofcartographic image detection options from a set of points using Voronoi diagrams as a new detection technique. This technique was further developed in two separate articles[31] and verified in sample data. Bayer (2010)[32] compared several methods for detecting cartographic images (techniques based on the analysis of transformation keys and the analysis of Voronoi diagram properties).

The proposed algorithm makes it possible to automatically detect cartographic images from analysed maps and is supplemented by the option to approximate other parameters of the cartographic image, such as the position of the cartographic pole or the value of an undistorted circle of latitude. For now there is no algorithm available that delivers this type of detection (analysis of a cartographic image in a general position). B. Jenny's algorithm implemented in MapAnalyst makes it possible to detect cartographic images only in a normal position. There is not a fixed number of cartographic images; additional images can be added if one knows the visual display equation. Due to the narrow, specific focus of analyses, there is just one comparable solution that is available in MapAnalyst.

Out of the implementation work, data structure designs have been completed. Cartographic imaging (suitable representations) has been selected and the format for image definition files has been proposed. Furthermore, around ten invariants suitable for detection were selected and detection algorithms were proposed.

Conclusion - future and development

At Charles University, completion and consultations on the cataloguing methodology are primarily planned for 2012. To this end, the AACR2R and RDA rules will be compared. Cataloguing will continue with plans to process at least 11,000 map sheets and 20 atlases, with special emphasis placed on Czech and early prints. Furthermore, problems associated with cataloguing, such as note fields, copies and map facsimiles, will be addressed. Special cataloguing templates, e.g. for military maps, will be created. The creation of formal descriptors for cartographic materials will be completed, and issues regarding subject headings will be addressed.

Another 11,000 map sheets and 20 atlases should be digitised, with priority going to collector's atlases, rare map sheets, Czech maps and possibly part of the military maps. The operation of the Digitool digital repository and the data storage site at Charles University will be subject to further testing and fine tuning.

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[29] B. Jenny, L. Hurni 2011, "Studying cartographic heritage", *Computer & Graphics*, Vol. 35, No. 2, 402-411.

[30] T. Bayer 2007, "Detekce kartografického zobrazení z množiny bodů", Sborník příspěvků 27. konference o geometrii a počítačové grafice, Brno, ISBN 978-80-85763-41-6.

[31] T. Bayer 2007, „Detekce kartografického zobrazení z množiny bodů, praktické zkušenosti", *Geodetický a kartografický obzor*, Vol. 53, No. 3, 10-15.

T. Bayer 2008, "Detekce kartografického zobrazení z množiny bodů", *Geodetický a kartografický obzor*, Vol. 54, No. 2, 10-15.

[32] T. Bayer 2010, "Detekce kartografického zobrazení", *Geodetický a kartografický obzor*, Vol. 56, No. 6, 122-130.

In 2012 the Charles University Map Collection plans to publish imported maps with a metadata record in the OAI-PMH interface for georeferencing purposes, publish test maps (preparation of the new map viewer in the repository) and connect the new viewer to the MLB Georeferencer.org tool.

The Geonework metadata catalogue will be further developed. In addition to the usual administration of works according to bibliographic records, Geonework also makes it possible to use the spatial information contained in the documents. To this end it will be necessary to connect the Geonetwork opensource metadata catalogue with the PostgreSQL database system and GeoServer map server both at the metadata level and to publish designated raster data.

It will also be essential that modules be created: one for automatic caching that will allow for quickly displaying extensive raster data; and one for mutual conversion of Dublin Core and ISO19139 metadata standards. The module should allow for searching and visualisation in complex cases involving series of maps.

An e-learning course will be created. The basic version will contain explanations and practical demonstrations, references to further reading and interactive quizzes. In terms of the use of technology to create the e-learning courses, the open source XML framework eLML seems to be an appealing alternative[33].

In the area of detecting unknown cartography images from the map, work will be conducted on implementing a numerically robust solution for constructing auxiliary data structures. In addition, it will be necessary to implement test invariants and improve their detection capabilities.

Our partners at Masaryk University in Brno will continue to develop tools for processing map series and a thesaurus of spatial objects (such as forests, rivers, cities, etc.). Our colleagues at the Moravian Library in Brno are continuing to develop georeferencing tools.

For users, the tools developed as part of the TEMAP project will translate not only into quick access to a large amount of full text, data and maps from home, abroad or anywhere else in the world, it will also represent entirely new opportunities for working with early maps that can be used in many areas of research, including landscape development, ecology, geology, hydrology and more. What lies ahead for the Map Collections are professional processing, subsequent use and protection of the documents. Experts in the field can also look forward to unique discoveries of documents that were not known to exist or have been long missing.

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[33] M. Potůčková 2011, "E-learningový kurz" Výroční zpráva za rok 2011 TEMAP, Praha.

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