Daniel Oltean, Digital libraries: Greek manuscripts at the Royal Library of Belgium

Introduction

The Royal Library of Belgium (KBR) preserves approximately 35,000 rare books, including 4,500 medieval codices in different languages. The manuscript department of the KBR is, thereby, one of the largest in the world.

The original core of the manuscript collection comes from the dukes of Burgundy's ancient library, a prestigious one in medieval Europe, founded by Philip the Bold (d. 1404). At the time of his successor Charles the Bold (d. 1477), this collection already contained as many as 950 volumes. Nowadays, the manuscript department preserves around 270 of them.

The library systematically enriched over time. It includes, among others, the collections of Rembert Goethals (d. 1707), Charles van Hulthem (d. 1832), and Arthur Merghelynck (d. 1908), as well as manuscripts of the Bollandists, i.e., the Jesuit scholars engaged, from the 17th century, in the publication of the "Acta Sanctorum (The lives of the saints)."

The digitisation of the manuscripts has already begun for about ten years. 2920 digitised manuscripts are now (2023) available on "Belgica,"[1] the KBR digital library, including 213 manuscripts belonging to the ancient library of the Dukes of Burgundy.[2]

The Greek manuscripts/texts refer to 201 papyri, manuscripts (including rolls), and fragments spread in other multilingual manuscripts. For several reasons, they were not yet the object of systematic digitisation. However, linguistically focused projects exist, such as digitising of the twelve 17th-century Irish manuscripts preserved at the KBR.[3]

A. Greek Manuscripts at the KBR

The identification of the Greek manuscripts in published or online catalogues of the KBR is not always an easy task. They are not grouped under a single acronym. The best list can be found not on the KBR portal but on Pinakes, the website of the Institute for Research and History of Texts (IRHT) in Paris.[4]

From 201 Greek manuscripts and fragments, only eleven are now digitised (six manuscripts and five fragments):

Greek manuscripts:

KBR no.	Century	Observations
4476-78	13/14th c.	Erroneously mentioned as a multilingual manuscript in the KBR online description.
11288	16th c.	-
11367	16th c.	-
IV.485[5]	16th c.	-
IV.572	14th c.	-
IV.912	14th c.	-

[1] https://belgica.kbr.be/belgica/
[2] https://www.kbr.be/en/browse-213-manuscripts-from-the-library-of-the-dukes-of-burgundy/
[3] The project was initiated by the Leuven Centre for Irish Studies (KU Leuven) in collaboration with the KBR, the Embassy of Ireland to the Kingdom of Belgium, and Irish Script on Screen project (Dublin Institute for Advanced Studies), https://www.kbr.be/en/projects/digitisation-of-irish-manuscripts/.
[4] https://pinakes.irht.cnrs.fr/notice/fonds/221/
[5] Bibliothèque royale 1969, 156-159.

Greek fragments in multilingual manuscripts:

KBR no.	Century	Observations
8920	17th c.	Erroneously mentioned as a Latin manuscript in the KBR online description.
8922-24	17th c.	-
8940	17th c.	-
8943	17th c.	Erroneously mentioned as a Greek manuscript in the KBR online description.
II.4159	18th/19th c.	-

Five other KBR Greek manuscripts (KBR 11358, 11375, II.2404, IV.100, and IV.303[6]) containing Tetrevangelium liturgical book can be accessed via the webpage of the Institute for New Testament Textual Research (INTF) in Münster (digitisation based on copies preserved at the institute).[7]

The importance of the Greek texts at the KBR is related to the following aspects:

a. papyri;[8] there are only two (but remarkable) papyri:
    - KBR IV.329 (7th c.);[9]
    - KBR IV.590 (6th c.);
b. manuscripts antiquity: it seems that the oldest complete Greek manuscripts are from the 11th century, such as KBR 2407 and IV.322,[10] but some palimpsests contain even older texts from the 8th/9th c.; there are also many manuscripts from the 13th century; Renaissance period (15th /16th c.); and Bollandist golden age (17th c.);
c. palimpsests; there are some manuscripts of this type, such as:
    - KBR IV.459 (8th/9th+14th c.);[11]
    - KBR II.407 (11th+13th c.);
    - KBR II.2404 (10th+11th c.);
    - KBR II.2728 (14th c.);
d. Rolls; there is only one manuscript of this type, KBR IV.912 (14th c.), unusually long (885 cm);
e. illuminated manuscripts; among them:
    - KBR 11358 (13th c.);[12]
    - KBR IV.100 (16th c.), a luxury manuscript copied and illustrated in the entourage of Mary of Austria (d. 1558);[13]
    - KBR IV.1015 (17th c.);[14]
f. watermarks; many manuscripts contain watermarked papers:
    - KBR IV.487 (15th c.);
    - KBR IV.602 (15th c.);[15]
    - KBR IV.953 (18th c.);
    - KBR IV.1025 (17th c.);

[6] Bibliothèque royale 1969, 16-18.
[7] https://ntvmr.uni-muenster.de/manuscript-workspace
[8] Wittek 1978, 246-247.
[9] Bibliothèque royale 1969, 3.
[10] Bibliothèque royale 1969, 8.
[11] Bibliothèque royale 1969, 30-33.
[12] Images at ff. 59v, 97v, and 157v, see Gaspar, Lyna III, 1984, no. 36, 100-101 and Pl. XXa.
[13] Five full-page images, see Bibliothèque royale 1969, 153-155; Wittek 1978, 251.
[14] Ten images, see Wittek 1979, 554 and pl. 77.
[15] Wittek 1979, 249.

- KBR IV.1027 (14th c.);
- KBR IV.1038 (16th c.);
- KBR IV.1039 (14th c.);[16]

g. manuscripts containing unique (sometimes unpublished) pieces:
   - KBR II.407 (11th+13th c.), containing a unique hagiographical text inventoried as BHG (=Bibliotheca Hagiographica Graeca) 1564;
   - KBR II.4836, containing a unique controversial list of the Latins "errors;"
   - KBR IV.459 (8th/9th+14th c.), containing the BHGs 1623c and 2054h, unknown in other manuscripts;
   - KBR IV.881 (16th c.) includes the unique "Treatise on the Immortality of the Soul" by Christopher Contoleon (16th c.);[17]

h. manuscripts and cultural history; some manuscripts preserve remarkable information about authors, copyists, owners, or sponsors:
   - KBR 11270-75, 11291-93, and 1871-77 (15th c.), manuscripts copied by Geek humanist writer Michael Apostoles (d. 1474/1486 ca.);
   - KBR IV 434 (15th c.), autograph manuscript of Renaissance writer John Plousiadenos (d. 1500);[18]
   - KBR IV.100 (16th c.), already mentioned, copied and illustrated in the Habsburg Netherlands, in the entourage of Mary of Austria;
   - KBR 14774 (16th c.), manuscript belonging to the library of Francesco Toressani (d. 1557 ca.), brother-in-law of the Venetian printer and humanist Aldo Manuzio (d. 1515); King Francis I of France (d. 1547) bought Toressani's library in 1542/1545;
   - KBR IV.1038 (16th c.), a manuscript containing the notes of Joachim Camerarius (d. 1574) on Souda lexicon (a 10th-century Byzantine encyclopaedia);
   - manuscripts copied or annotated by the Bollandists Heribert Rosweyde (d. 1629): KBR 7773, 8191-93, 8229, 18864-74, and Daniel Paperbrochius (d. 1714): KBR 8943;
   - KBR IV.491 (18th c.), a manuscript containing letters of Alexander Mavrocordatos (d. 1709) and Nicholas Mavrocordatos (d. 1730), partially unpublished;[19]
   - 21 Bollandist manuscripts used during the preparation of Acta Sanctorum edition (Collectanea bollandiana): KBR 7773, 7812, 8155-62, 8163-69, 8191-93, 8229, 8230, 8231, 8232-33, 8368-71, 8398-8400, 8450-51, 8599-8600, 8736-48, 8920, 8936-38, 8943, 14124, 18235-36, 18864-74, and 18906-12.

[16] Wittek 1979.
[17] Wittek 1979, 250-251.
[18] Wittek 1979, 250.
[19] Bibliothèque royale 1969, 171.

B. Digitisation plan

The digitisation of the KBR Greek texts concerns the creation of manuscripts' digital versions, grouped in a virtual collection, further used to improve their accessibility, preservation, and dissemination. The current project is inspired by the already existing experience of the KBR DIGIT department team,[20] as well as other similar plans set by different libraries and institutions across the world.[21] Led by the owner institution, the digitisation plan would include the following ten steps grouped into four categories:

SCOPE

1. Assessment

The first step of the process is a general evaluation of the Greek collection to identify the digitisation aim and needs. It includes a first estimation of costs and potential challenges. The assessment includes some essential questions regarding the relevance of such a project:

- why is necessary the digitisation of the Greek KBR texts?
- what is added value of this project?
- what are the possible difficulties in accomplishing it?
- what are the costs?

Once those points are fully clarified and the necessary funds arrive, a project manager will take control of the next steps.

2. Partnerships

Identifying potential collaborations with other institutions interested in digitising Greek manuscripts could expand the existing expertise, supplement financial resources, and guarantee the dissemination of results.

Possible supporters include the King Baudouin Foundation - Heritage and Culture programme,[22] the Embassy of Greece to the Kingdom of Belgium, the Hellenic Institute of Cultural Diplomacy in Belgium,[23] the Andrew W. Mellon Foundation (New York),[24] and the Stavros Niarchos Foundation (Monaco).[25] The last two institutions already funded digitisation projects related to Greek manuscripts.

[20] https://www.kbr.be/en/digitisation/an-introduction-to-the-digit-department/

[21] Metamorfoze, The Netherlands' National Program for the Preservation of Paper Heritage, https://www.metamorfoze.nl/english; National Library of New Zeeland Digitisation Plan 2019-2022, https://natlib.govt.nz/about-us/strategy-and-policy/digitisation-plans/digitisation-plan-2019-2022; National Library of Finland Digitisation Programme 2021–2024, https://www.doria.fi/handle/10024/180341; International Federation of Library Associations and Institutions, Guidelines for Planning the Digitization of Rare Book and Manuscript Collections, https://repository.ifla.org/handle/123456789/454; Bibliothèque Nationale de France, Schéma numérique 2020, https://www.bnf.fr/fr/strategie-et-vision#bnf-ressources; Vatican Apostolic Library, The digital project, https://www.vaticanlibrary.va/en/the-collections/the-digital-project.html.

[22] https://kbs-frb.be/en/heritage-and-culture

[23] https://www.hicd.be/

[24] https://www.mellon.org/search/manuscripts

[25] https://www.snf.org/en/work/priorities/arts-culture/

PLAN

3. Manuscript selection (or not)

Depending on the financial resources allocated to this project, digitisation could concern the entire collection or only a selected group of manuscripts. In the latter case, the selection process could consider the following criteria:

- digitisation added value; many manuscripts will add essential information to be used in various public domains such as research, education, art and culture, public science, and relationships with local and foreign institutions; the digitisation process could include, for example, only the collection's oldest manuscripts;
- library needs and restrictions; on the one hand, digitisation could embrace some of the deteriorated manuscripts in danger of losing information and the fragile ones to view in person; on the other hand, the library could advise against digitisation based on the precarious physical condition of a manuscript; in this second case, the restoration (especially of the binding) must precede digitisation;[26]
- metrics; this criterion refers to the digitisation volume (number of folios per manuscript), the funding related to a specific group/type of manuscripts, and the manuscripts used/viewed most frequently by researchers/the public;
- ethical criteria, i.e., equality in selecting manuscripts from different geographical, cultural, ethnic, and religious groups.

It could also be decided to digitalise first some manuscripts of interest from the selected group. Such a prioritisation could attract both the attention of specialists/the public and supplementary funding.

4. Standards

Defining the technical specifications and standards is an essential step in the process. Standards assure quality, interoperability, storage, and dissemination. They refer to different aspects:

- quality of images, including elements such as image resolution, colour depth, colour saturation, image lighting, and image brightness;
- foliation, which should be provided; if it does not exist, the manuscript foliation is necessary before digitisation;
- manuscript metadata, including the complete list of elements that will be included; a list of languages used to display information is also compulsory;
- file formats and website design; those aspects are essential for the preservation and dissemination of digital items.

5. Technical equipment, human resources, and workflow

The technical equipment certainly already exists. It must include the following:

- digital camera – minimal requirements: type: DSLR; resolution: 24 megapixels; sensor: DX; lens: 50mm; save options: JPEG, TIFF & RAW (minimally processed image direct from the camera sensor) – with tripod, lighting, and backdrop;
- computer hardware with external hard drive;
- image editing, monitor calibration, and web design software;
- network attached storage devices.

Human resources also exist. A minimal team includes:

[26] Tomalak, 2013; Korthagen et al. 2019, 27-30.

- team manager;
- photographer;
- metadata creator;
- software specialist.

The team members will accomplish the main digitisation tasks, but some of them could involve other KBR specialists. The workflow includes the following:

- manuscript preparation and displacement;
- equipment preparation/calibration;
- digitisation (taking pictures);
- metadata creation;
- software adjustments (organising and renaming files, editing images, etc.);
- quality control;
- storage;
- online publishing.

PROCESS

6. Images

First, an appropriate space for digitisation will be created/arranged (if it does not already exist). KBR specialists will advise (or not) removing the manuscripts from the permanent location and bringing them into the digitisation space. Digitisation must not place manuscripts at risk of damage from handling or use. An opening of a 100/120-degree angle will generally be recommended (many manuscripts may not be safely opened to 180 degrees).

After a first capture session, the team will establish the model of the images, based on the standards already mentioned and the previous KBR experience, and calibrate the equipment.

The process must begin with all the manuscript recto-pages and continue with the verso-ones after turning the book. Sometimes, the significant parchment manuscripts are challenging to digitise because they tend to approach or move away from the camera. In those cases, the photographer could hold them down either an acrylic finger or a concave acrylic plate.

The palimpsests are special cases. They require distinct photographic operations to separate the upper script from the lower one. Nowadays, multispectral photography offers outstanding solutions by taking multiple images from the same folio in the same position illuminated by a pre-set succession of fixed wavelengths of light. Those images capture the different reactions of the parchment to different light waves and make them visible to human eyes. However, multispectral photography requires the specialised knowledge of image scientists working with philologists.[27]

Another possible situation is the appearance of the writing of the verso folio on the recto. In this case, it is necessary to carefully combine the recto and verso images to obtain a better result.

It should also be noted that not only the pages bearing the handwritten text are to be digitised but all document parts: the binding, the covers, the upper and lower inside cover, the spine, the edges, the endpapers, and the blank pages. The writing or decoration on the edges or spine, for example, could

[27] The images resulting from multi-spectral captures must be accompanied by specific metadata related to multi-spectral technology, see Bognar et al., 2021.

potentially be of great use to scholars in reconstructing scriptoria or in assigning provenance, especially when such writing and decoration are not recorded in catalogue entries.[28]

After shooting, the photographer and software specialist will rename, arrange, crop, edit, and save the pictures. The names chosen for files must respect a standard format to ensure consistency and facilitate future research. It generally contains a (short) descriptive name and pagination, which follows the sequential numbering of folios without any modification.

7. Metadata

Metadata provides essential information about manuscripts, such as title, date, description, content, people involved in the creation, and owners. Even if digitisation is a first step towards the further full scholarly description of manuscripts, the team must recognise the importance of the quantity (and quality) of metadata offered. Digitisation must provide as much metadata as possible, even by improving present KBR metadata standards. This new relevant information that could be added relates to the following:

- physical description of manuscripts items (including bindings, spine, edges, etc.);
- intellectual content and text divisions; on the British Library website, each digitised manuscript contains a full description of the content, e.g., Ms. Add. 14066;[29]
- important or full list of illuminations;
- marginal notes, which may provide additional information related to the content of the manuscript, generally belonging to the readers; metadata must indicate annotations' content, position in folio, relation to the main text, language, relevance, and eventually author;
- references; the Vatican Library website adds comprehensive bibliographic references to each manuscript, e.g., Ms. Barberini gr. 336, with 186 references;[30]
- important (or full list of) owners;
- links with similar metadata existing in other Greek KBR manuscripts;
- links with universally accepted identifiers such as Wikidata,[31] GeoNames,[32] Pleiades,[33] and Trismegistos;[34]
- image metadata, including, among others, resolution, dimensions, date of creation, and production information;
- iiiF manifest;
- copyright information;
- administrative metadata, including, for example, the names of the photographer/designer/team and the date of creation.

A particular aspect of metadata improvement would refer to the names and terms used in descriptions. As a process of standardisation has already begun at the international level, metadata could exploit international authority files (such as VIAF = Virtual International Authority File[35]), prosopographic databases (such as PmbZ = Prosopographie der mittelbyzantinischen Zeit[36]), thesauri, and specific lists of terms.

[28] O'Hogan, 2015 provides a provisory list of Greek manuscripts of the British Library containing such writing on edges.
[29] https://www.bl.uk/manuscripts/FullDisplay.aspx?ref=Add_MS_14066&index=16
[30] https://digi.vatlib.it/mss/detail/Barb.gr.336
[31] https://www.wikidata.org/wiki/Wikidata:Main_Page
[32] https://www.geonames.org/
[33] https://pleiades.stoa.org/
[34] https://www.trismegistos.org/
[35] https://viaf.org/
[36] https://www.degruyter.com/database/pmbz/html?lang=en

Moreover, it would probably be helpful to convert existing metadata according to a standard metadata model, such as Dublin Core[37] or TEI.[38] Unfortunately, there is not yet a consensus regarding this aspect. It would also be useful to consult the Europeana Data Model (EDM), the European framework of cultural heritage metadata,[39] or the two-level metadata schema used in "e-codices" website,[40] the Virtual Manuscript Library of Switzerland. The latter contains both an overview compliant with the Open Archive Initiative specifications[41] (so with Dublin Core) and a detailed description based on the project's interpretations of TEI (P5). It also allows end-user observations/annotations, which could improve existing metadata.[42]

Even more important is to secure metadata interoperability, i.e., the potential for metadata to cross boundaries between different digital contexts. This aspect becomes crucial when a potential user tries to explore manuscripts from different collections across the world described by different sets of metadata. Modelling manuscript metadata as linked data is perhaps the best option. It would be possible through collaboration among manuscript scholars, metadata specialists, digital humanists, and computer scientists.[43]

Finally, probably one of the most challenging facets of this step would be to provide the entire Greek text of manuscripts using OCR and HCR (Handwritten Text Recognition) techniques. This is still not entirely possible for the moment, but different types of experiments in recent years have shed more light on this topic. The results obtained (sometimes in the case of published books) with tools like Transkribus, [44] Abby FineReader,[45] and Tesseract[46] could be improved/extended for manuscripts in the future[47]. However, two main aspects concerning handwriting in old Greek manuscripts complicate this evolution. On the one hand, there are many different representations of the same character, even in the same document. On the other hand, the copyists did not write characters in same the way across the centuries. It is not only about the differences between majuscule and minuscule styles but also the numerous types of minuscule handwriting, such as Bouletée, Perl, and Beta Gamma scripts.

8. Storage

On the one hand, storage refers to the method adopted to save and name the files. The team will use the type of files used at the KBR and choose appropriate names for the new files to quickly identify them. Generally, it is recommended that files be stored in uncompressed formats or with lossless compression to preserve image quality and integrity.

On the other hand, determining appropriate storage solutions and strategies guarantees the preservation of digital data over time. The team will consider technical solutions regarding backup systems, redundancy, migration plans, and long-term preservation techniques. The project will use network-attached storage devices (NAS), which contain multiple hard drives that are backed up across each other. Three copies of every item will be preserved, one of them in the cloud. The team will regularly

[37] https://www.dublincore.org/specifications/dublin-core/dcmi-terms/
[38] https://tei-c.org/
[39] https://pro.europeana.eu/page/edm-documentation
[40] https://www.e-codices.unifr.ch/en
[41] https://openarchives.org/
[42] For example, the manuscript Basel, Universitätsbibliothek, AN IV 6 (15th c.) is presented in broad terms at https://www.e-codices.unifr.ch/en/list/one/ubb/AN-IV-0006 and fully described at https://www.e-codices.unifr.ch/en/description/ubb/AN-IV-0006/HAN. Metadata contains links to the manuscript sections, decorations, and illuminations and allows cross-referencing through a significant number of tags.
[43] It is the case of Mapping Manuscript Migrations Project, https://mappingmanuscriptmigrations.org/en/; see Koho et al., 2021.
[44] https://readcoop.eu/transkribus/
[45] https://pdf.abbyy.com/
[46] https://github.com/UB-Mannheim/tesseract/wiki
[47] Platanou, 2021; Perdiki, 2022.

perform integrity checks on digital files to detect errors or alterations. It would use integrity verification tools such as checksums to ensure that files have not been modified or corrupted.

DELIVER

9. Dissemination

The result of the process is the free access to digitised manuscripts following FAIR (Findable, Accessible, Interoperable, Reusable) principles. This step could involve adding new items to the existing KBR portal, such as manuscript metadata, as well as improving the current search functions of the website. For example, searching only for Greek manuscripts could attract new users and facilitate public access.[48]

I think website search options are one of the critical aspects of digitisation. They must allow the formulation of different queries according to specific needs, including keywords, exact phrases, Boolean operators, and wildcards to narrow the search. Filters such as language, date, location, type of manuscript, etc., will restrict the search and offer more relevant results.

10. Monitoring

In order to assure the effectiveness and quality of the entire process, the project may include regular monitoring of both digitisation workflow and end-user feedback. It is a never-ending step, which refers to aspects such as the fidelity of the digitised object to its original, regular backups, and the quality of web services.

C. Workflow/Resource implications

As the KBR board already has a very good experience in digitisation, there would probably not be major implications regarding technical equipment and human resources. However, there are two other essential aspects to be taken into consideration:

- funding; this is the crucial element in every similar process; in the project's second step, which refers to possible partnerships, I already shared some ideas;
- metadata creation; given the particularities of the Greek manuscripts, a specialist in Greek palaeography, codicology, and/or cultural history could join the team and offer his knowledge to implement this project.

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[48] A model to follow would be the digital manuscript collection of the Bodleian Libraries in Oxford, https://digital.bodleian.ox.ac.uk/search/?fq=object-type%3A%22Archives+and+Manuscripts%22, which also include JSON codes of different types of search, https://digital.bodleian.ox.ac.uk/developer/data/. Medieval Manuscripts in Flemish Collections website uses the same format, which allows identifying Greek manuscripts, https://mmfc.be/s/start/objects?facet[mmfc_msLanguageName_ss][]=Old%20Greek.

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