Water Management Digital Knowledge Repository as an Online Tool to Preserve, Maintain and Develop Technical Heritage of Water Sciences

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Abstract. Water Management Digital Knowledge Repository presented in this article is unique in the sense that it helps to preserve the heritage of water profession and facilitates access to the latest information for a wider public. This is particularly important in a country where water-related disasters have not only threatened the people in the past but unfortunately, they need to be prepared for such events in the future, too. Therefore, the digital knowledge repository, based on six pillars (eLearning, Photos, Videos, Journals, Textbooks, Glossary), plays a valuable and important role in Hungary.

Keywords: Water Management; Digital Knowledge Repository; Database; Scientific Heritage; Multimedia Archive, eLearning; Mobile Application.

1 Introduction

The Water Management Digital Knowledge Repository (WMDKR) (https://vdt.uni-nke.hu/) represents an unprecedented collection of professional information for engineering students, educators, practitioners, etc. engaged in the domain. It encompasses a comprehensive array of resources, including (among others) courseware, textbooks, manuals, and even a water management dictionary. The video and audio library features biographical interviews with prominent water professionals, subject-specific film compilations, archival professional films, and flood documentaries (Fig. 1). These collections on water sciences created in Hungary serve as a valuable knowledge source primarily for professionals. However, some of them contain relevant information for the public as well due to their cultural and historical values. The repository serves to long-

term preservation of the scientific heritage and is continuously updated to provide the latest information for educational purposes.

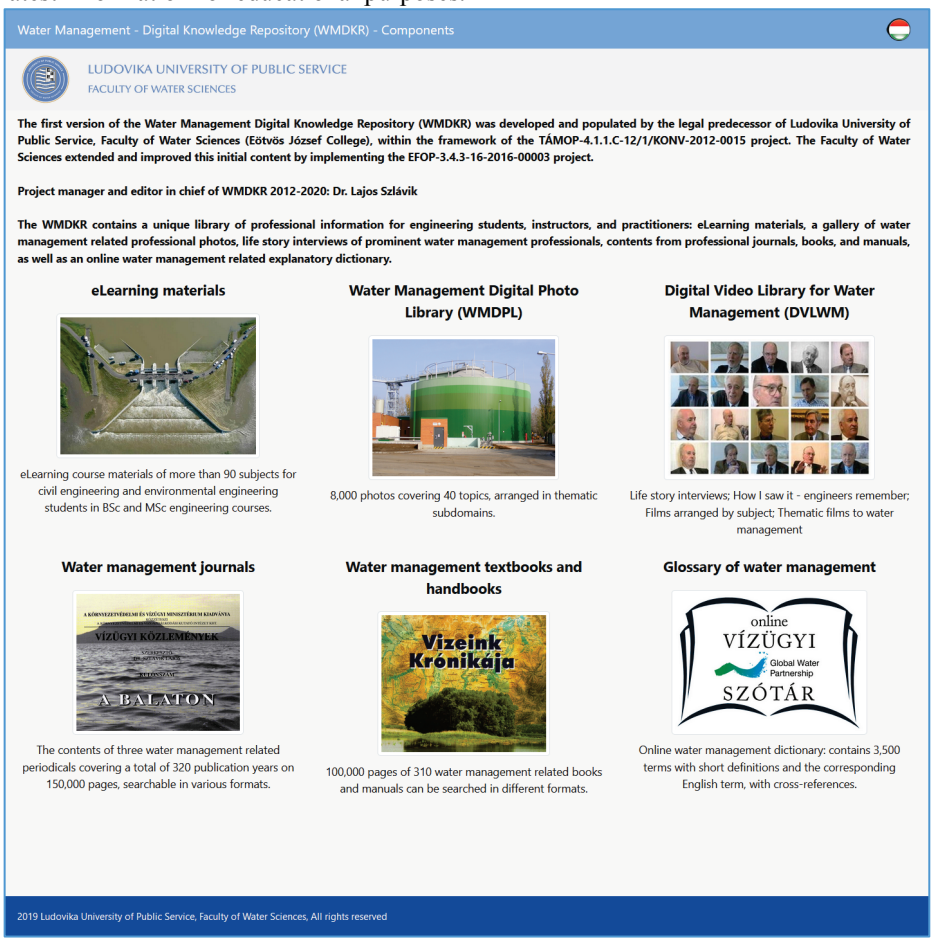

Fig. 1. Opening page of the Web site of the Water Management Digital Knowledge Repository (WMDKR).

Creating the WMDKR started in 2007 with the digitization of archival (celluloid) films, which preserved many aspects and knowledge of the technical heritage of water management. The earliest film in this repository is a "Budapest footage taken by the Lumière brothers in 1896", made about the left-hand traffic of the first Hungarian bridge on the Danube in Budapest. Most of the archival professional films on water and environmental issues are owned by the Hungarian Hydrological Society (MHT) and the Hydrologia Hungarica Foundation (HHA) (https://www.hidrologia.hu), and the celluloid films have been digitised for the WMDKR. The collection has been supplemented with digitised material from the repositories of the Environmental and Water Archives and the Environmental and Water Museum (Esztergom). The WMDKR currently holds 916 selected films, amounting to more than 233 hours of footage.

The extension of the repository to include digitized films and an increasing array of new documents with eLearning materials is the result of a development work between 2013 and 2023. The eLearning content was developed and populated by the Eötvös József College (EJF) of Baja during 2013-2015 in the framework of the TÁMOP-4.1.1.C-12/1/KONV-2012-0015 project "Higher Education Cooperation for the Water Sector", guided by Professor Lajos Szlávik.

After completing the TÁMOP project, the repository has been further enriched with a selection of reference books and journals, based on the collaboration of ARCANUM Database Ltd., the General Directorate of Water Management, and numerous other organisations. Additionally, with the support of the Global Water Partnership Hungary Foundation (GWP), an interpretative and foreign language dictionary has been incorporated into WMDKR.

The next phase of development and expansion of the WMDKR was carried out between 2017-2022, within the framework of a new project by the legal successor of EJF, the Faculty of Water Sciences of the Ludovika University of Public Service (LUPS FWS). The project EFOP-3.4.3-16-2016-00003 was entitled "Quality development in higher education regarding the strategic educational competences, to adapt the changes in economic and environmental conditions and to improve/ameliorate the accessibility of the training components". The EFOP project was managed by Dr. Gábor Keve, whereas the representative of WMDKR stayed on Professor Lajos Szlávik.

The eLearning Department of HUN-REN SZTAKI continuously contributed to the success of the collaborative project with the design, implementation and presentation of multimedia and eLearning content, completed the development and assessment of the repository as well as its introduction to the formal high-level education in the hydrology domain. This work was coordinated by Zsolt Márkus and Miklós Veres.

As a result of the collaborative efforts, by 2024 the WMDKR has become available for students, tutors, and practicing professionals in water management by hosting a vast collection of technical information. This includes digital curricula, selected photo- and video archives, scripts of journals, reference- and handbooks, as well as an online explanatory guide of hydrology. Unexpectedly, the WMDKR became a key element of high-level hydrology education during the COVID-19 pandemic period between 2020-2021.

2 Components of the Water Management Digital Knowledge Repository (WMDKR)

The home screen of WMDKR website on Fig. 1. shows the six pillars of the WMDKR, namely:

1.) eLearning materials
2.) Water Management Digital Photo Library (WMDPL)
3.) Digital Video Library for Water Management (DVLWM)
4.) Water management journals
5.) Water management textbooks and handbooks
6.) Glossary of water management

Some components of the WMDKR – excluding the eLearning materials and the Water Management Digital Photo Library (1 and 2) – are available free to anyone interested at the website of the LUPS Faculty of Water Sciences (https://vdt.uni-nke.hu/).

In addition, all the water-related journals, textbooks, and manuals in the VDT are available to anyone by accessing the HUNGARICANA public collections portal: Library/Collections/Water Collections (https://library.hungaricana.hu/hu/collection/vizugyi_tudastar/).

The primary goal of this service is to make the vast amount of cultural treasures and historical documents about our common past in the national collections available to everyone in a spectacular, fast, and transparent way. The continuously enriching virtual collections of the repository are designed to provide quick access to the information, to meet the requirements of in-depth exploratory research as well as to assist more complex research.

At the Hungarian eFestival 2015 organised by the Association for Informatics Society, the WMDKR entered by Eötvös József College won the special prize for "Digital Preservation of Cultural Heritage". According to the decision by the jury, the website was entitled to maintain the ranks "Excellent Hungarian Content" and "User-Friendly Website" for two years.

2.1 eLearning Materials

From an educational point of view, the most important component of WMDKR is represented by the eLearning materials (Fig. 2).

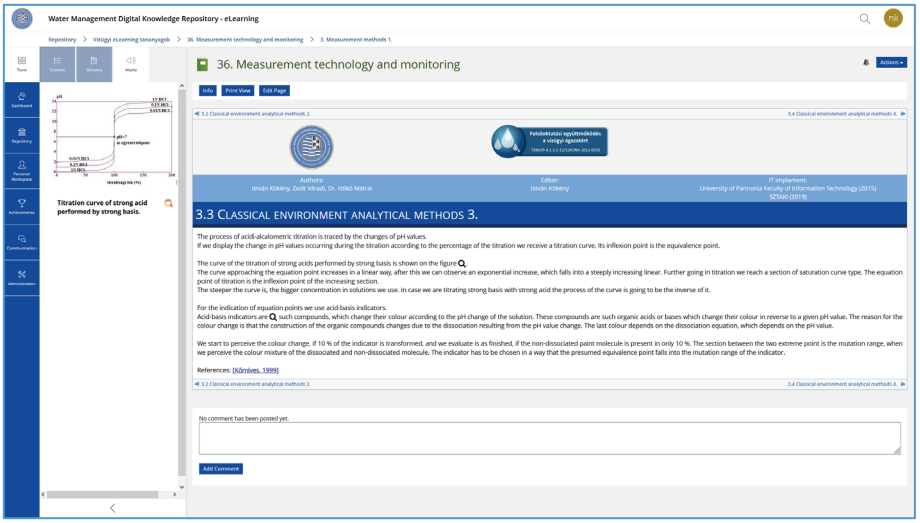

Fig. 2. A screen from an eLearning training material.

The teaching materials were produced in Hungarian for 41 curricula and in English for 2 curricula in the period 2013-2015, within the framework of the TÁMOP 4.1.1.C project. They were developed for the BSc (Bachelor) and specialised postgraduate courses

in civil and environmental engineering. These training materials were supplemented and expanded in the framework of the EFOP-3.4.3 project between 2017 and 2022, and additional individual training materials were created in Hungarian and English, too.

The system currently contains a total of 94 specific professional eLearning course materials, as well as related tests and examination tasks. These eLearning course materials are important parts of the Creative Learning Programme (CLP) of the Faculty of Water Sciences of LUPS, launched in 2022.

Users can only access the system with a unique identifier (login and password). This is primarily for privacy reasons and to ensure that user rights are properly protected. As a result of the classification, student and different levels of instructor rights can be assigned. This allows the creation of course materials, the monitoring of examinations, and the tracking of learning progress for the teacher of any subject.

A great advantage of the thematic teaching materials maintained here is that the illustrations, media elements, literature references, and definitions are stored in a separate database. This reference database can also be used by other curricula. In addition, the interoperability of these subjects is facilitated by cleverly designed cross-references.

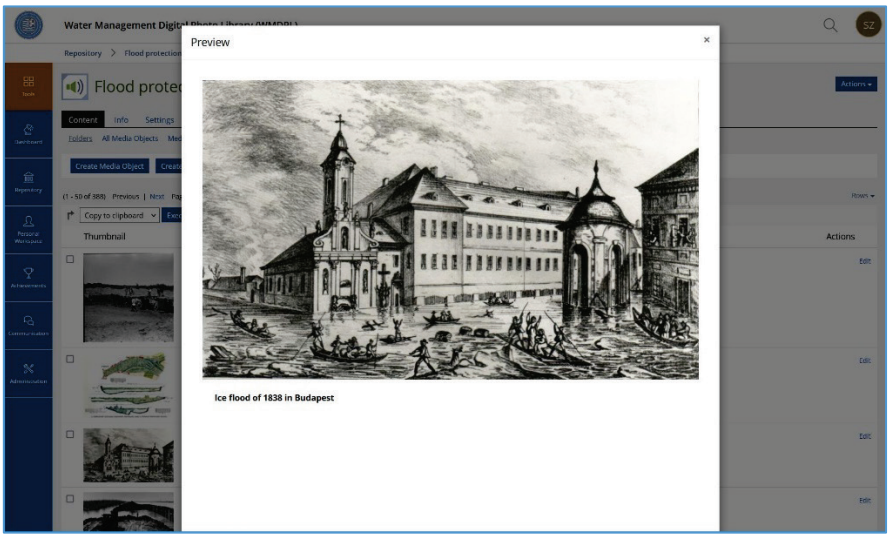

Fig. 3. Subject-specific photo repository.

2.2 Water Management Digital Photo Library (WMDPL)

The Water Management Digital Photo Library (WMDPL) is a thematically structured media collection, containing about 8,000 photos, in a thematic arrangement analogous to the eLearning materials. Each photograph is associated with the following information: short description, place and date of taking, name of the photographer, and optionally some keywords. Thanks to these metadata, the WDPL can be easily used for publications, research reports, applications, scientific works, theses, and dissertations (Fig. 3).

2.3 Digital Video Library for Water Management (DVLWM)

The Digital Video Library for Water Management (DVLWM) is a thematically structured film collection. It contains archival water-related films and edited compilations in 9 categories listed below. The content of each category can occasionally be expanded, and new categories can be added, too (Fig. 4).

Categories of the Digital Video Library for Water Management (with the total number of elements for each category in brackets):

(1) Biography interviews with distinguished engineers (20)
(2) This is how I saw it - engineers remember (part 1) (20)
(3) This is how I saw it - engineers remember (part 2) (14)
(4) Short films on main subjects taught to engineers (20)
(5) Professional films (6)
(6) Archival professional films on water management and environment (916)
(7) Digital film material of water management directorates (319)
(8) Flood documentaries (4)
(9) The XXXVIII Annual Meeting of Hungarian Hydrological Society (1)

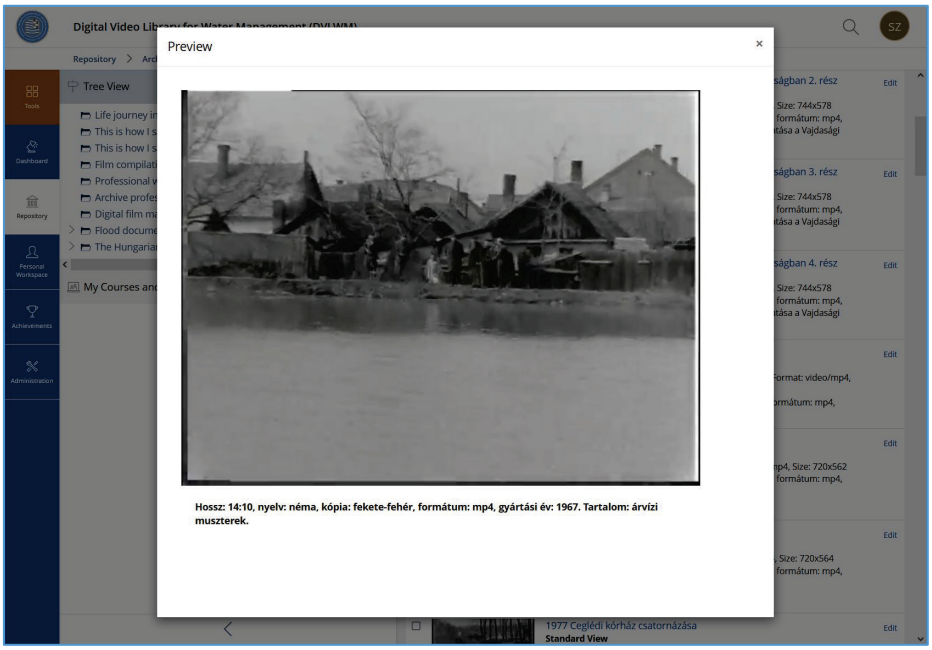

Fig. 4. Film archive.

2.4 Water Management Journals

WMDKR contains almost 150,000 pages of material from a total of 320 volumes of four Hungarian water journals, in digital, searchable duplicate form. Among the journals there are also the publications of the Hungarian Hydrological Society.

The digital content was produced by ARCANUM Ltd. The first step of processing of the printed documents was the scanning of the whole material, followed by the text recognition, which turned the image into text. The efficiency and accuracy of the software used proved to be very good and resulted 98-99% accuracy even with 19th century printed material and up to 99.5% for high-quality prints.

The automatic text recognition resulted in a two-layer PDF, which has an upper layer (scanned image) and a lower layer (text itself). This allows the user to authentic image while the search is performed on the text. The resulting standard two-layer PDF was suitable for publication on the Internet.

To display and publish a two-layer PDF, ARCANUM Ltd. used its proprietary software, which allows sophisticated, high-speed, full-text search, browsing between search terms, displaying results, highlighting, scaling pages, and downloading. The search system is supported by detailed help, worth to be carefully studied before using the system.

2.5 Water Management Textbooks and Handbooks

The same methodology described in the previous chapter was used to prepare and use the textbooks.

The WMDKR contains 100,000 pages of textbooks and manuals, also in searchable duplicate form. One of the oldest volumes is by József Képessy, published in 1867 in Pest. In addition, the database also includes the national and regional volumes and maps of the Water Management Master Plan of 1965 (28 volumes) and the National Water Management Master Plan of 1984 (2 volumes).

2.6 Glossary of Water Management

The technical vocabulary used in water management has changed significantly over the past decades. The looming water crisis, climate change, the new EU water policy, the growing importance of protecting aquatic ecosystems, the involvement of society in decision-making processes, new international conventions, the development of information technology, etc. have brought new terms and sometimes changed them or even modified the meaning of old ones.

Hungary hosted the 2013 Budapest Water Summit; this event also drew attention to the lack of a comprehensive and up-to-date water management glossary or a Hungarian-English dictionary. Native Hungarian professionals often encounter problems of interpretation or search for English terms in English-language articles or when creating an article in English. Water and aquatic specialists in environmental protection also need clear definitions in their studies. In international relations (e.g. UN Conventions, EU working groups, Danube basin, and transboundary water bodies cooperation), it is also of increasing importance to have a clear understanding of English, as it is getting an increasingly important language for the water industry, but the same is true for the development of water exports and projects abroad.

Given the traditional accumulation of water expertise in Hungary and the rapidly changing professional challenges, as well as the change of linguistic expressions, the

compilation of a Hungarian-English dictionary has become extremely timely. The work started in 2013 within the framework of the Global Water Partnership (GWP) Hungary Foundation, with the collaboration of renowned Hungarian water professionals and the contribution of 10 donors. The work reached the stage of presenting a basic version to the professionals in the summer of 2015. The dictionary has been developed with the collaboration of 33 authors, under the guidance of József Gayer, Editor-in-Chief. The dictionary has been in continuous operation since 2015. Its original publication site is https://www.gwpszotar.hu, but it has also been published on several publicly available internet forums. GWP has contributed to WMDKR by offering its dictionary to be included in the system, too.

The dictionary currently contains nearly 3,500 words with English and Hungarian equivalents along with a Hungarian definition (max. 1024 characters). The terms in the definitions and those defined in the glossary have been cross-referenced to facilitate their interpretation, and in some cases are accompanied by diagrams and formulas.

3 The Technology behind the Repository

SZTAKI applied the open-source ILIAS Learning Management System (LMS) (https://www.ilias.de) to administer users (students and lecturers of the faculty, and employees of authorised partners cooperating with the faculty), content (learning materials, glossary, and bibliography), and assessment. The ILIAS system was customized according to the requirements of the university. Students and lecturers of the faculty, and employees of partners who signed a cooperation agreement with the faculty are authorised to log in to the LMS and access the training content. The content includes learning modules, a glossary, and a bibliography; all of them can be represented by a built-in component of ILIAS (Fig. 5).

The question pool and test components of the LMS are applied both to self-assessment and examinations. The test questions can be associated with a question pool, which can contain many questions along with the correct answers. The questions are randomly selected from the pool when the students start filling in a test. Due to this feature, different students can receive the same test with different questions and the student can fill in a test several times without repetition.

ILIAS offers a wide range of functions that can be exploited in other components of the WMDKR as well as the management of the eLearning materials. The Photo Repository is realised by applying the Media Pool component of the ILIAS. It can be accessed only by the users registered in ILIAS.

The Video repository is also implemented in the ILIAS LMS. It is publicly available without registration. It is implemented by using Media Pool, Mediacast, and Learning Module components. The Media Pool contains several videos on the same topic. Learning Modules are used to introduce the video in the format of a multimedia page to provide an overview of the video. The multimedia page may include images, an excerpt from the video, a biography, link to the video. Mediacast is used for streaming audio in the WMDKR.

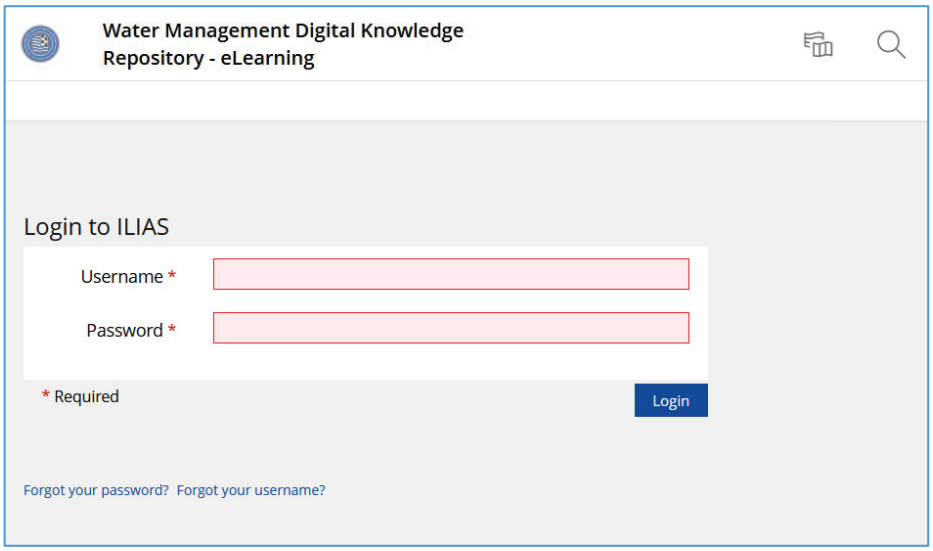

Fig. 5. Login page of the Web site of the LMS.

Some videos (documentaries on floods and presentations made at the Annual Assembly of the Hungarian Hydrological Society) are archived by using the SZTAKI SSS® (Synchronous Slide and Stream) Technology in the video repository. The SZTAKI SSS Technology offers a service for archiving and presenting conference materials, university lectures and many other types of presentations. It can display videos and various types of related illustrations (slides or other multimedia items) synchronously. The archived presentation can be displayed either on a PC through the Web or on a mobile device. The SZTAKI SSS system can create standardised eLearning packages from the presentation. Since it is fully compatible with the SCORM standard, the SSS Player is ready for bidirectional communication with SCORM-compliant eLearning frameworks, such as ILIAS and Moodle. Therefore, the recorded presentations can be easily uploaded into existing eLearning repositories. The layout can be customised based on the requirements of the user (Fig. 6).

The SSS System consists of two main applications:

- SZTAKI SSS Player application – a multiplatform player for synchronised videos.
- SZTAKI SSS Editor application – an editor for creating synchronised packages.

Fig. 6. VDVI – screens from a radio documentary on water flow in Hungary in 1970.

4 Benefits

Experience so far has shown that the WMDKR is an excellent research and teaching tool and can even be used to train teachers. It has been specifically used for in-house pedagogical training of selected trainers. The eLearning system has been applied both during the preparation and in the examination phases to make the completion of exams and assessments easier and more objective. In engineering education, the development of numerical and drawing skills is more predominant, and descriptive, essay-type work is less common. Nevertheless, the ingeniously devised tests and the so-called formula questions (computational questions) offered by the eLearning ILIAS-based system have proved to be particularly useful in recent years.

Although no specific satisfaction survey was carried out, the feedback from students is very positive. Well-practised and repeatable tests really help preparation, and a big advantage is that students can do this on their own schedule. Even the instructor can assess the activity in a personalised way. The tests indeed take a lot of time to set up at first, but this investment pays off later, as the continuously expanded question sets provide sufficient immersion for the development of new question sets. Students do not have to wait for the assessment either, as they can see their scores immediately after completing the tests and calculations.

For the time being, the main deficiencies are caused due to the continuous version updates required by IT security, which unfortunately do not always cover all beneficial new features. In the case of migrations, applications that worked well in the past may become fundamentally changed or even may not be available in the future.

All in all, the system has proven its applicability and benefits many times and is therefore the preferred choice for use in education.

5 Related Mobile Applications

SZTAKI created and published the INFO@HAND NKE-VTK VDT (in English LUPS FWS WMDK) smartphone application (Fig. 7). The application presents the knowledge repository and the related contents on mobile devices both in Hungarian and English. It is available on iOS (iPhone, iPad) and Android platforms. The contents provided by the system can be used offline, i.e. the information can be retrieved without an Internet connection. Its services include the list of favorites, receiving push notifications, etc.

The application belongs to the GUIDE@HAND mobile application family developed by the eLearning Department of SZTAKI (https://guideathand.com/) (Márkus & Wagner, 2011). The application family can meet a wide variety of demands and trends of the present life. It consists of more than 80 multilingual offline applications running on smartphones and tablets and provides tools and interactive services for mobile exploration of places, events, organisations, cultural objects, etc.

The main menu of the application contains the following items:

- *Information* presenting general information on the repository. It introduces the project, the main components of the knowledge repository, and the award granted to the digital repository.
- *Elearning Materials* containing the list of available eLearning materials and their short contents.
- *NKE VTK* introduces the Faculty of Water Sciences Ludovika of University of Public Service.
- *Authors* containing the list of the authors with their photos, positions at the university, the list of eLearning materials they authored, and the list of subjects they teach at the university.
- *Contact* containing email addresses to be used in case of any issues.
- *More* containing some general functions (e.g., *Update*, *Favourites, Notifications,* etc.)

Other applications related to water management developed by SZTAKI are as follows:

- **BOOK@HAND - 111 aquatic monuments in Hungary.** The application represents a guide to memorials of water management. It enlists the memorials and provides information on them. They can be also displayed on a map to facilitate finding the nearby POIs.
- **INFO@HAND Hungarian Hydrological Society.** The application introduces the Hungarian Hydrological Society and its professional events.
- **EVENT@HAND World Water Day.** The application distributes the information on the World Water Day in Hungary.

6 Conclusions

This article aimed to provide information on the current state of development and evolution of the state of the art in the transformation and digital representation of water-related knowledge available in traditional media (print, images, films, sound recordings). It is the task of present and future engineers, computer scientists, and developers to go further, to help, to extend the digital set of professional knowledge increasingly complete, better, more comprehensive, faster, and more complex information. The next challenge might be the application of artificial intelligence to our Water Management Digital Knowledge Repository to help the researchers and students finding the relevant information in this constantly developing online system.

The past pandemic period (COVID-19) has repeatedly shown that the energy invested in WMDKR has paid off. In fact, it has become an everyday part of our education system. This is not only due to the virtualisation of old knowledge but also to the fact that new generations prefer to learn by computer rather than by reading traditional textbooks.

Acknowledgements.

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References

Márkus, Z. L., & Wagner, B. (2011). GUIDE@HAND: Digital GPS Based Audio Guide that Brings the Past to Life. *Digital Presentation and Preservation of Cultural and Scientific Heritage, 1*, 15-25. https://doi.org/10.55630/dipp.2011.1.2

Szlávik, L. (2023), Vízügyi Digitális Tudástár [Water Management Digital Knowledge Repository], *Vízügyi Közlemények, 105*(2), 83-118. https://library.hungaricana.hu/en/view/VizugyiKozlemenyek_2023/

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