ASSESSMENT OF GLOBAL FUTURE WATER PROBLEMS PER PEOPLE'S PERSPECTIVE

K.B. BOATENG[1], E.O. BERKO[1], A. KHRAKOZ[1], Liliana TÖRÖK[1], Zs. TÖRÖK[1]

[1]John Wesley Theological College, Department Environmental Security, Budapest, Danko Street, No. 11, 1086, Hungary

Corresponding author: torokliliana@yahoo.com

Abstract. *Water management and availability are pressing global issues where impacts are seriously varied between regions, age groups, and even genders. In many parts of the world, surface waters bodies often suffer from pollution, habitat degradation and decreased flow, which further increase water scarcity and quality problems. Awareness of these aspects is a first step in changing attitude and behaviour in relation to the use and protection of aquatic resources. The main objective of this paper was to assess people's opinion on the management, availability, purity and accessibility of water globally. A total of 463 responses were collected per the timelines between the years 2022 – 2024. The high number of positive responses per the five (5) questions stated in the questionnaire form indicates that water is not available to humans in all parts of the world and therefore the need for this research. High positive answers raise the alarm of the need and urgency of water management and availability. The geographical distribution of beliefs about water in Africa, Europe, America and Asia enabled us to analyze the answers per gender and different age groups. There is a sense of hope that water scarcity issues can be solved but there must be strategic efforts made to get there. The results of this study can provide a comprehensive picture based on the individual approach to the need to conserve aquatic resources.*

Keywords: *water quality, water scarcity, water availability, people's perceptions*

INTRODUCTION

Water supply, purity, accessibility, management challenges are now major concerns. Equally important is the fact that riparian zones buffer and protect waterways, which serve as a vital role in the maintenance of healthy aquatic ecosystems; this effectiveness, however, is lowered by urbanization and inappropriate land-use practices, further adding to the stress of the water resources that are already experiencing strain (IAROVOI et. al, 2023). Like many other watersheds, the Danube River basin has a long history of human alteration and severe, future effects of climate change are predicted (FRIEDRICHS-MANTHEY et. al., 2023). Thus, there is a need to manage the water resources on the earth to be able to sustain the living conditions for life here on earth with a view of future generations.

Our anthropophagic behaviours have made us the main agents of environmental change. The world and its climate are change due to our actions (COSGROVE & LOUCKS, 2015).

Freshwater resources are of major economic and ecological importance. Excessive abstraction, pollution from human activities (agriculture, industry, households), climate and weather changes, introduction of invasive species can have significant environmental and socio-economic consequences. These superimposed on the low flows of the rivers, the depletion of underground water, the loss of wetlands, desertification, the risks to food security and economic

production put the entire human society at risk (****, 2017). We are modifying the characteristics of our freshwater resources, which are essential to our physical and economic survival, along with changes to the environment brought on by increases in food and energy production as well as human migration into metropolitan areas (COSGROVE & LOUCKS, 2015).

Most of the freshwater on Earth is shared by multiple nations, and many rivers, lakes, and groundwater aquifers span national boundaries. Approximately 40% of the world's population depends on shared water sources found in the approximately half of the Earth's land surface that are covered by international watersheds (COOLEY & GLEICK, 2011).

Over the past several years, sustainable water resources management (WRM), water governance and stakeholder engagement has gained a lot of attention in the interdisciplinary and transdisciplinary research around the world (LOUCKS, 1994; MEGDAL et al., 2017).

WRM is no longer solely a technical response; instead, it now incorporates input from a variety of stakeholders, including indigenous people and civil society organizations (CRITCHLEY et al., 1994, WOSTL P. et al., 2007, JACOBS et al, 2010; TÖRÖK et al., 2019; MARIN et al, 2020).

In this respect, our paper emphasises the results of a three-year project that tried to highlight the differences in perception of water-related problems, as well as possible solutions among the widest possible range of people from all over the world.

MATERIAL AND METHODS

Study Design

Data collection was carried out as part of a student project carried out between 2022-2024 at John Wesley Theological College, Budapest. The target audience was mainly young people from Africa and Asia studying in Hungary. A total number of 20 students and teachers were involved in the collection of data.

The questionnaires were distributed in the countries of the European Community, outside it, as well as in the United States of America. The questionnaire contained 5 opened and closed questions related to future issues (such as availability, quality, storage and optimization for agricultural purposes) of water.

The participants were informed about the nature of the research and their line of contribution to the research if they agreed to join. The age, gender, educational level, occupation and nationality of the participants were taken into consideration and recorded. This method is known to provide the drafting of the survey with quantifiable and in-depth results (BIRD DK., 2009).

The main dissemination channels used for the survey were brief face to face interview, calls, social media applications (for eg WhatsApp, Messenger), Google form (https://forms.gle/cbbujabMqesq685y6).

Data analysis

Standard descriptive statistics were used to highlight the perception of the problems related to the distribution, accessibility and quality of water among the widest possible spectrum of participants.

Responses to closed questions were recorded as binomial (yes/no). In the situation where the respondents gave maybe answers, these were considered positive answers, and the answers were quantified as such. Respondents who answered with "I don't know" or undecided were excluded from the analysis.

The selection of the indicators and statistical variables are based on the following categories: age young (children and adolescents) less than 16 years old, 17-25 years old, 26-36 years old; young adults 37-45 years old, adults over 46-55, 56-65 years old; seniors 65 – 75 year-old and up to 76 years old; gender (male and female) and nationality. When the responses were distributed by continent, respondents regardless of nationality who lived for more than 20 years on another continent were included in that continent.

RESULTS AND DISCUSSION

Many research and initiatives have been produced to examine the availability and demand for water globally. In reality, in many parts of the world, especially in those with limited water supplies, water demand has reached crisis heights (MANCOSU et al, 2015).

Water scarcity is a problem that many parts of the world are facing today (ALCAMO et al, 1997; RIJSBERMAN, 2006; LIU et al., 2017). The anticipated rise in the global population growth rate implies that future food consumption is anticipated to be higher, which will have a direct impact on the amount of water used for agriculture. The growing worldwide demand for food puts more strain on the world's freshwater and land resources (BORRAS et al, 2011). Furthermore, considerable water usage for irrigation is anticipated in the context of growing competition between agriculture and other economic sectors due to increased water shortages and drought brought on by climate change (JIMENEZ et al, 2014).

A sustainable approach to water resource management in agriculture is crucial since, in many parts of the world, the balance between water supply and demand has reached critical levels, and future increases in both water use and food production are predicted (MANCOSU et al, 2015).

Understanding the behavior and preferences of the population in relation to water is essential in planning future water resources management measures (PROUTY & ZHANG, 2016; ECK et al 2019, CAUBERGHE et al. 2021). To address these goals, during three years of investigation we interviewed and recorded in our questionnaires 463 answers (Table 1)

Table 1

The distribution of survey participants by year

Timeline	No. participants
2022	160
2023	53
2024	250

It was a consensus (Fig. 1) from various ideas coordinated from different continents to ascertain views and connect it to truths across these continents. A wide majority of the people had views of water wars in the future. This reflects the view that water resources available are being depleted at a higher rate and as population increases, people will soon be conflicting others for the water resources. This could be due to pollution to wide water resources available or mishandling of water resources available leaving just a few water resources to cater for the masses.

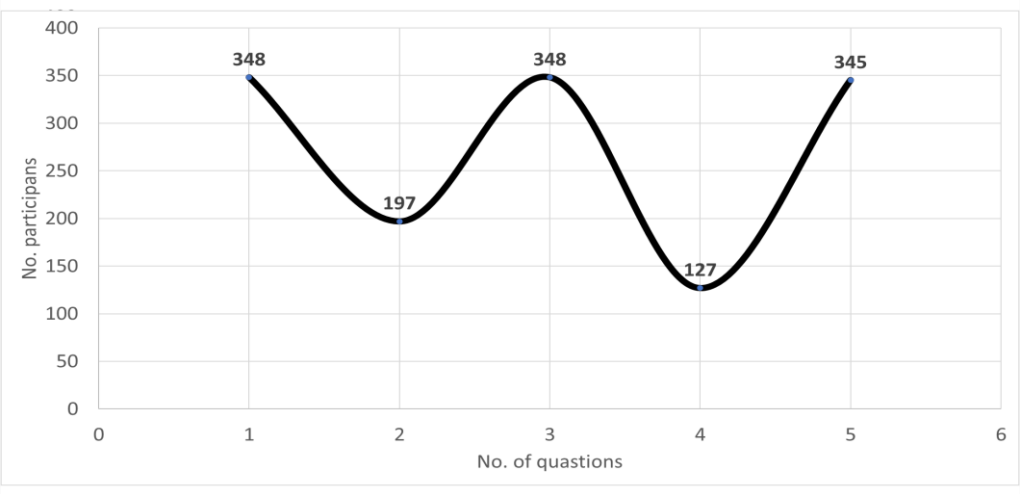

Fig. 1 - The distribution of positive answers to each question

Furthermore, there is a pessimistic belief that there will not be pure water in the future. The survey gathered less than half of the total number of people believing that water will be pure in the future. This is a troubling thought which in fact may just be the case. The purity of water resources encompasses reduction in pollution of water resources, developing technologies to improve upon the quality of water. This denotes the global desire to maintain water resources available.

Another point worth noting is the possibility of optimising water in agriculture. The dominant perception from the survey is that it is possible to optimise water used in agriculture. This idea may be varying across continents due to the level of infrastructure that exists in various

continents. For instance, within the Asian continent, methods as: Drip or sprinkler irrigation systems, rainwater harvesting, replacement of open canals by underground pipes, change in crop pattern, soil management, IS technology in water resources and land use pattern management are used for are used to improve the management of water resources (SHAN et al., 2020)

Considerable water usage for irrigation is anticipated in the context of growing competition between agriculture and other economic sectors due to increased water shortages and drought brought on by climate change (JIMENEZ et al, 2014). The reality of optimising water for agriculture use is possible but will require strategic plans.

Overall, issues with the availability of water excessively harm the most vulnerable groups of the population; women and children in developing regions (CAIRNCROSS et al., 2010). In many cultures, a large burden of collecting water rests on women. In fact, as a result of the lack of clean water, their physical and time burdens increase. Moreover, limitations in access to sanitation due to insufficient water will again affect women and girls because their special needs concerning hygiene will not be covered.

Our survey reveals a notion that water is not available to humans in all parts of the world.

The results obtained were less than half which supports a general idea.

The distribution of beliefs was very similar between age groups and there are no relevant gender differences (Fig 2)

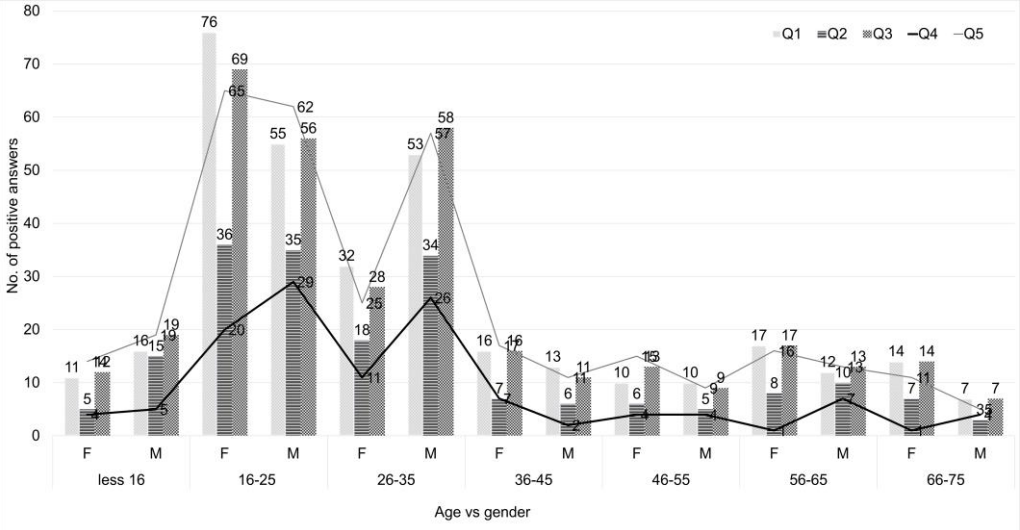

Fig. 2 - The distribution of beliefs about water by age and gender

Water availability to all humans is an issue and a troubling foresight at the same time.

The quality and access to potable water is less of an issue, especially in urban areas such as Budapest (NAGY-KOVÁCS et al, 2019; ****2024), than it would be in either rural or

developing countries, but even there, the most disadvantaged in society may have problems gaining fair and equal access to water. Water shortages also hit different age groups differently. Children are highly susceptible to waterborne diseases resulting from a lack of proper sanitation and sources of water contaminated with unsafe substances. Older adults, however, face challenges in accessing clean water due to mobility issues or diseases that inhibit their ability to obtain water. In urban areas, older adults are highly vulnerable to weather extremes, such as flooding and droughts, which are worsened by poor management of riparian zones and urban streams.

Water deficit, water demand, water resources, water pollution, are closely related to population growth, as well as economic growth, being at the same time much more strongly interconnected in space and time with local conditions than with global ones (BORETTI & ROSA, 2019). For instance, rapid population growth, widespread poverty, inequitable access, climate change and low capacity to develop and manage adequate water infrastructure in Africa (FILHO et al, 2022) confirm the continent's water problems, anticipated since 1989. It is anticipated that the African continent would face severe problems in the future due to water scarcity. "Water scarcity is now threatening two-thirds of the African population," FALKENMARK (1989) said. Over the past 20 years, Zimbabwe has experienced times of extreme drought, which has increased the demand on the limited freshwater resources and raised the possibility of disputes between water users, mainly between the urban and agricultural sectors but also within the agricultural sector itself.

Across Europe, organic pollution, morphological and hydrological changes in water bodies, urban, industrial and agricultural land use over the last 160 years, together with demographic changes and water consumption, have contributed to changes in water quantities and qualities in European river basins (FERREIRA et al., 2019).

In America, the 20th century was marked by specialization and consolidation of agriculture that led to the increase of nitrate–nitrogen concentration in rivers and streams, particularly in those watersheds where corn cropland occupies more than 25% of the total area. (BROUSSARD & TURNER, 2009)

However, even if the impact of human activities is visible all over the world, the scenario of humanity's water footprint based on population and economic growth, consumption patterns, production pattern and global trade and technology development until 2025 showed that reducing humanity's water footprint to sustainable levels is possible even with population growth (ERCIN & HOEKSTRA, 2014).

Our results (Fig 3) also show the ideologies gathered by people from the various continents.

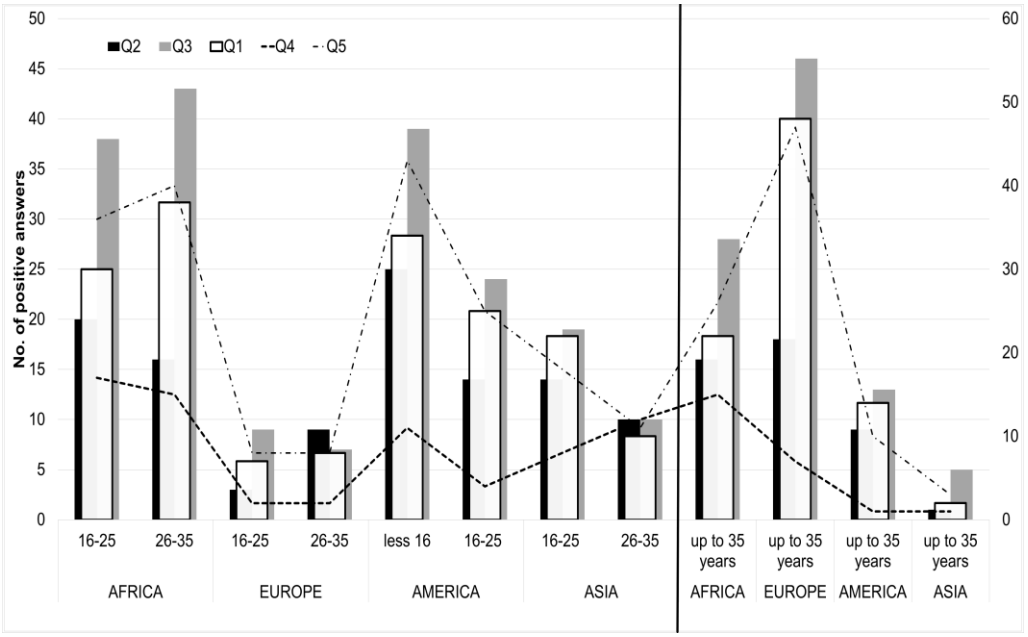

Fig. 3 The distribution of beliefs about water by geographical distribution

The results reveal the hope that it is possible to optimise water used in agriculture. It recorded the highest number of positives across board in the survey. This is a response which could be backed by the current situations in the various continents as people believe they can do better with the preservation and efficient use of water resources in agriculture but also responses could denote the knowledge of the age groups that took part in the survey. With advanced technologies and infrastructure development, water could be properly channelled into agriculture to ensure a better use of its resources with even more outstanding results. Furthermore, with constant education, citizens across continents can push further to ensure water resources are kept clean and devoid of measures to pollute these water resources.

It is possible to store water for future use according to the general idea gathered from the survey. This is a reality but could be challenging and will need monumental efforts to achieve this, because is well documented that storage loss especially in reservoirs is a challenge with increasing need for storage. Globally, 30-40% of irrigated areas, 20% of global electricity generation in the form of hydropower, as well as flood control, recreation and navigation are provided by water stored in reservoirs (WISSER et al. 2013)

The concept of integrated water resources management, or IWRM, has been developing since the early 1980s. IWRM is a reaction to the growing pressure on our water resource systems from population increase and socioeconomic development.

Water management can take many different forms, depending on political, cultural, traditional, economic, and legal systems. According to CREVELLO (2004), one of the key

elements of contemporary management is the creation of an institutional and administrative framework that facilitates the participation of individuals with diverse interests, allows for cross-cultural and cross-issue dialogue, and encourages collaboration and coordination of management action.

CONCLUSIONS

From the results of this analysis, the following characteristics of the population segment considered were highlighted:

- No significant differences between continents were found in terms of the general model of distribution of responses by gender.
- Regarding water quality, the most optimistic are men from Europe
- Regarding the accessibility of the water resource globally, Asian women and men in the 26-35 age group are the most optimistic
- Regarding the storage of water for subsequent use and its optimization for agriculture, all of the below categories have a positive attitude vis a vis the storage of water for the respective subsequent use and its optimization for agriculture:
    - young people (less than 16 years old) regardless of gender, as well as men regardless of age from America.
    - men 16-25 years old, young men from Europe.
    - women and men over 35 years old, and young people regardless of gender from Africa.
    - Asian women and men over 35 years of age.
- Regarding water-related problems, the most pessimistic attitude is found in the following categories:
    - women over 26 and men over 35 from Europe,
    - women in the age categories between 16-25 and over 35 in America,
    - young people in the 16-25 age category, regardless of gender, from Asia

By assessing the responses given by the interviewees, it is worthy of noting that water and its management issues are not significantly affected by age, cultural and even geographical backgrounds. The situations of water availability are not of main concern across continents. There is a sense of hope that water scarcity issues can be solved but there must be strategic efforts made to get there. The idea of technology will be a pivot in securing water resources to always match up the corresponding needs of the world's population on earth at that point in time. To manage water shortages, there needs to be a campaign to inform people about the importance of protecting our water sources and making constructive contributions to climate change. To preserve our hope, organizations and authorities are urged to promote the importance of water management and protection.

ACKNOWLEDGEMENTS

We would like to thank all those who supported us during the three years of investigations, without their help we could not have reached this stage.

BIBLIOGRAPHY

ALCAMO, J., DÖLL, P., KASPAR, F., SIEBERT, S., 1997, Global Change and Global Scenarios of Water Use and Availability: An Application of WaterGAP 1.0, 47p. Center for Environmental Systems Research (CESR), University of Kassel: Kassel, Germany

BORRAS, S.M., HALL, R., SCOONES, I., WHITE, B., WOLFORD, W., 2011, Towards a better understanding of global land grabbing: An editorial introduction. *The Journal of Peasant Studies* 38(2): 209–216. https://doi.org/10.1080/03066150.2011.559005

BORETTI, A., ROSA, L., 2019, Reassessing the projections of the World Water Development Report. *npj Clean Water* 2, 15. https://doi.org/10.1038/s41545-019-0039-9

BRID, D. K., 2009. The use of questionnaires for acquiring information on public perception of natural hazards and risk mitigation –a review of current knowledge and practice. *Natural Hazards and Earth System Sciences*, 9: 1307-1325.

BROUSSARD, W., TURNER, R. E., 2009, A century of changing land-use and water-quality relationships in the continental US. *Frontiers in Ecology and the Environment*, 7(6), 302–307. doi:10.1890/080085

CAIRNCROSS, S., HUNT, C., BOISSON, S., BOSTOEN, K., CURTIS, V., FUNG I.CH., SCHMIDT W-P., 2010, Water, sanitation and hygiene for the prevention of diarrhoea. *International Journal of Epidemiology* 39:i193–i205, doi:10.1093/ije/dyq035

CAUBERGHE, V., VAZQUEZ-CASAUBON, E., VAN DE SOMPEL, D., 2021, Perceptions of water as commodity or uniqueness? The role of water value, scarcity concern and moral obligation on conservation behavior. *Journal of Environmental Management*, 292, *112677*. doi:10.1016/j.jenvman.2021.112677

COSGROVE, W. J., LOUCKS, D. P., 2015, Water management: Current and future challenges and research directions. *Water Resources Research*, 51: 4823–4839, doi:10.1002/2014WR016869.

COOLEY, H., GLEICK, P. H., 2011, Climate-proofing transboundary water agreements. *Hydrological Sciences Journal*, 56(4): 711-718, https://doi.org/10.1080/02626667.2011.576651

CREVELLO, S., 2004., Dayak land use systems and indigenous knowledge. *Human Ecology*, 16(2): 69-73.

CRITCHLEY, W.R.S., REIJ, C., WILLCOCKS, T.J., 1994, Indigenous soil and water conservation: A review of the state of knowledge and prospects for building on traditions. *Land Degradation and Rehabilitation* 5(4): 293-314.

ECK, C. J., WAGNER, K. L., CHAPAGAIN, B., JOSHI, O., 2019, A Survey of Perceptions and Attitudes about Water Issues in Oklahoma: A Comparative Study. *Journal of Contemporary Water Research & Education*, 168(1): 66–77. https://doi.org/10.1111/j.1936-704x.2019.03321.x

ERCIN, A. E., HOEKSTRA, A.Y., 2014, Water footprint scenarios for 2050: A global analysis. *Environment International*, 64: 71-82, https://doi.org/10.1016/j.envint.2013.11.019

FALLENMARK, M.,1989, The massive water scarcity now threatening Africa—why isn't it being addressed? *Ambio* 18(2): 112-118.

FERREIRA, T., GLOBEVNIK, L., SCHINEGGER, R., 2019, Water Stressors in Europe: New Threats in the Old World, ch 8, 139–155. IN: *Multiple Stressors in River Ecosystems. Status, Impacts and Prospects for the Future.* doi:10.1016/b978-0-12-811713-2.00008-x

FILHO W. L., TOTIN, E., FRANKE, J.A., ANDREW, S. M., ABUBAKAR, I. R., AZADI, H., NUNN, P. D., OUWENEEL, B., WILLIAMS, P. A., SIMPSON, N. P., 2022, Understanding responses to climate-related water scarcity in Africa. *Science of The Total Environment* 806(1), 150420, https://doi.org/10.1016/j.scitotenv.2021.150420

FRIEDRICHS-MANTHEY, M., LANGHANS, S.D., BORGWARDT, F., HEIN, T., KLING, H., STANZEL, P., JÄHNIG, S. C., DOMISCH S., 2023, Three hundred years of past and future changes for native fish species in the upper Danube River Basin—Historical flow alterations versus future climate change. *Diversity and Distributions*, 1-14, DOI: 10.1111/ddi.13808

IAROVOI, S., URWA, J., HALMAI, O., TÖRÖK, L., TÖRÖK, ZS., 2023, Preliminary study of the ecological status of riparian zones of running waters in a central European urban area (Budapest, Hungary), *Research Journal of Agricultural Science*, 55 (3):112-120, ISSN: 2668-926X

JACOBS, K., LEBEL, L., BUIZER, J., ADDAMS, L., MATSON, P., MCCULLOUGH, E., FINAN, T., 2010, Linking knowledge with action in the pursuit of sustainable water-resources management. *Proceedings of the National Academy of Sciences*, 113(17): 4591–4596. doi:10.1073/pnas.0813125107

JIMÉNEZ CISNEROS, B.E., OKI, T., ARNELL, N.W., BENITO, G., COGLEY, J.G., DÖLL, P., JIANG,T., MWAKALILA, S.S., 2014, Freshwater resources. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 229-269

LIU, J., YANG, H., GOSLING, S. N., KUMMU, M., FLÖRKE, M., PFISTER S., HANASAKI, N., WADA, Y., ZHANG, X., ZHENG, C., ALCAMO, J., OKI, T., 2017, Water scarcity assessments in the past, present, and future, *Earth's Future*, 5: 545–559, doi:10.1002/2016EF000518.

LOUCKS, D. P., 1994, Sustainability implications for water resources planning and management. *Natural Resources Forum. A United Nations Sustainable Development Journal*, 18(4): 263-274.

MANCOSU, N., SNYDER, R.L., KYRIAKAKIS, G., SPANO, D., 2015, Water Scarcity and Future Challenges for Food Production. *Water*, 7: 975-992. https://doi.org/10.3390/w7030975

MARIN, E., TÖRÖK, L., MIERLA, M, TÖRÖK, ZS., 2020, Stakeholders' perception on algal blooms in Danube Delta, as decision support for aquatic ecosystems. Scientific Annals of the Danube Delta Institute, 25: 83-92

MEGDAL, S.B., EDEN S., SHAMIR, E., 2017, Water Governance, Stakeholder Engagement, and Sustainable Water Resources Management, Water, 9, 190; doi:10.3390/w9030190

NAGY-KOVÁCS, ZS., DAVIDESZ J., CZIHAT-MÁRTONNÉ, K., TILL, G., FLEIT, E., GRISCHEK, T., 2019, Water Quality Changes during Riverbank Filtration in Budapest, Hungary. Water, 11, 302; doi:10.3390/w11020302

PAHL-WOSTL, C., CRAPS, M., DEWULF, A., MOSTERT, E., TABARA, D., TAILLIEU, T., 2007, Social learning and water resources management. *Ecology and Society* 12(2): 1-19.

PROUTY, C., ZHANG, Q., 2016, How do people's perceptions of water quality influence the life cycle environmental impacts of drinking water in Uganda? *Resources, Conservation and Recycling, 109, 24–33.* doi:10.1016/j.resconrec.2016.01.019

RIJSBERMAN, F. R., 2006, Water scarcity: Fact or fiction? *Agricultural Water Management*, 80(1-3): 5–22. doi:10.1016/j.agwat.2005.07.001

SHAN, V., SINGH, S. K., HARITASH, A. K., 2020, Water Crisis in the Asian Countries: Status and Future Trends, Springer Transactions in Civil and Environmental Engineering ch. 10., 173-194. IN: Kumar M et al. (eds.), Resilience, Response, and Risk in Water Systems. Shifting Management and Natural Forcings Paradigms , https://doi.org/10.1007/978-981-15-4668-6_1

TÖRÖK, L., TÖRÖK, Z., PHILIPSON, P., POLITI, E., 2019, Towards improving water management in Romania; Stakeholders perceptions of Satelitte- Based cyanobacteria bloom assessments. Journal of Environmental Protection and Ecology 20 (3): 1094-1101,

WISSER, D., FROLKING, S., HAGEN, S., BIERKENS, M. F. P., 2013, Beyond peak reservoir storage? A global estimate of declining water storage capacity in large reservoirs. *Water Resources Research*, 49(9), 5732–5739. doi:10.1002/wrcr.20452

***, 2017, Freshwater resources ch2:74-77. IN: Green Growth Indicators 2017, OECD Publishing, Paris. DOI: https://doi.org/10.1787/9789264268586-12-en

****, 2024, https://www.ovf.hu/en/hydrography-water-quality/water-quality