Doctoral (PhD) Dissertation Assessment

Candidate: Roquia Ibrahim Saad Rizk

Title: **Advanced comprehensive water quality assessment**

Institute: University of Pannonia, Institute of Environmental Engineering

Doctoral School of Chemical Engineering and Material Sciences

Assessor: Anna Farkas PhD

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1. Topic evaluation

The primary goal of this research was the assessment of the quality status of Lake Nasser (Egypt) and Lake Balaton (Hungary), both of relevant importance as public water resources, recreational sites, and aquatic habitats.

For this purpose, the candidate has applied novel evaluation approaches that enabled the integration of a wide range of physico- chemical parameters recorded at a large spatial scale throughout the lake areas.

The selected physico-chemical parameters are used as standard benchmarks for water quality characterization.

In addition, the candidate also performed an evaluation of the pollution status of lakes, based on the trace metal loads recorded in the water and sediment compartments as well as in the tissues of prevalent fish species populating the lakes.

As currently various evaluation approaches are in use to characterize the quality status of surface waters, the candidate decided to also assess the performance of these techniques, and the results of this interpretation could serve as a valuable support in future studies of the field.

The scientific impact of this research is relevant as the results provide both new data outlining the spatial- temporal variability of the quality status of the studied lakes, as well as disseminates the applicability of various multi-criteria decision-making techniques to integrate water quality indicators and provide a numerical measure of water quality.

2. Literature review

The candidate performed an appropriate review of the scientific literature connected to the addressed research topic therefore, the established conceptual design of the research work is sound. Presently, the reliable assessment of the quality status of surface waters is a prime task that could enable the implementation of efficient protection measures for the sustainability of their ecosystem services. The literary references reviewed by the candidate are broad in time and include the most relevant knowledges of the subject. The competent overview of the topic

presented in the Introduction section demonstrates profound knowledge of the theme in its broad aspects.

3. Presentation of research goals

The research objectives are presented in a separate chapter and the research questions addressed are clearly specified as follows: 1. assessment of the quality status of Lake Nasser (Egypt) and Lake Balaton (Hungary) by means of standard physico-chemical water quality parameters and anthropogenically sourced micropollutant loads (trace metals); 2. the overall quality status evaluation of the waterbodies via quality indices computed based on the weighted parameters determined at large spatial scales; 3. the comparative performance evalaution of current quality assessment approaches of surface waters.

4. Materials and Methods

The techniques used in this research are in line with the formulated aims and are clearly presented. Reliable measurement techniques were employed to record on site the main physico-chemical parameters serving as benchmarks to rate the quality of surface waters as defined in the Water Framework Directive and pertaining legal regulations. Sample matrices (water, sediment, fish samples) collected for trace metal content determination were properly conserved on site and were processed by valid techniques for elemental analysis. Importance has been paid for the quality control of chemical analysis when quantifying trace metals by including in analysis certified refence materials that supports the validity of generated data.

The candidate applied proper statistical approaches to identify significant differences or correlations between datasets.

5. Results and Discussion

The results of this research are convincing and objectively interpreted. The candidate used novel assessment techniques to rank and weigh the water chemistry data as well as the trace metal (Cd, Cu, Pb, Zn) loads in water, sediment and fish organs sampled at locations spanning representative sites of Lake Nasser and Lake Balaton. The application of novel multi-criteria decision-making (MCDM) evaluation tools enabled to reliably outline spatial differences in the quality status of the investigated lakes and to identify the main physico-chemical factors that pose concerns in these waterbodies.

Water chemistry recordings were weighted and ranked by the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) and Simple Additive Weighting (SAW) then, the ranking performances and robustness of the two evaluation methods were assessed via the Sum of Ranking Differences (SRD). The Aquatic Environmental Index (AEI) evaluation tool was used as reference in the performance evaluation of the two MCDM techniques.

The relevance of contamination with trace metals of the abiotic compartments (water, sediment) and of biota (fish) were evaluated by computing for each sample matrix and per sampling site an integrated Metal Pollution Index (MPI) providing in this way a better understanding of the pollution status of representative sites within each lake.

The candidate objectively interpreted the results obtained within the frame of the research that served as basis for the present dissertation and properly compared the own findings with previous research achievements of the field related to these waterbodies.

The most remarkable findings of this research that deserve particular attention in my opinion are the following:

- the candidate demonstrated that the multi-criteria decision-making techniques (TOPSIS, SAW) used to characterize the quality status of the considered lakes provide similar and reliable quality rankings of the study sites.
- the candidate demonstrated that both MCDM techniques evidenced the N- and P loads as factors with greatest environmental risk for Lake Balaton, while for Lake Nasser, the most critical factor was proven to be the water temperature.
- the candidate contributed with new data concerning the trace metal pollution of Lake Nasser and Lake Balaton and highlighted spatial- temporal trends in contamination.
- based on the novel trace metal contamination data generated within the work performed by the candidate signs of decline in metal contamination of the studied waterbodies is apparent.

6. Conclusions

Based on the results obtained, the PhD candidate logically draws five relevant conclusions, which correspond to the tasks set.

1. The water quality of Lake Nasser is good and safe for current uses. According to the novel MCDM evaluation approaches applied, consistently water temperature was evidenced to be the most important influencing factor of the quality status of Lake Nasser.
2. For Lake Balaton water quality issues were outlined in the Western basin of the lake at the inlet point of River Zala, raised by nutrient (P, N) overloads of the river water.

3. Conceptual differences between the water quality assessment approaches used in this research have been highlighted and their specific application fields defined.
4. The pollution by trace metals of the studied lakes was regarded as low therefore, the use of water for public purposes and the consumption of fish populating the lakes do not raise human health concerns.
5. The pollution assessment approaches applied in this research enabled the detection of both spatial and temporal variations in water quality status as well as in the trace metal contamination of lakes and the obtained results proved to be in line with findings of previous survey results.

7. Structure of thesis

The dissertation has a logically built-up structure including a focused introductory part, appropriate literature review, a clearly presented Results and Discussion section, objective conclusions and the summary of new results generated via the experimental work set up. Considering its structure and extent, the length of the thesis is 101 pages and contains 21 tables and 37 figures and includes the following sections: Abbreviations and symbols used – 2 pages; Introduction – 4 pages; Literature review – 10 pages; Materials and methods – 7 pages; Results and discussion – 49 pages; Conclusion and recommendations – 2 pages. Finally, the candidate summarizes in 12 points the new findings achieved within the frame of the studies performed to solve the initially established goals.

Overall writing meets the standards expectable for a PhD dissertation.

The dissertation is well structured and particularly the quality of figures is impressive.

8. Closing thoughts and declaration

The research achievements of the candidate were published in highly scored scientific journals of which in three publications was the first author and the candidate was also co-author of additional three SCI publications. In addition, the candidate contributed also to works published in Hungarian language. The candidate presented her scientific achievements related to the present dissertation in a high number of international and national conferences, which demonstrates her high-quality scientific activity.

Overall, the dissertation demonstrates that the doctoral degree candidate possesses in-depth theoretical knowledge and high-level practice in the field of Environmental Engineering, thus testifies adequate qualities and skills for conducting independent research. The only weakness of this dissertation is related to the section summarizing the "New Scientific Findings". Here, few points may better be regarded as concluding remarks, rather than true new achievements. Nevertheless, this minor error does not significantly affect the overall high quality of the dissertation.

In consideration of the foregoing, I give my positive review and strongly recommend to the Committee to favourably evaluate the doctoral dissertation entitled "**Advanced comprehensive water quality assessment"** prepared by Roquia Ibrahim Saad Rizk.

Tihany, 30.03.2023.

PhD Thesis Evaluation Report by: Farkas Anna

Anna Farkas PhD
senior research fellow
Balaton Limnological Research Institute