

SCIENTIFIC OPINION

By: Assoc. Prof. Emilia Ivanova Tcherkezova, PhD, National Institute of Geophysics, Geodesy and Geography at Bulgarian Academy of Sciences (NIGGG-BAS), Department of Geography, Section “GIS“

Subject: Dissertation for awarding the educational and scientific degree “**doctor**” in scientific field 4. Natural Sciences, Mathematics and Informatics, Professional field 4.4. Earth Sciences („Terrestrial hydrology and water resources “)

Author of the dissertation: Aleksandar Dimitrov Vasilev

Dissertation Topic: Hydrographic characteristics of lakes in the Rila Mountains

Scientific Supervisor: Prof. Neli Hristova, PhD

Reasons for preparing the scientific opinion: Participation in the scientific jury of the dissertation defense according to the order № RD-38-41/26.01.2023 of the Rector of the “St. Kl. Ohridski University”.

1. General description of the submitted materials

The PhD candidate Aleksandar Dimitrov Vasilev has presented a set of documents in connection with the procedure for awarding the educational and scientific degree "doctor". They comply with the requirements of the Law for development of the academic staff in the Republic Bulgaria (LASRB), the Regulations for its implementation, and the Regulations on the Terms and Procedures for Acquiring Scientific Degrees and Holding Academic Positions at "St. Kliment Ohridski" University.

2. Short biography of the PhD candidate

The PhD-student Aleksandar Dimitrov Vasilev was born on November 2, 1987. In 2011 he obtained a Bachelor's degree in Geology (2007-2011) at the Faculty of Geology and Geography, “St. Kl. Ohridski University”. Subsequently, he also obtained a Master's degree in Regional Geo-energy Resources and Strategies (2012-2013) in 2013 defending a Master thesis "Strategies for Improving Energy Efficiency in the Sofia Metro" at the same faculty.

In the period 01.02.2019 - 01.02.2022 Mr. A. Vasilev studied the doctoral program "Terrestrial Hydrology and Water Resources" at the Department of Climatology, Hydrology and Geomorphology of the Faculty of Geology and Geography, Sofia University. “St. Kliment Ohridski" with scientific supervisor Prof. Neli Hristova, PhD, under whose supervision this PhD thesis has been developed.

3. Topicality of the dissertation

The dissertation is dedicated to the study of geographical, hydrographic and morphometric characteristics of high mountain lakes, lake groups and lake systems in the Rila Mountains through field observations and measurements, classification of individual morphometric indicators, as well as through the establishment and analysis of statistically significant relationships between these indicators using statistical methods (descriptive statistics, frequency and correlation analysis).

The relevance of the problem is justified by the fact that on the basis of previously published data and the data from this PhD thesis it is possible to trace the evolution of lakes and to analyze climate changes in high mountain hypsometric belts over the last 60 years.

4. Characteristics and evaluation of the PhD thesis

The electronic version of the dissertation is developed in a volume of 169 pages of which 11 pages with list of references with 132 titles - 45 in Cyrillic and 87 titles in Latin, as well it contains 63 figures, 54 tables, three photographs and one appendix (163 - 169 pages). It can be assumed that the sources used are sufficient to achieve the purpose of the study.

Structurally, the dissertation consists of an introduction, three chapters, a conclusion, a bibliography and one appendix.

The introduction emphasizes the relevance of the research topic and the degree of previous study of the investigated issues. In this part the object, the subject, the goal and the tasks and the territorial scope and research limitations are briefly and clearly defined. 173 lakes were studied in the Rila Mountains, located as follows: 16 in the Northwestern Rila, 2 in the Southwestern Rila and 1 in the Central and Eastern part of the mountain.

The structure of the thesis is provided briefly and in a well synthesized form.

The first chapter includes the theoretical and methodological basis of the dissertation research. *The theoretical part* presents the existing approach in the scientific limnological literature for description of lakes by different attributes - morphogenetic (origin of the lake basins), as well as hydrographic, hydrological, hydrophysical, hydrochemical, hydrodynamic and hydrobiological, which can be used to classify lake basins by one or more attributes on the one hand, and to reveal the diversity of lakes on the other hand. The presented text shows a good theoretical background of the doctoral candidate related to the topic of the dissertation research.

In this chapter the research methods were clearly described. These methods have been appropriately selected for the purpose of the thesis and include: a) field observation methods (carried out during the summer and autumn months between 2019 and 2022) and measurements to collect own empirical data using Suunto Ambit 3 and polar v800 Javier Gomez Noya watches, Deeper Smart Sonar Chirp+ three-beam wireless sonar, Garmin 62sc GPS., a specially adapted D11 rc Boat Fish Finder boat for measuring lake bottoms, as well as measurements of lake area, length and width from satellite images using Google Earth Pro; b) a method of classifying lake objects according to certain morphometric indicators (area, length, width, maximum depth, degree of shoreline development, etc.); c) statistical methods (descriptive statistics, correlation and cluster analysis) for the general characterization of lakes and the description of lake groups, and d) methods for subdivision of lakes into lake systems.

The selected methods show an original methodological approach of the dissertation research, including the collection of own empirical data, their processing and analysis with other existing ones.

The second chapter presents the general patterns found in the distribution of the lakes according to different features (altitude, belonging to different parts of the Rila Mountains and the catchment areas of the Iskar, Maritza, Struma and Mesta rivers) and morphometric indicators (area, length and width of the water mirror, length of the shoreline, maximum, mean and relative depth, shoreline development, etc.) for the entire study area and geographical distribution of the statistically significant relationships between the individual morphometric indicators by mountain partition of Rila.

The geographical description of the studied lakes was carried out on the basis of: a) their geographical coordinates, b) number of individual lakes and lake groups in different parts of the Rila Mountains, c) altitude and mountain parts; d) morphometric features and selection of certain classes enabling the characterization of the lakes, e.g. area (F), length (L), breadth (B)

and their description using descriptive statistics, e.g. root mean square deviation, median and coefficient of variation of the area of the lakes by mountain sections, maximum depth of the lakes and their classification into five groups – very shallow lakes, shallow, medium deep, deep, very deep; longitude, length and shoreline development factor. Based on the indicators area and length of the shoreline, as well as on the length of the water mirror and the length of the shoreline (S), as well as on the width of the water mirror and the length of the shoreline, the studied lakes were grouped into five categories: very small, small, medium, large and very large. Based on the shoreline development coefficient (Ks) the shoreline was categorized as weak, medium, and highly fragmented. In addition, in a separate subsection, the doctoral candidate examines correlational dependencies between lake morphometric indicators through factor, regression and correlation analysis.

The conclusions presented at the end of the second chapter are comprehensive and well-argued.

Due to repetition of some lake names or lack thereof, the PhD candidate has used an additional description in order to distinguish them and makes a proposal for the names of some of them, which in my opinion deserves attention from the scientific community, e.g. Dodovo lake (from the Urdini lakes group) – named after the village of Dodov; "Vysoko Urdino" (the highest located lake of the "Urdini Lakes" group, the lakes "Golyamo Karaomerichko", "Sredno Karaomerichko", "Malko Karaomerichko" and "Najko Karaomerichko" from the group of Karaomerichki (Karaomerishki) lakes, named after place in the lake group and on their area size.

The third chapter is dedicated to the morphometric characteristics of the lakes and lake groups according to their belonging to the mountain parts – Northwestern, Central, Eastern and Southwestern Rila, as well as to the description of their geographical features (geographical coordinates, lake groups and lake systems, altitude, and assigned new names), the morphometric measurements and calculations of statistically significant relationships between certain parameters of the water mirrors.

The lake group "Urdini" is analyzed in detail.

In the same chapter, the doctoral candidate presents the studied lakes, lake groups and systems according to their belonging to the river catchments of Iskar, Maritsa, Mesta and Struma, so these results could be used not only in the scientific geographical aspect, but also by institutions related to territory and water resources management.

In the *conclusion*, the scientific and scientific-applied results are formulated and summarized. The conclusions correspond to the general theme of the research represented in the thesis.

5. Evaluation of scientific and applied results and contributions

The formulated scientific contributions by the doctoral candidate A. Vasilev have two main aspects: scientific (theoretical) and applied. In my opinion, the following contributions are significant in the scientific aspect:

1. The PhD candidate defines the term "lake system" (limnosystem) as "a group of lake basins interconnected by water flows (p. 40 of the dissertation)", thus considering lakes as dynamic limnosystems.

2. The PhD candidate has studied a total of 173 lakes (20 more than previous studies) through his own field studies and observations. The measurement technologies used allow maintaining up-to-date information on the studied lakes, their description and analysis by means

of a number of relevant morphometric indicators, and comparative characteristics with previous measurements.

Of note here is the detailed information presented in the appendix of the doctoral thesis, synthesizing both the collected measurement data and information on the studied lakes their affiliation to specific lake groups, limnosystems, mountain parts and river catchments.

In addition, I will note that the classification of lakes by threshold values of the used indicators can be assessed as a scientific result in this dissertation.

3. The naming of 16 hitherto nameless lake reservoirs has, in my opinion, a significant contribution in a theoretical aspect. This result also is a scientific-applied contribution.

In my opinion the PhD candidate has not formulated and substantiated very well the scientific-applied and applied contributions of his dissertation research, which, however, with the results achieved, is not devoid of such, namely:

1. The results related to the collection of up-to-date empirical data on the studied lakes and their current morphometric characteristics has a pronounced applied contribution to hydrological and limnological research in this mountainous region.

2. The proposed names of so far unnamed lakes, as well as their description according to their belonging to different mountain divisions of the Rila Mountains and the catchment basins of the rivers Iskar, Maritza, Struma and Mesta, can be defined as a significant scientific and applied contribution to modern geographical research in Bulgaria, and could be used by various institutions and management bodies, such as regional and national basin directorates, regional and national environmental institutions, etc.

6. Critical notes, recommendations and questions

I find no serious flaws or misconceptions in this dissertation research. I think that the conclusion should be more detailed, despite the fact that individual chapters contain summaries of the obtained results.

I have a remark on a more precise formulation of the contributions of the dissertation.

I recommend the PhD candidate to continue his research in this direction.

It would be interesting to know the PhD candidate's opinion, does he think that the methodology used is applicable to other high mountain areas in the country and does it allow for a comparison with high mountain lakes, lake groups and systems in other regions of the world?

7. Evaluation of the publications related to the dissertation

The PhD candidate has submitted three publications, related to the dissertation theme and the main research problem. In two of them he is a stand-alone author.

In addition, the PhD student has developed and successfully completed a project in support of PhD students at the PhD Institute of Sofia University. Kl. Ohridski", related to the study of glacial lakes in the Rila Mountains.

8. Evaluation of the abstract

The abstract has a total volume of 30 pages and adequately reflects the structure and content of the dissertation. It complies with the requirements established by practice, containing

the main results achieved in the dissertation research, a reference of contributions and publications.

9. Conclusion

The dissertation "Hydrographic characteristics of lakes in the Rila Mountains" authored by Alexander Dimitrov Vasilev contains scientific and scientific-applied results that represent a contribution to the study of lakes in this high mountain region of Bulgaria.

In my opinion, it meets all the requirements of the of the Law for development of the academic staff in the Republic Bulgaria (LASRB), the Regulations for its implementation, and the Regulations on the Terms and Procedures for Acquiring Scientific Degrees and Holding Academic Positions at "St. Kliment Ohridski" University.

The dissertation shows that Alexander Dimitrov Vasilev has the necessary theoretical knowledge and professional skills to conduct independent scientific research.

Due to the above, I give my positive assessment of the conducted dissertation research on the basis of the presented dissertation, the abstract and the other publications to me for scientific opinion, as well as due to the achieved results and contributions.

In view of the arguments presented in this scientific opinion, I clearly state my positive assessment of the presented dissertation and suggest that the Scientific Jury award the educational and scientific degree of "Doctor" to the PhD candidate Alexander Dimitrov Vasilev in the scientific field 4. Natural Sciences, Mathematics and Informatics, professional field 4.4. Earth Sciences ("Terrestrial and Water Resources Hydrology").

Date:
5 April 2023

Member of the Scientific Jury:
/Assoc. Prof. Emilia Tcherkezova, PhD/