

REVIEW

From Assoc. Dr. Kalina Rosenova Radeva

Subject: Dissertation on the award of an educational and scientific degree of
“Doctor” in a professional field 4.4. Earth Sciences
(Terrestrial Hydrology and Water Resources)

Thesis topic:

ASSESSMENT OF RIVER FLOW AND WATER RESOURCES IN THE CATCHMENTS WEST OF OGOSTA RIVER

with author Kalin Krastev Seymenov, a Ph.D. student at the Climatology, Hydrology
and Geomorphology Department, Faculty of Geology and Geography, Sofia
University "St. Kliment Ohridski" on the Ph.D. program " Terrestrial Hydrology and
Water Resources" under the supervision of Prof. Dr. Nelly Hristova

The review has been prepared by the requirements of the Law on the Development of Academic Staff in the Republic of Bulgaria, the Regulations for its Application, and the Regulations on the Terms and Conditions for Acquiring Academic Degrees and Occupying Academic Positions at Sofia University "St. Kliment Ohridski", Adopted by a decision of the Academic Council on 31.10.2018. Kliment Ohridski" for appointment of the scientific jury, No RD-38-40/22.1.2024 and decision of the first meeting of the scientific jury of 31.01.2024.

Kalin Seymenov has submitted all the necessary documents required for the dissertation defense procedure.

1. Information about the PhD student

Kalin Seymenov has successfully completed his undergraduate studies in Geography and a master's degree in the Department of Geology and Geography at Sofia University "St. Kliment Ohridski". During his master's program, he undertook internships at the Regional Inspectorate of Environment and Water - Environmental Control Directorate, and the Ministry of Environment and Water, focusing on water protection. While working on his dissertation, he is currently employed as a specialist at the NIGGG – BAS - Center for Hydrology and Water Management. Seymenov's curriculum vitae reflects his targeted and profound interest in diverse

aspects of hydrology, with a particular emphasis on water quality. He has produced a noteworthy list of publications (17 in total), primarily as the sole author. Additionally, he has participated in seven projects and presented at 17 scientific conferences and seminars. I know Kalin Seymenov personally from the years of his studies in our faculty and I have wonderful impressions of his professional qualities and diligence in performing various research tasks. I believe that he is a specialist in the field of hydrology and can realize independent scientific developments.

The documents on the competition presented by the doctoral student show that the work on the dissertation was carried out within the legal deadline and all the requirements and the Regulations on the terms and conditions for acquiring academic degrees and occupying academic positions at Sofia University "St. Kliment Ohridski" have been met.

2. General characteristics and evaluation of the content of the dissertation

The dissertation encompasses a total of 212 pages, which include 14 appendices amounting to 77 pages and a bibliography comprising 142 literary references. The body of the dissertation contains 27 figures and 46 tables. It is systematically organized into an Introduction, four main chapters, a conclusion, a bibliography, annexes, a list of abbreviations, and detailed descriptions of tables and figures. The core content of the dissertation, highlighting scientific results and analyses, is featured in Chapter 4, with a volume of 69 pages. The bibliography lists 142 literary sources, all accurately cited within the text. The work also incorporates seven publications by the author.

This dissertation fulfills the essential requirements expected of a doctoral thesis, embodying a scholarly research orientation. Except for minor exceptions, the narrative is articulated in a precise manner, making it comprehensible to both experts in the field and a broader audience.

INTRODUCTION — The 4-page introduction outlines the dissertation's relevance, motivation, research object and subject, objectives, and tasks. It also addresses the study's limitations and its scientific contribution before detailing the organizational structure of the dissertation.

Relevance of the Dissertation Topic: The dissertation's topic is undeniably relevant. The sustainable management of water resources, a crucial element of a territory's natural resource potential, necessitates rational management or what is known as the sustainable development of the water sector. Water quantity and quality reflect both natural conditions and anthropogenic impacts on the territory. Given global warming, increasing anthropogenic impacts, and the escalating risk of extreme events such as floods and droughts, it is of particular importance to delineate the characteristics of the hydrological regime, with a special focus on the stability of runoff conditions in catchment areas. Water quality significantly influences the usability of water resources. The crux of sustainable water resource management lies in preserving water's self-purification capability. This can be achieved through the construction and upkeep of sewerage systems, treatment of industrial and domestic wastewater, and reduction of pollutants from

agricultural sources. In this vein, the doctoral candidate aims to "analyze and assess river flow and water resources in the catchments west of the Ogosta River." Furthermore, the author outlines six specific objectives, including examining approaches and methods for the quantitative and qualitative assessment of river water amidst climate change and anthropogenic impacts; compiling a time series of annual, monthly, and daily water quantities and physicochemical water quality indicators, and evaluating their significance for the study; analyzing spatial-temporal and quantitative parameters and trends in the variation of annual flow, monthly and seasonal water volumes, and extreme hydrological events; quantifying water resources and assessing river water quality.

The objectives and goals are appropriately formulated. It is also noteworthy that there is a scarcity of hydrological studies within our country that examine the condition of water resources in this region, further underscoring the study's importance.

CHAPTER 1. THEORETICAL-METHODOLOGICAL BASIS OF RESEARCH (10 pages). In this chapter, the Ph.D. student outlines the primary theoretical formulations, alongside the approaches and methods for the quantitative and qualitative assessment of river waters.

The chapter is divided into two sections. The first part explores the theoretical and methodological foundations for the quantitative assessment of river flow and water resources. The second part elaborates on the theoretical and methodological basis for the qualitative assessment of water. The Ph.D. student delves into the main methodological approaches and procedures, elucidating various methods—including experimental, mathematical-statistical, graphical, and cartographic—utilized in the study of river flow and water resources. Emphasis is placed on the significance of automating and enhancing the instrumentation for measurements and the role of statistical analysis in comprehending hydrological processes. The discussion-oriented nature of the exposition is highlighted as a significant advantage in the analysis of the methods and approaches employed. However, it's worth noting that the absence of an analysis of balance methods, which are essential for modeling hydrological processes and a key approach in identifying and evaluating anthropogenic impacts in catchments, is quite noticeable.. Additionally, methods for determining ecological flow have not been addressed, despite the implementation of Water Framework Directive (WFD) principles regarding sustainable water management, which encompasses meeting human water needs, economic considerations, aquatic ecosystems, and wetlands.

CHAPTER 2. TERRITORIAL COVERAGE, SOURCE DATA AND SURVEY METHODS (18 pages). This chapter of the study is divided into three parts.

The research area encompasses the northwestern part of Bulgaria, covering 3790 km² and including the catchments of the Topolovets, Voinishka, Vidbol, Archar, Skomlya, Lom, and Tsibritsa rivers. The first section describes the boundaries, size, natural-geographical, administrative-territorial, and demographic characteristics of the region under study. The second section elaborates on the source data, which primarily consists of river flow data collected from

the hydrometric network supported by the National Institute of Meteorology and Hydrology (NIMH) and the Executive Environment Agency (EEA). It details the hydrometric stations and monitoring points, observation periods and durations, and evaluates the quality of the source data. In the third section, the Ph.D. student evaluates the research methodologies applied in the dissertation, incorporating both general and specialized scientific methods for assessing water stress and quality, with an emphasis on their practical deployment. This segment demonstrates the doctoral candidate's solid theoretical preparation and judicious selection of research methods. The use of two software packages, HydroOffice and IHA, by the Ph.D. student is notably commendable. As someone who has dedicated years to the assessment of water quality, I fully support the doctoral candidate's application of the Canadian combinatorial index to ascertain the water quality status in the study area.. The chapter concludes with well-reasoned and logical findings.

CHAPTER 3. FACTORS FOR THE FORMATION OF THE QUANTITY AND QUALITY OF RIVER WATER IN THE CATCHMENTS WEST OF THE OGOSTA RIVER (20 pages).

In this chapter, an analysis is conducted on the factors that influence the formation of the volume, regime, and physicochemical status of surface water in the region. This analysis is supported by maps, tables, and graphical illustrations.

In this segment of the dissertation, the Ph.D. student meticulously examines the factors that contribute to water formation (including climatic, morphographic, geomorphological, geological, hydrogeological, hydrographic, hydrological, soil-geographic, and biogeographic factors) along with anthropogenic activity within the study area. The section occasionally includes details that lack in-depth analysis, which can detract from the primary objective of the study. Despite these observed limitations, the analysis effectively meets the objectives established by the doctoral student, and the nature of the study necessitates such a descriptive methodology.

CHAPTER 4. RIVER FLOW AND WATER RESOURCES IN THE CATCHMENTS WEST OF THE OGOSTA RIVER

This chapter presents the actual findings of the study, divided into two main sections. The first section (4.1. Quantitative Assessment of River Flow and Water Resources) delves into the homogeneity and probability distribution, statistical characteristics, fluctuations, and trends of annual river flow, volume of surface water resources, and the degree of water provision for the population. It further elucidates the spatial-temporal and quantitative parameters of high and low waters, monthly and seasonal discharge, and extreme water levels. The second section undertakes an analysis of the water's physicochemical status in accordance with the current ordinance and evaluates the quality of the river water. The chapter concludes by synthesizing the gathered results.

The exposition begins with a comprehensive analysis of annual river flow, including the multiannual average flow and a homogeneity check of the time series. The author employs nonparametric tests for evaluating uniformity, suitable for such analyses. A non-uniformity in the

time series of annual flow, notably during the mid-1980s, was identified, aligning with findings from other studies, thus lending additional credibility to the results. In analyzing the perennial dynamics of river flow the author demonstrates conformity with national trends through moving averages and curves of integral differences, a methodological approach that effectively highlights positive and negative cycles in flow dynamics. The study proceeds to examine the provision of river flow and water resources, employing empirical curves to assess water quantity variability. Utilizing the Falkenmark index to calculate per capita water resources adds significant value, enabling the assessment of potential water stress risks in individual catchments. Despite a reduction in water usage volume, the findings indicate that low-water years and the dilapidated state of water infrastructure subject the population to water stress and even absolute water scarcity. A thorough review of water usage in the river basins under study is provided, focusing on water resources utilization for economic purposes, the state of water supply and irrigation infrastructure, and significant water losses within the water supply and sewage systems. While a wealth of data is presented, there is a noted absence of in-depth analysis. It would be beneficial to include more detailed interpretations and discussions on the implications for water resource management in the area.

The analysis then shifts to examining high and low water states, and the monthly and seasonal flow dynamics. An increase in the amplitude between minimum and maximum monthly and seasonal flow values is observed, alongside a statistically significant reduction in winter and spring water volumes post-1980s, and a rise in the frequency of extreme hydrological events. The author aptly associates these changes with climate change, a critical aspect of the analysis. However, further examination of additional factors influencing flow dynamics, such as land use and hydrotechnical structures, could enhance the study.

The water quality assessment (section 4.2) begins with an analysis of ten selected indicators for evaluating the physicochemical status of the waters. The main pollutants are identified, with their seasonal and annual variations detailed, aiding in tracking pollutant dynamics. The water quality assessment is robustly justified with prior research findings and benchmarked against reference standards. The selection of the CCME WQI combinatorial index for water quality assessment is appropriate, given its broad acceptance and utilization in scientific research. It provides a systematic approach to categorizing water quality and simplifies the comparison of results across different periods. The application of the CCME WQI offers a clear depiction of water status, establishing pollution by biogens (nitrate nitrogen, total nitrogen, and BOD) but indicating an overall improvement in the physicochemical status of the waters. For enhanced depth and practicality, the analysis could benefit from more detailed temporal studies, and including recommendations would augment its utility. The chapter's text concludes with an analysis of territorial differences in water quality, highlighting the role of land cover in pinpointing potential pollution sources. This approach is promising but could be further refined by incorporating specific examples and advocating for continuous monitoring. This represents a significant contribution to understanding the factors affecting water quality in the region and lays a foundation for future research endeavors. From the conducted analysis, the author formulates four substantial conclusions, the last of which appears contentious.

The concise conclusion outlines the primary outcomes of the research, which are additionally

illustrated through tables and graphical representations in an annex spanning 78 pages.

3. Evaluation of dissertation publications

The results from the dissertation research have been disseminated through two independent publications, both of which have been published in refereed and peer-reviewed scientific journals. The first paper, "Perennial Dynamics of River Flow in the Catchments West of the Ogosta River," appeared in the Yearbook of Sofia University "St. Kliment Ohridski," Faculty of Geology and Geography, Book 2 – Geography, Volume 115. The second article, titled "Water Quality Assessment of the Danube's Tributaries West of the Ogosta River," is written in English and was published in the Proceedings (scientifically reviewed, ISSN: 2683-0558) of the Third Scientific Conference on "Climate, Atmosphere and Water Resources in the Context of Climate Change" - 2021, organized by the Institute of Climate, Atmosphere, and Water Research of the Bulgarian Academy of Sciences.

4. Contributions

I affirm the contributions of Kalin Seimenov as valid and meaningful, enriching current knowledge and scientific progress with applications in research and practical settings.

5. Autoreferate and author's reference

The autoreferate is structured in a total volume of 36 pages and is a sufficient sample of the dissertation. The main research, results and conclusions, as well as the contributions, are reflected.

6. Opinions, recommendations, remarks and questions on the dissertation

I have no significant critiques of the dissertation presented. I observed that most comments and suggestions raised during the internal discussion of the dissertation have been considered and incorporated into the text. However, I do have some recommendations and inquiries:

- I suggest that the literature review could be expanded to include similar studies conducted in European watersheds.
- The text is articulated in a coherent and clear scientific style. Nonetheless, the narrative sometimes becomes less concise and coherent, particularly where overly detailed explanations are provided.
- I would advise the Ph.D. student to devise a model set of measures that could enhance the status of river water.
- I request the Ph.D. student's perspective on applying the analysis of monthly and seasonal flow dynamics of the studied rivers, for instance, in determining ecological flow. Additionally, I would like the doctoral candidate to share his views on the relevance of the findings for practical water resource management in the study area.
- A conclusion stated on page 127, "... - does not affect the qualitative status of water flows,"

is ambiguously phrased and appears to conflict with other conclusions.

I have two questions for the candidate:

1. Do you believe the findings suggest a diminution of the continental characteristics of the hydrological regime in the studied area?
2. As a future water resources specialist, do you consider it necessary to enhance surface water monitoring by incorporating additional physicochemical parameters for water quality assessment?

7. Conclusion

Despite the recommendations and remarks provided, I believe that the Ph.D. student possesses substantial theoretical knowledge on the subject, along with the professional and scientific competencies necessary to undertake independent research. The dissertation titled "Assessment of River Flow and Water Resources in the Catchments West of the Ogosta River" fulfills the requirements set forth by the Law on the Development of Academic Staff in the Republic of Bulgaria, as well as the rules and procedures for the admission and training of Ph.D. students and the acquisition of the "Doctor" degree at Sofia University "St. Kliment Ohridski".

Based on these considerations, I recommend to the Scientific Jury that Ph.D. student Kalin Krastev Seymenov be awarded the educational and scientific degree "Doctor" in the field of higher education - 4.4. Earth Sciences, with a scientific specialty in " Terrestrial Hydrology and Water Resources".

April 8, 2024

Reviewer:

(Assoc. Prof. Dr. Kalina Radeva)