

REVIEW

of a dissertation thesis, on:

ASSESSMENT OF THE RIVER RUNOFF AND WATER RESOURCES IN THE WATERSHEDS WEST OF THE OGOSTA RIVER,

submitted by Kalin Krastev Seymenov, a full-time doctoral student in the professional field 4.4. Earth Sciences (Land and Water Resources Hydrology), Department of Climatology, Hydrology and Geomorphology at the Faculty of Geology and Geography of Sofia University "St. Kliment Ohridski", scientific supervisor Professor Nelly Hristova, PhD

by Associate Professor Krasya Kolcheva, PhD, Centre for Hydrology and Water Management at the National Institute of Geophysics, Geodesy and Geography - Bulgarian Academy of Sciences.

1. BRIEF BIOGRAPHICAL DATA OF THE DOCTORAL STUDENT

Kalin Krastev Seymenov completed his higher education in the period May 2014÷.September 2019 at Sofia University "St. Kliment Ohridski", acquiring a Bachelor's degree in Geography and a Master's degree in Climate change and water management. Seymenov was chosen as the student of the year 2018/2019 of Sofia University "St. Kliment Ohridski" (in the professional field "Natural Sciences") and received an award for student research in the field of climatology and hydrology for a project report: "Application of non-parametric criteria for homogeneity and normal distribution on series with annual runoff in the Arda river basin".

From February 2020 to 2023, Seymenov was a full-time doctoral student in the program "Land and Water Resources Hydrology".

In the period September 2018 – October 2018, Seymenov worked as an intern in the Directorate of Water Management of the Ministry of Environment and Water (MOEW), and from April 2019 to October 2019 he was an intern in the Directorate of Environmental Control, Water Protection direction to the Regional Inspectorate of Environment and Water (RIEW). Since November 2021, Seymenov has been working as a half-time specialist-geographer at the "Centre for Hydrology and Water Management" at the National Institute of Geophysics, Geodesy and Geography with the Bulgarian Academy of Sciences (NIGGG - BAS).

Kalin Seymenov has good computer skills in MS Office (Word, Excel, Power Point), XLSTAT 2018, SPSS+, Hydro Office, IHA and basic in ArcGIS, as well as language training in English.

2. GENERAL CHARACTERISTICS OF THE DISSERTATION WORK

The dissertation work, 212 pages in volume, is structured as follows:

- *Introduction*, clarifying the relevance, the motives, the object, the subject, the aim and the objectives of the research, its limitations and the scientific significance of the dissertation (3.5 pages);

- *First chapter – Theoretical-methodological basis of the study*, presenting the theoretical formulations and the methods for quantitative and qualitative assessment of the river waters under conditions of anthropogenic and climatic impacts (15 pages);

- *Second chapter - Territorial scope, source data and research methods*, reviewing and analyzing the territorial scope, the hydrometric monitoring (points and source data) and the

selected research methods (19 pages);

- *The third chapter - Factors for the formation of the quantity and quality of river waters in the watersheds west of the Ogosta River* - analyzes the runoff-forming factors, the regime and the physicochemical state of the surface waters (21 pages);

- *Chapter Four - River Runoff and Water Resources in the Watersheds West of the Ogosta River*, comprising a detailed quantitative assessment of the river runoff with analysis of the spatio-temporal and quantitative parameters of the high and low water, the monthly and seasonal variations and the extremely high and low water levels, and assessment of the physicochemical state of the river waters (69 pages);

- *Conclusion*, which, in a page and a half, summarizes the results of the research;

- *Used literary sources and appendices* – (84 pages).

The work contains: 46 tables, 27 figures, 5 pages with references (142 cited sources - 86 in Bulgarian, 56 in English) and 14 appendices.

3. ASSESSMENT OF THE CONTENT OF THE DISSERTATION WORK

Relevance of the topic

The doctoral student justifies clearly and accurately the importance and the need for expansion and upgrade of the research, aimed at evaluating the quantitative and qualitative changes in the river runoff under the conditions of anthropogenic and climatic changes. The fundamental role of reliable and sufficient data for the assessment of the surface runoff needs to be emphasized, both for periodic assessment of the state of the surface water bodies and for reassessment of the permitted water withdrawals, as well as for the hydrological and water management studies at basin, local and water management system level. In the context of sustainable water management, this will improve the periodic update of the River Basin Management Plan (RBMP) - a key instrument of Directive 2000/60/EC of 23.10.2000 of the European Parliament and the European Council, establishing a framework for Community action in the field of water policy (the so-called Water Framework Directive (WFD)).

Object, subject, aim, objectives, limitations and scientific significance of the research

To achieve the aim of the research - "Analysis and assessment of the river runoff and water resources in the watersheds West of the Ogosta river" - four objectives have been well formulated, reflecting the work done on the dissertation. The lack of publicly available information on daily water quantities after 1983 is the basis of the study's limitations, and the provision of up-to-date data on the quantitative and qualitative status of the surface water in the studied watersheds directly corresponds to its importance.

Chapter one: "Theoretical-methodological basis of the research", structured in two main subsections, contains an in-depth review of the methods for quantitative and qualitative assessment of river waters.

Subsection 1.1. *"Theoretical-methodological basis for quantitative assessment of river runoff and water resources"*, considers experimental, mathematical-statistical, graphic, cartographic and other types of methods for assessing the river runoff, with an emphasis on the mathematical-statistical methods, applied for establishing the homogeneity and the statistical parameters of the hydrological series, analysis of the monitoring hydrometric information and a study of the variability of the river runoff. Finally, the importance of the mathematical modeling has been pointed out.

Subsection 1.2. *"Theoretical-methodological basis for quality assessment of waters"* - includes the theoretical basis, normative regulation and methods for assessing the state of the surface waters in a qualitative aspect.

In conclusion, chapter one outlines a theoretical-methodological framework and

considers some of the methods for researching the quantity and quality of river waters under changing conditions. The indicated as proposed by the EU Water Framework Directive (WFD) approach in Subsection 1.2., page 15, concerns the assessed biological, physical-chemical (general indicators and specific pollutants) and hydro-morphological quality elements for the ecological state of the surface waters, in accordance with Annex V of the WFD and Guideline No. 6. In the current RBMP 2016-2021, in order to establish the quality of the surface waters, an assessment of their ecological state is carried out according to the "General approach for assessing the ecological state and ecological potential of surface water bodies in the Republic of Bulgaria" approved by the Ministry of Education and Culture and of their chemical state through a comparative analysis of the average annual measured concentrations and the determined quality standards, according to the Ordinance on environmental quality standards for priority substances and some other pollutants, dated November, 9th, 2010, adopted with a Decree of the Council of Ministers No. 256 on November, 1st, 2010.

Chapter two: "Territorial scope, source data and research methods": Subsection 2.1. clarifies the location, the boundaries, the natural-geographical, administrative-territorial, demographic and hydrological characteristics of the studied area - the northwestern part of Bulgaria with an area of 3790 km², including the catchments of the rivers Topolovets, Voynishka, Vidbol, Archar, Skomlya, Lom and Tsibritsa (right tributaries of the Danube). The surface water bodies defined in the "River Basin Management Plan" of the Basin Directorate "Danube Region" are also given with their main characteristics. Subsection 2.2. specifies the type, source and the periodicity of the source information, and Subsection 2.3. describes the research methods: *cartographic* - making maps, using ArcGIS 10.4., of the average annual rainfall, the relief, the hydrographic structure and hydrometric network, of the slope gradients, geology, soils and land use; *descriptive statistics* - to determine the main statistical characteristics of the river runoff; *non-parametric statistical tests* - for assessing the homogeneity and the type of probability distribution; *graphical methods* - building on the previous ones by determining the trend of the time series; *correlation analysis* - to establish the degree of dependence between the river runoff and the factors, determining it; *the moving average value and the curve of the integral differences* - for the analysis of the multi-year runoff dynamics; *empirical securing of the river runoff*; *threshold method* - for estimating an extremely high runoff; *Volkenmark index* - for assessing the water stress; *dissection of hydrographs using IHA* - to analyze the time series describing the regime of a given river; and *river water quality assessment index*.

From the exposition in chapter two, it can be summarized that: the selected area of small and medium-sized rivers in length and catchment area with sensitivity to climatic and anthropogenic influences is comprehensively characterized, including by means of maps; the source data for the assessment of the river runoff are mainly taken from the hydrological yearbooks for the period from 1946/1960÷1983 and from the National Institute of Meteorology and Hydrology for the period 2000÷2005, and for the assessment of the physicochemical state of the river waters - from the Executive Environmental Agency (EEA) for the period 2015÷2020; from the purposefully differentiated research approaches, emphasis is placed on hydrological, cartographic and statistical ones; by means of the selected combinatorial index from 2001 - Canadian Council of Ministers of the Environment Water Quality Index (CCME WQI), ten physicochemical indicators have been evaluated against the accepted threshold value - the maximum permissible concentration to achieve "good status" from Ordinance No. H 4/14.09 .2012 for Surface Water Characterization.

Chapter three: "Factors for the formation of the quantity and quality of the river waters in the watersheds West of the Ogosta River": In relation to the complex impact of natural and anthropogenic factors determining river water quantity and quality, chapter three

is structured in two main subsections. The first of them (3.1.) examines in detail and analyzes the natural-geographical factors, determined by climate, morphology, geomorphology, hydrology, geology, soil cover and afforestation, and the second one (3.2.) considers the anthropogenic factors, related to the pressures from agriculture and associated irrigation, water intake for the domestic and industrial sectors and hydropower construction. The considered natural factors are illustrated by the corresponding maps. The conclusions made at the end of the chapter generally define the possible changes in the river runoff, resulting from the impact of these two groups of factors, without specifying the significant ones for the studied area.

The fourth chapter: "River runoff and water resources in the watersheds West of the Ogosta River", contains numerous calculation procedures for quantitative and qualitative assessment of the surface waters in the river watersheds of the pilot area, which are in accordance with the methods, presented in chapter two.

The quantitative assessment of the river runoff and water resources in Subsection 4.1. starts by determining the statistical characteristics of the river runoff with a check for homogeneity of the annual hydrological series and establishing a significant heterogeneity for most of them. The multi-year period is divided into two subperiods (with conditionally undisturbed and conditionally impaired runoff), containing series of the same kind and almost the same length. The study of the multi-year runoff dynamics shows a longer low-water cycle with different beginning and end for the individual watersheds and a trend of decrease in the annual water volumes for all watersheds. The distribution of the river runoff by water level during the studied years is similar to the series of high-water and low-water years determined for the country based on data from empirical curves for the period 1931÷2003. The analysis of water uses in the studied river basins and the calculations with the Falkenmark Index define the priority water-using sectors (domestic, industrial, hydropower and agriculture with irrigation and fish farming) and the risk of water shortage in low-water years. For the high-water events, a linear relationship has been established between the average altitude of the river basins and the average date for the occurrence of the high waters with a coefficient of determination of 0.90. Permanently reduced water levels outside the summer-autumn hydrological season are reported most often in the months of June and November, but not in every hydrological year. Synchronization of the multi-year dynamics of the monthly runoff with the dynamics of the annual runoff has been established for the months of June and September and a decrease in the monthly water volumes after the mid-1980s in the months of February, March, April and May. The seasonal runoff variation is similar to the monthly runoff. With regard to climate variability, what is pointed out is a predominant moderate continental climate influence with a more intense reduction of the spring runoff compared to the winter runoff in recent decades and the presence of an extremely high river runoff in the spring of high-water years and of an extremely low one in the summer-autumn season of low-water years.

The results of the computational procedures for assessing the physicochemical state of the river waters, presented in Subsection 4.2., are based on a component analysis, aimed at determining the main polluting substances, as well as on a complex analysis regarding the ten selected indicators with the application of the CCME WQI. The analysis of the average annual values of the CCME WQI show that the river waters in the watersheds, located to the west of the Ogosta River, are of "good" and "very good" quality during the studied period. A spatial analysis of water quality is also made, distinguishing the studied area into two parts - mountainous and plain. It has been established that the pollution of the river waters in the mountainous part is due to the soil erosion and the developed mountain stock-breeding, and those in the plain part - to the excessive use of fertilizers and pesticides in the agricultural areas and the lack of domestic and industrial sewers and water-treatment facilities.

The conclusions made at the end of the fourth chapter, related to disturbed structural uniformity of the hydrological series, increased variability and reduction of the river runoff

and the higher frequency of extreme hydrological events, are mainly in the context of the climate changes after the 1980s, but with the clarification that water quality can also be negatively affected by floods.

The final part of the dissertation makes general conclusions, consistent with the entire exposition of the quantitative and qualitative state of the river waters in the studied area, mainly determined by climate change.

Abstract

The structure of the abstract meets the requirements and reflects the content of the dissertation work accurately and in a synthesized form. However, the scientific contributions are indicated only in the abstract.

Contributions

Distinguished in theoretical and applied aspects, the contributions are well formulated and prove that the present dissertation has its scientific value in the development of the studies, related to the quantity and quality of surface waters and the planning process.

4. PUBLICATION ACTIVITY

The author of the dissertation has submitted two independent articles (one in Bulgarian, the other in English), published respectively in the Yearbook of Sofia University "St. Kliment Ohridski", Faculty of Geology and Geography, Book 2 - Geography, Volume 115 and in the Proceedings (scientifically reviewed with ISSN: 2683-0558) from the third scientific conference on the topic: "Climate, atmosphere and water resources under the conditions of climate change" – 2021 - at the Institute for Climate, Atmosphere and Water Research at the Bulgarian Academy of Sciences. The articles directly correspond to the aims and objectives of the dissertation in both research directions.

5. CONCLUSION

Given the review and the evaluation of the provided documentation, I believe that the dissertation work on the topic: "Assessment of the river runoff and water resources in the watersheds West of the Ogosta River" achieves its aim by building on the research, related to assessing the changes in the river runoff and the state of the surface waters and the doctoral student has the qualities and competence to conduct independent scientific research. In this regard, I propose to the respected members of the Scientific Jury to vote "YES" and to award Kalin Krastev Seymenov the educational and scientific degree "Doctor of Philosophy - PhD" in the professional field 4.4. Earth Sciences, scientific specialty "Land and Water Resources Hydrology".

Sofia, 7 March 2024

Reviewer:
Assoc. Prof. Krasya Kolcheva, PhD