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# REVIEW

on dissertation for obtaining the educational and scientific degree "Doctor" in: field of higher education **6. "Agricultural Sciences and Veterinary Medicine"**,professional field **6.1. "Crop Production"**, scientific specialty **"Soil Science"**

**Author of the dissertation:** **Krastena Valerieva Ilieva**
Doctoral student (full-time) at the Department "Forestry" at the University of Forestry (UF), Sofia, Bulgaria.

**Dissertation Topic:** "Assessment of soil resources in the Botevgrad Valley".

**Reviewer:** Prof. Dr. Veneta Naydenova Krasteva-Penkova, Institute of Soil Science, Agrotechnologies and Plant Protection "Nikola Pushkarov" – Sofia,
**6. "Agricultural Sciences and Veterinary Medicine"**,professional field **6.1. "Crop Production"**, scientific specialty **"Soil Science"**, appointed as a member of the Academic Jury by Order № ЗПС-667/24.11.2025год. of the Rector of the UF.

## 1. Brief introduction of the candidate.

Full-time doctoral student Krustena Valerieva Ilieva was born on August 17, 1986 in the town of Lom. In the period 2002-2008, she studied at the National Vocational High School of Veterinary Medicine "Prof. Dr. D. Dimov", the town of Lovech, majoring in Veterinary Technician.

From 2015 to 2018, she was a student at the University of Forestry, majoring in Agronomy - Plant Protection with a Bachelor's Degree. In the period 2018-2019, she received a Master's Degree - Plant Pest Control - Forestry University. In 2021, she was enrolled as a full-time doctoral student in the Department of Soil Science at the Faculty of Forestry of the University of Lvov. Since 2019, she has been the manager of the Agro-pharmacy in the town of Mezdra, which is in accordance with the specialty of her education. PhD student Ilieva has computer skills and works with Microsoft office programs - Word, Excel, Power Point, Access, Internet.

## 2. Relevance of the problem.

Modern soil science increasingly applies the principle of classifying soils by combining morphological, physical, chemical and physicochemical features within a specific area. This includes taking into account temperature and water regimes, soil-forming processes and the ecological conditions under which the profile is formed.

Obtaining up-to-date information on soil resources is essential for determining their quality, for early identification of degradation processes, forecasting their development and maintaining the soil information system necessary for timely and scientifically based diagnostics.

Rapid changes in the interaction between the three basic elements of nature and society – soil – land – man – in recent decades often lead to an imbalance in their rational use. Human intervention on soils is gaining ever larger dimensions.

The diagnosis and regulation of unfavorable soil qualities is possible through the application of complex quantitative and qualitative assessments, taking into account the degree of manifestation of degradation processes and their impact on plants, agroecosystems and humans. The presented dissertation work has been developed in this direction.

## 3. Degree of knowledge of the state of the problem and creative interpretation of the literature review.

Doctoral student Ilieva has conducted an extensive literature review specifically related to the topic under development. She has reflected all soil research related to the Botevgrad Valley region, conducted from the beginning of the 20th century to the present day. The literature review devotes significant space to the topic of land assessment and its fertility. The doctoral student has familiarized herself with and presents to us the basic principles and parameters of land assessment in the USA, Europe, Russia and Bulgaria.

The literature review conducted is sufficient in volume and shows that Ilieva has become thoroughly familiar with the specific studies of leading scientists from Bulgaria and the world on issues of soil science-genesis, classification and methodologies of classical soil science for determining soil type, chemical analyses and data interpretation.

In the literature review, doctoral student Ilieva presented the main principles and approaches of the World Soil Classification (WRB), which she applies in the presented dissertation. The collection of current information about the soils in the Botevgrad Basin leads to their classification according to the modern criteria of the World Soil Classification (WRB).

On this basis, she builds a modern database and carries out an up-to-date assessment of soil diversity and land use in the region. The review of various literary sources presented to us thus shows that Ilieva is well acquainted with soil genetic classifications in Bulgaria and in the world, which is also evident in the presentation of the dissertation in the following chapters.

## 4. Aim, objectives, hypotheses and research methods. Relevance of the chosen research methodology to the stated aim and objectives of the dissertation.

The aim of the topic being developed is clearly formulated, namely: to determine and assess soil properties on a local scale for the Botevgrad Valley region.

The tasks through which the set aim is achieved are well formulated, presented in a logical sequence and implemented accordingly.

A summary and digitization of the available geological, soil, relief, climate and land cover information for the region has been made and an up-to-date database has been created;

Sampling areas were determined using GPS coordinates; field studies were carried out - morphological description of the soil profiles, laboratory analyses to determine the main properties of the solid and liquid phases by horizons; laboratory analyses to determine the physical and chemical characteristics of the soils;

Variations of the main soil indicators under different types of land use have been determined; microbiological studies have been conducted to assess the biogenicity of soils under the influence of different agricultural crops to determine the microbiological profile of soil horizons; an integrated database has been created on the factors of soil formation and the spatial distribution of the main soil types in the region;

An assessment and classification of soils was made in accordance with the World Soil Resources Reference Base (WRB), and summarized conclusions were presented on their condition and fertility; dependencies and patterns between the studied soil indicators were established through statistical analysis.

The selected methods for soil research in the Botevgrad Valley are scientifically selected. Classical methods for describing soil profiles, determining the color of horizons, physico-chemical analyses, and biological and enzymatic studies have been applied.

The dissertation also applies modern methods that are increasingly entering science, such as: Spatial analysis and mapping - ArcGIS 10.5 (license of LTU); Spatial data interpolation - using the inverse distance weighted (IDW) method with the Spatial Analyst extension in ArcGIS.

The methods of Geostatistical Modeling – Kriging Maps (Surfer 8, Golden Software, 2002) were used.

## 5. Visualization and presentation of the results.

The dissertation is written on 148 pages. It presents a wealth of photographic material (18 pieces) of soil profiles, arable areas and various types of land use; 42 pieces of correctly numbered tables with marked units of measurement; 36 pieces of maps and 10 pieces of graphs. 130 pieces of literary sources (which are accurately cited in the dissertation) were used - of which 111 pieces in Bulgarian and 19 pieces in Latin. The dissertation is written in a high scientific style, has consistency and connectivity between the individual chapters and shows the doctoral student's ability to accurately interpret the results obtained.

## 6. Discussion of results and literature used.

The dissertation work is well and clearly structured. A sequence is observed in it. The goals and objectives of the research are presented, an extensive literature review is made and everything that has been studied about the ecology and soils in the Botevgrad Valley known from the literature to date is noted.

An overview of the main factors of soil formation for the study area has been made. The relief of the area, its geology, climate, hydrological conditions (presence of rivers and tributaries), the characteristic natural vegetation (and the main agricultural crops grown in the area have been noted) have been described in detail and accurately. The study areas (soil profiles) have been correctly selected so as to cover the soil diversity in the Botevgrad Valley.

They cover the valley (flatter part) and the surrounding mountainous part of the site. The 7 soil profiles are from 325 m above sea level to 644 m above sea level. Their location is fixed with GPS coordinates, a full morphological description of soil horizons is presented, supplemented with photographic material of the profiles. The results of the field study and laboratory analyses are presented in tabular form.

Physical properties and structure of the soil, mechanical composition, bulk and relative density and porosity of the soils, water properties, chemical properties were analyzed and interpreted. The types of soil differences were determined according to the Bulgarian Soil Classification and the World Reference Base.

The precise determination of the soil type was carried out using methodologies used in world soil science, which allows the integration of the obtained data into national and European databases. The area share of the individual soil types distributed on the territory of the Botevgrad Valley was determined. A soil map in GIS is presented, which shows the location of the soil differences

The largest areas in the region are occupied by Gray Forest Soils (20.5%); Alluvial-Deluvial (16.9%) and Lithosems (5.2%). Alluvial-Meadow (6.8%), Deluvial and Deluvial-Meadow – (7.4%). Light Gray (pseudopodzolists) (2.8%), Alluvial – (0.8%), Rendzins – (0.6%), Dark Gray Forest – (0.1%), Brown Forest – (0.3%). Analyses have been made for microbiological and enzymatic activity of the soils. The risks of erosion and heavy metal contamination have also been described. The interpretation of the results is consistent with the specific natural conditions and the impact of man on nature.

To investigate the spatial variation of soil physicochemical properties, interpolation maps created using a geostatistical technique called kriging are presented. This is a method used to estimate values at unknown locations based on values at nearby known locations (Oliver et al., 1990, Van Beers et al. 2004).

In mapping, kriging is used to interpolate values between samples to create a continuous surface, representing the spatial distribution of a particular variable. This method was applied in the dissertation, where multiple maps characterizing certain parameters and properties of soils are presented.

Based on the results obtained from the laboratory analyses, interpolation maps were compiled for individual parameters - pH, sorption capacity, exchangeable Ca, Mg, Al, and those representing the distribution of agrochemical indicators - total N%; $NH4^+$ mg/kg; $NO_3^-$ mg/kg; total P %; $P_2O_5$ mg/100g; total K %; $K_2O$ mg/100 g; humus %.

A lot of data is also presented in the section on microbiological characteristics of the studied soils (presence of bacteria, fungi and enzyme activity), which are a major factor in soil biogenicity and are an indicator of soil health.

The main factors contributing to soil erosion are examined in detail, and maps are presented for: soil susceptibility to erosion; a map of distribution by slope groups and a map of distribution of the actual risk of planar water erosion. The maps are accompanied by descriptions of the factors and precautionary measures to reduce erosion in the area.

The dissertation presents heavy metal pollution, with the results of the analyses being compared with both the national geochemical background and international reference bases. The average concentrations of heavy metals in the soils of the Botevgrad Basin show a clearly pronounced anthropogenic enrichment, especially for lead (Pb), copper (Cu) and cadmium (Cd).

The content of Pb and Cu significantly exceeds the European and national background values, which is explained by the influence of industry, transport and urbanization. The average values remain within the permissible limits, but the study is useful for accounting for the load of soils with heavy metals. The dissertation also presents an agronomic assessment of the lands by their category. It is noted that the largest areas are occupied by lands of the 6th category, followed by lands in the 5th category. The areas of the lands in the individual categories are presented on the graph and in the form of a map.

The material presented in the dissertation contains many new data that enrich the information about the Botevgrad Valley in the current period. These are useful studies because they show what the actual ecological state of the region is and what measures should be taken to protect the lands. According to the presented material, the soils in the region are in relatively good condition (equilibrium), but their excessive load with the use of artificial fertilizers, insecticides and herbicides can lead to the destruction of their structure, a decrease in microbiological activity, etc. negative consequences.

## 7. Contributions of the thesis.

3 theoretical-methodological and 6 scientific-applied contributions are presented. They are formed on the basis of the original methodological development, as new data were obtained and modern methods were applied through the application of GIS, geostatistical analyses, etc.

I accept all contributions as true and the result of the scientific work carried out. The development is distinguished by its relevance, originality in approaches and will help to reach scientifically based answers to some problems in the agrarian policy of the region, production and the land market. It collects in one place a lot of information, which through modern methods of

graphic programs is easily applicable and provides opportunities to supplement or expand.

The value of the development is that an integrated methodology has been introduced, which combines different approaches (reflected in the dissertation) and can serve as a model for assessing soils in closed valley systems (e.g. the Radomir, Kyustendil and valley fields in the Rose Valley). The research has a great practical focus in relation to prospects for the development of agriculture in the region and more modern application of GIS systems in the field of agriculture.

## Scientific contributions

An integrated methodology combining geostatistical analysis, soil diagnostics, biological and enzymatic indicators and GIS-based mapping has been introduced for the assessment of soils in closed valley systems. (methodological contribution)

Lithological and anthropogenic factors influencing heavy metals were distinguished by comparing vertical profiles, surface samples, enzyme activity and European reference databases (FOREGS, GEMAS). (scientific contribution).

The applicability of biological and enzymatic indicators as indicators of the ecological state and self-purification of soils in areas with varying degrees of anthropogenic pressure has been proven. (confirmatory contribution)

## Scientific and applied contributions

I accept the presented scientific and applied contributions without any comments and believe that they contain a lot of information that can be useful for farmers, ecologists in the Botevgrad municipality, and the public interested in soil protection issues in the region.

Soil types have been systematized based on genetic characteristics for the entire basin, specifying their spatial distribution and diagnostic criteria.

Based on data from laboratory soil analyses, digital maps of mechanical composition, physicochemical properties, agrochemical condition, enzyme activity, erosion risk and heavy metal content have been created - the first for the Botevgrad Valley on this scale.

Specific measures to increase fertility are proposed, based on the identified N, P and K deficiencies and the unfavorable agrochemical characteristics.

A new quality assessment of the lands of the valley is proposed through an adapted five-step FAO methodology and synthesis of local soil and landscape indicators.

Areas of high ecological vulnerability have been identified, including erosion-hazardous terrains and local anthropogenic anomalies of heavy metals. Background and characteristic concentrations of major heavy metals for the region have been established, which complement the national geochemical database and can serve for future monitoring.

## 8. Assessment of the extent of the dissertator's personal involvement in the contributions.

I am convinced that the doctoral student has a major personal involvement in the formulation of the contributions, because they are the result of the work done. Behind each contribution are field and laboratory data, as well as computer skills for working with Geographic Information Systems. The topic of the dissertation provides an opportunity for an upgrade of

knowledge, specifically in the field of soil science - getting to know methodologies, field studies, etc.

## 9. Critical comments and questions.

I have no critical remarks towards the doctoral student.
Question: What crops would you recommend to be grown on the most common soils in the region - Gray Forest? What measures should be taken to improve the negative indicators of Light Gray (pseudopodzolic) soils and for which crops are they most suitable in the specific region?

## 10. Published articles and citations.

In connection with the dissertation, the doctoral student presents 5 publications, all of which are on the topic of the dissertation.

## 11. Assessment of the publications on the dissertation: number, nature of the publications in which they are printed. Reflections in science - use and citation by other authors.

5 publications have been presented on the dissertation. Three issues have been published in specialized journals "Soil Science, Agrochemistry and Ecology"; Ekologia Balkanica and "Bulgarian Journal of Soil Science", indexed in WOS-CABI and two issues are from participation in conferences, also indexed in WOS-CABI.

The presented abstract objectively reflects the structure and content of the dissertation.

## CONCLUSION:

On the basis of the different research methods learned and applied by the PhD student, the correctly derived experiments, the made generalizations and conclusions, I consider that the presented dissertation meets the requirements of the FRAADB and the Regulations of the University of Forestry for its application, which gives me the reason to evaluate it as **POSITIVE** .

I take the liberty of suggesting that the Honourable Scientific Jury also vote in the affirmative and award the Krastena Valerieva Ilieva the educational and scientific degree ***"Doctor"*** in the scientific specialty "Soil Science".

**Date:** March, 2026year. **REVIEWER:** ..
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