

## REVIEW

by **Prof. Romyana Yankova-Avramova, PhD,**

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For awarding the educational and scientific degree "Doctor" in the area of higher education: 4. Natural Sciences, Mathematics, and Informatics, Professional sub-area 4.2 Chemical Sciences, the doctoral program "Ecology and Environmental Protection". The title of PhD dissertation is "Study of the content of polycyclic aromatic hydrocarbons in atmospheric aerosols", author Eng. Stela Ivanova Naydenova, Faculty of Natural Sciences, University "Prof. Dr. Assen Zlatarov", Department of "Ecology and Environmental Protection".

By order No UD-503/16.12.2024 from the Rector of University "Prof. Dr. Assen Zlatarov" I'm appointed as a member of the scientific jury. At its first meeting I was chosen to write a review. I have received all materials for the competition in electronic form.

### **1. Brief biographical data**

Stela Ivanova Naydenova completed her higher education in 1997 at University "Prof. Dr. Assen Zlatarov", earning a Master's degree in Industrial Ecology, and is a Chemical Engineer. Since February 1998, she has been a lecturer in the Department of "Ecology and Environmental Protection" at the Faculty of Natural Sciences, University "Prof. Dr. Assen Zlatarov". The courses taught by Eng. Stela Naydenova include the following: Protected Areas; Ecology; Air Pollution and its Impact on Ecosystems; Ecological Monitoring; Field Practice in Ecology; Ecological Legislation and Standards.

## **2. Presented materials**

I have received a complete set of documents required by the Law for the development of the academic staff in the Republic of Bulgaria (LDASRB) and RAIDASRB (Rules on the application of LDASRB), and according to the rules of University "Prof. Dr. Assen Zlatarov":

- ✓ the thesis;
- ✓ thesis abstract (51 pages);
- ✓ curriculum vitae of the applicant;
- ✓ list of applicant's scientific publications;
- ✓ a reference for the original scientific contributions of the thesis.

## **3. General description of the presented materials.**

According to the data in the submitted materials and the reference with data from world databases (Web of Science (WOS), Scopus), the PhD student's points (90) exceed the required number of points according to the minimum national requirements for PhD studies in the field of higher education 4.2 Chemical sciences: total number of points - 80, including 50 points from the dissertation for the degree of Doctor of Science (group A) and 30 points from the scientific publications (group G).

According to the received documents, the list of publications (WOS, Scopus) with which Eng. Stela Naydenova participated for the PhD degree is 3, of which:

- two publications are indexed in Q3 quartile journals;
- one publication is in a journal with an SJR ranking.

The total points accumulated under Indicator Group G amount to 40 points, exceeding the required minimum. Notably, the doctoral candidate is the first author in all listed publications.

Additionally, the submitted author's abstract accurately reflects the structure and content of the dissertation, ensuring transparency and coherence in presenting the research findings.

#### 4. Dissertation thesis

*The main goal* of the dissertation is to investigate the concentrations and temporal variations of PM<sub>2.5</sub> (fine particulate matter with an aerodynamic diameter of 2.5 µm) and associated biologically and ecologically significant pollutants, including polycyclic aromatic hydrocarbons (PAHs), in the city of Burgas.

The dissertation comprises a total of 156 pages, containing 49 tables and 66 figures. The bibliography consists of 202 references. The thesis is structured into the following main sections:

- **Introduction**, where the objectives and tasks of the dissertation are formulated, along with a discussion on the relevance and significance of the research topic (pp. 5–7).

- **Literature Review**: Analysis of the current state of research on the problem, including air pollution by atmospheric aerosols and PAHs; sources and characteristics of atmospheric aerosols; the impact of PM (particulate matter) on the environment; methods for measuring PM concentrations; polycyclic aromatic hydrocarbons—properties, sources, effects on human health, and methods for analysing atmospheric PAHs (pp. 8–56).

- **Experimental Section (pp. 57–62)**: This section outlines the sampling locations in Burgas, the sampling methodology, and the method for determining the mass concentration of PM. It also details the reagents, materials, and standards used, the sample preparation process, and the analysis of the studied PAHs. Additionally, a health risk assessment is conducted.

- **Obtained Results and Discussion (pp. 63–139)**:

✓ *Comparative Analysis of PM<sub>10</sub> and PM<sub>2.5</sub> (pp. 63–72)*:

A linear regression analysis was applied to examine the relationships between the concentrations of PM and PAHs with meteorological parameters and other pollutants. A significant correlation was found between PM and PAHs, with high-

molecular PAHs being more strongly associated with particulate matter, while low-molecular PAHs are more distributed in the gas phase.

Temperature does not show a significant correlation with PM and PAHs, likely due to the short study period and the dominant influence of emission sources. Relative humidity shows a positive correlation with PM<sub>10</sub>, which could be attributed to the aggregation of fine particles. Wind speed is negatively correlated with the concentrations of PM and PAHs, confirming the local nature of emissions.

A strong positive correlation was found between NO<sub>2</sub> and PM<sub>2.5</sub> ( $R = 0.74$ ) and PAHs ( $R = 0.58 - 0.96$ ), confirming that vehicular traffic is a major source of PM. Solar radiation also affects the distribution of PM and PAHs through photochemical reactions. Atmospheric pressure shows a negative correlation with PM, which can be linked to condensation processes and the scattering of pollutants.

The results highlight the significance of local emissions, meteorological conditions, and chemical processes in determining the concentrations of PM and the associated PAHs in atmospheric air.

- ✓ *Atmospheric levels, distribution, sources, correlation with meteorological parameters, and other pollutants of PAHs associated with PM<sub>2.5</sub> in Burgas (pp. 73-139):*

The study investigates the concentrations of fine particulate matter (PM<sub>2.5</sub>) and polycyclic aromatic hydrocarbons (PAHs) in the atmospheric air of Burgas during the period 2020-2023, with a special focus on seasonal and meteorological influences, as well as pollution sources. The main pollution sources are associated with combustion processes, including biomass burning and road transport.

It has been established that during the winter season of 2021, the highest concentrations of PM<sub>2.5</sub> and PAHs were recorded at monitoring points linked to intensive heating, such as "Vazrazhdane" and "Lazur". PAHs with 4 and 5 rings, characteristic of combustion processes, dominated in these areas, and linear regression analysis showed a strong correlation between these compounds and PM<sub>2.5</sub>.

However, the levels of carcinogenic compounds remained below sanitary norms, except for some samples during the spring of 2021, where exceedances were observed at the "Vazrazhdane" site.

The study indicates that meteorological conditions, such as temperature inversions and rainfall, significantly affect the concentrations of pollutants. For example, rainy days lead to a reduction in PAH levels, while high temperatures and solar radiation stabilize these compounds in the atmosphere.

The health risk assessment shows that the levels of toxic and mutagenic compounds do not exceed safe levels throughout the study period. However, the study highlights the importance of monitoring pollutants and their interaction with meteorological conditions, noting that in some cases, pollution may pose a significant health risk, especially when high PAH concentrations are found near their sources.

It has been concluded that the main sources of pollution in Burgas are linked to local combustion processes and traffic, with concentrations of PAHs and PM<sub>2.5</sub> varying significantly depending on the season, meteorological conditions, and geographical characteristics of different monitoring sites.

**- Main contributions:**

**1) Scientific contributions**

➤ *The first detailed study of PAHs concentrations in different fractions of particulate matter for the Burgas Municipality.* The study provides a unique analysis of the concentrations and distribution of 17 PAH compounds in atmospheric aerosols, including both PM<sub>2.5</sub> and the coarser PM<sub>10</sub> fractions. This is the first study of its kind covering different neighborhoods of Burgas, offering valuable data on the spatial and seasonal distribution of PAHs, which has not been previously studied in the region.

➤ *Revealing the relationship between PAHs, meteorological factors, and other atmospheric pollutants.* The study examines and analyzes the correlation between the concentrations of the investigated PAH-associated PMs, key meteorological parameters, and other atmospheric pollutants, providing new insights into the complex interactions in the atmosphere. These results contribute to understanding the mechanisms of PAH distribution, transformation, and retention under various meteorological conditions and environments.

➤ *Health risk assessment associated with PAH exposure.* The study evaluates the impact of PAHs on human health by applying a quantitative health risk assessment. The results indicate that PAH levels, particularly during the winter months, could pose a significant health risk, although the calculated excess cancer risk (ECR) is not considered a high priority.

## **2) Applied scientific contributions**

➤ *Improvement of air quality management and regulatory policies.* The results of the study provide a valuable basis for developing regulatory policies aimed at reducing pollution in urban areas with high concentrations of atmospheric PAHs and improving environmental quality and the associated public health status.

➤ *The implemented methodology,* which includes modern sampling and analysis techniques, is applicable to other research and environmental monitoring programs. It can be used to assess air pollution levels in various regions and conditions, identify probable emission sources, evaluate their impact on air quality according to regional specifics, and assess their health effects.

## **5. Critical Remarks and Recommendations:**

Since the research of Eng. Stela Naydenova has high scientific value, I recommend publishing her future results in international journals with a high impact factor.

## CONCLUSION

I consider that the dissertation and the abstract submitted to me for review meet the requirements of the Law on the Development of the Academic Staff in the Republic of Bulgaria and its implementation regulations, and I recommend the scientific jury to award Eng. Stela Ivanova Naydenova the degree of "Doctor" in the field of higher education 4. Natural Sciences, Mathematics and Informatics, Professional sub-area 4.2. Chemical Sciences, PhD program "Ecology and Environmental Protection".

06.02.2025 г.

Reviewer:

Подпис задвижен  
Чл.2 от ЗЗДД

Prof. Rumyana Yankova, PhD