

REVIEW

By Dr. Mariana Genova Doncheva -Boneva - Professor at the University of Forestry

dissertation for the award of the educational and academic degree of “**Doctor**”

by: field of higher education 4. Natural Sciences, Mathematics and Informatics

Professional field 4.3. Biological sciences

Doctoral programme in Ecology and Ecosystem Protection

Author: Nikola Stamenov Angelov

Topic: "Possibilities for sustainable management of urban soils through buffer green areas"

Research supervisors:

Prof. Dr. Iliana Georgieva Velcheva - Plovdiv University "Paisii Hilendarski"

Assoc. Prof. Dr. Ekaterina Ivanova Valcheva - Agricultural University - Plovdiv

1. General description of the submitted materials

By Order No. RD-21-2267 of 10.12.2024 of the Rector of Plovdiv University "Paisii Hilendarski" (PU) I have been appointed as a member of the scientific jury for providing a procedure for the defence of a dissertation thesis entitled: "Possibilities for sustainable management of urban soils through buffer green areas" for the acquisition of the educational and academic degree of "Doctor" in the field of higher education 4. Natural Sciences, Mathematics and Informatics, Professional field 4.3 Biological Sciences, doctoral programme Ecology and Ecosystem Protection. The author of the dissertation is Nikola Stamenov Angelov – doctoral candidate in the part-time form of study at the Department of Ecology and Environmental Protection with scientific supervisors Prof. Dr. Iliana Georgieva Velcheva - Plovdiv University "Paisii Hilendarski" and Assoc. Prof. Dr. Ekaterina Ivanova Valcheva - Plovdiv Agrarian University

The set of materials submitted by the University of Plovdiv on electronic media follows Article 36 (1) of the Regulations for the Development of the Academic Staff of the University of Plovdiv and includes the following documents:

- A request to the Rector of PU for disclosure of the dissertation defence procedure;
- CV in European format;
- Minutes of the Departmental Council relating to the reporting of readiness for the opening of the procedure and to the preliminary discussion of the thesis;
- Dissertation;
- Author's abstract;
- List of scientific publications on the topic of the dissertation;
- Copies of scientific publications;
- A declaration of originality and authenticity of the attached documents;
- Reference to compliance with minimum national requirements;
- Opinion of a supervisor.

The doctoral candidate has attached two publications.

The submitted documents are well formatted and arranged according to the order described in the Regulations for the Development of the Academic Council of PU and facilitate the work with them. I have no comments on the documents submitted.

2. Brief biographical data about the doctoral candidate

Nikola Angelov was born in 1994. In 2017, he obtained a Bachelor's degree in Agronomy (Animal Husbandry) at the Agricultural University of Plovdiv. 2018 he graduated with a Master of Science in Plant Protection from the same university. From March 2020, he is enrolled as a part-time doctoral candidate at Plovdiv University Paisii Hilendarski. The PhD expires in March 2024. On 3.12.2024, the Department of Ecology and Environmental Protection held a departmental council for preliminary discussion of the doctoral candidate's dissertation and decided to open the procedure.

Nikola Angelov has over 2.5 years of experience as an agronomist at AGROSPECTRUM Ltd., where he organizes the production and sale of agricultural products.

3. Relevance of the subject matter and appropriateness of the set goals and objectives

This thesis aims to investigate the possibilities of sustainable management of urban soils using buffer grass strips. The focus is on large road arteries. The experiment was carried out in Plovdiv with the aim of bringing the model to other large cities.

The theme is actual, given the deteriorating urban environment. There is a need to define a sustainable species composition of herbaceous plants for landscaping areas around traffic-loaded streets. Established roadside grass strips have ameliorative functions by protecting the soil from pollution, accumulating toxic substances, and preventing dust and fine particulate matter (PM) air pollution. At the same time, herbaceous plants need to grow and thrive under the aggravated conditions in the city - soil and air pollution, deteriorated meteorological parameters, etc. To achieve the goal, the doctoral candidate set himself eight specific tasks developed sequentially in the dissertation.

4. Knowledge of the problem

The doctoral candidate is familiar with the problems of soil contamination in urban environments, physicochemical anomalies in soils, disturbance and alteration of microbial communities, and factors that affect the processes occurring in soils. More attention is paid to phytoremediation as a technical solution to the problem of heavy metal-contaminated soils. The doctoral candidate examines in more depth the scientific research on the selection of plant species for phytoremediation of soils, their ability to accumulate contaminants in biomass in elevated amounts and at the same time to be tolerant and adaptive to the degraded environmental conditions of the urban environment.

5. Research methodology

An adequate methodological approach was chosen to fulfil the set aim and objectives. Standard methods and modern equipment were used for the analyses, and appropriate statistical data processing programs were applied.

6. Characteristics and evaluation of the thesis

The dissertation is written on 132 pages long, including the literature review - 10 pages; aim and objectives, materials and methods - 18 pages; results of the conducted studies, discussion, generalisations, conclusions and contributions - 75 pages. The results are presented in 20 tables, 43 figures and 1 diagram. The bibliography includes 188 references.

The experiment is very well planned and executed. The object of the study is anthropogenic soils in the territory of the town Plovdiv. Experimental (near roadways) and control (in park environment) sites were selected in six city areas, reflecting different types of anthropogenic loading depending on urbanisation, wind rose and other factors. Depending on the soil and climatic conditions of the area, herbaceous plants have been selected for sowing in the construction of the buffer grass strips - crested wheatgrass, ryegrass, reed fescue, and starflower.

The thesis describes the fieldwork and laboratory analysis methods in great detail. In cases where standard methods for chemical, physiological, and biochemical analyses are used, it is appropriate to cite the standards or references where the methods are described, as this is presented, e.g. in section 4.4 of the thesis etc.

The "Results and Discussion" presents data from the extensive soil and plant surveys conducted by the doctoral candidate from the established grass buffer strips: Soil physicochemical studies - mechanical composition, organic carbon, total nitrogen, total and mobile phosphorus, total and mobile potassium, the content of 16 other macro- and microelements in soils; microbiological - determination of viable microorganisms, *Escherichia coli*, enterococci, actinomycetes, mould fungi, soil microbial biomass, the enzymatic activity of microbial communities in soils, metagenomic analysis; analysis of plant samples - physiological - photosynthetic intensity, transpiration intensity and stomatal conductance, chlorophyll "a" and "b", and carotenoids; biochemical - total soluble protein, free proline, catalase, glutathione peroxidase, glutathione reductase, total macro- and microelements content of plants. The research was conducted precisely, and the data obtained were processed using appropriate statistical methods. The doctoral candidate made an analytical evaluation of the results obtained from the research, comparing them with the results of studies by other authors, which confirmed and complemented the results obtained by the doctoral candidate. Through the statistical analysis, the doctoral candidate looks for trends, temporal and spatial relationships between the studied indicators in soils and plants from the selected sites. The applied multivariate analysis allows to evaluate the influence of 6 factors on the content of macro- and microelements in the studied soils. Specific recommendations and measures to improve the condition of urban soils in Plovdiv are formulated in the summary. A model for soil management and construction of buffer grass strips around the streets has been developed. An algorithm for assessing the effect of buffer grass strips has also been developed.

The doctoral candidate has summarised the results of his research in 8 clearly formulated conclusions.

7. Contributions and Significance of the Development for Science and Practice

In the dissertation, the doctoral candidate has formulated 2 scientific and 2 applied scientific contributions. I believe that more relevant contributions to science and practice can be identified from the studies that were conducted.

As scientific contributions, I can mention the following:

- Scientific data were obtained on the content of Ca, Mg, Fe, S, P, Na, V, Cr, Mn, Co, Ni, Zn, As, Mo, Cd, Pb, and U in the surface layer of soils from selected sites in six districts of the city of Plovdiv.
- Scientific data were obtained on the accumulation of Ca, Mg, Fe, S, P, Na, V, Cr, Mn, Co, Ni, Zn, As, Mo, Cd, Pb, and U in the root systems and vegetative organs of four species of herbaceous plants: perennial ryegrass (*Lolium perenne* L.), crested wheatgrass (*Agropyron cristatum* L.), reed fescue (*Festuca arundinacea* Schreb), and starflower (*Lotus corniculatus* L.).
- Data were obtained on the microbial communities in soils at selected sites in six districts of Plovdiv. The microbial communities were found to be dominated by representatives of the *Actinobacteriota* and *Proteobacteria* Divisions. The number of heterotrophic microorganisms was higher in highly anthropogenically influenced soils (near transposition arteries) compared to the control (park environment).
- Confirmatory data have been obtained on the response of some enzymes in herbaceous plants to the effects of degraded environmental conditions (e.g. proline).
- Select herbaceous plants' tolerance to degraded environmental conditions, combined with their high bioaccumulation of some toxic elements, has been demonstrated.

The scientific and applied contributions can be attributed to:

- A technology for constructing buffer green areas around road arteries with bioremediation functions has been validated for Plovdiv.
- A model was developed for urban soil management through the construction of buffer lawns around the streets, which can be applied in other cities, and this can be considered an opportunity for implementation.
- An algorithm has been developed to assess the effect of building buffer grasslands around roadways.

8. Assessment of the publications on the dissertation

The PhD student has submitted two publications directly related to the topic and research of the dissertation. The articles were published in an online edition in 2022 (<https://doi.org/10.3390/land11030343>). The publication has an IF = of 3.9 and an SJR of Q2. The publications are in English. One of the publications has 7 co-authors, and the other has 16. There are no citations listed so far. The PhD student reports 40 pts for both publications, indicating that the minimum requirements for the educational and academic degree of “Doctor” (30 pts) have been met.

9. Personal participation of the PhD student

Although the research is team-based, I believe the dissertation is the personal work of the doctoral candidate, who has actively participated in the experiments. I am justified in this belief by the opinion of the doctoral candidate's supervisor and the department's support in discussing the dissertation.

10. Abstract

The abstract in synthesised form conveys the content of the extensive study and correctly reflects the main results presented in the dissertation.

11. Critical comments and recommendations

I have the following comments and questions for the doctoral candidate:

1. The literature review is very brief in terms of the scale of the extensive research conducted.
2. Section 2.1, "Soil and environmental conditions in the urban environment," contains general information. It does not present specific results of studies by other authors on soil contamination in urban areas.
3. In Table 9, "data from other investigations" of soils in Plovdiv, the sources of these data are not cited. In my opinion, this information should be included in the literature review.
4. The Technological Model (Katova et al., 2023) is not cited in the bibliographic reference, although it is presented in too much detail.
5. Bulgarian authors' scientific papers on soil contamination with heavy metals in urban environments, microbiology of urban soils, and accumulation of toxic elements in herbaceous plants were not cited in the literature review.
6. The term "background sites" is inappropriate in this case. Background refers to a natural condition, and city parks are also anthropogenically influenced.
7. Texts that would be appropriate for the literature review are included in the results

I also have the following questions for the doctoral candidate:

1. Is the technological model for constructing buffer grass strips presented on pages 15-19 printed anywhere? Are you using this technology model, or are you implementing a new one when you do the fieldwork? If you are applying it, it should be included in the methodology.
2. What are your considerations for selecting this large set of elements analysed in soils and plants, given that there are no precautionary limits to assess their contamination for most of them?
3. Is there any information on the grass communities' species composition in the Plovdiv's roadside stripes?
4. Are there criteria by which the toxicity of accumulated trace element levels in grass species to be assessed?
5. You propose that the biomass from grass strip mowing be used for composting and recommend that the compost "be used in the creation of new grass buffer zones, thereby improving soil structure and providing an opportunity to reduce synthetic fertiliser inputs." Isn't there a danger of reintroducing toxic elements back into the soil?

12. Personal impressions

I don't know the doctoral candidate and have no personal impressions.

13. Recommendations for future use of the dissertation contributions and results

The dissertation contains significant scientific and applied scientific contributions. The developed urban soil management model can be used in other cities to create grass strips around high-traffic streets. The algorithm for evaluating the effectiveness of these grass strips may also be applicable to landscaping practice.

CONCLUSION

The dissertation contains scientific and applied scientific results that contribute to science and meet the requirements of the Law for the Development of Academic Staff in the Republic of Bulgaria (LADAPB), the Regulations for the Implementation of the LADAPB, and the Regulations of Paisii Hilendarski University.

While developing the dissertation, the doctoral candidate mastered many methods of field and experimental work, demonstrated in-depth theoretical knowledge of phytoremediation of urban soils contaminated with heavy metals, and demonstrated professional skills in conducting the necessary research and screening, analysing and evaluating the results obtained.

Due to the above, I confidently give a **positive evaluation of** the research that was conducted, presented by the above-reviewed dissertation, abstract, publications, results, and contributions. **I propose to the honourable scientific jury to vote positively for the award of the educational and academic degree of “Doctor” to Nikola Stamenov Angelov** in the field of higher education: 4. Natural Sciences, Mathematics and Informatics, Professional field 4.3 Biological Sciences, doctoral programme „Ecology and Ecosystem Protection“.

15.01. 2025 r.

Reviewer:

(Prof. Dr. Mariana Doncheva-Boneva)