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Review of the PhD thesis of Mr. Hassanali Mollashahi entitled „*Management of urban grasslands in the context of green infrastructure ecosystem services*”

conducted in the Institute of Agroecology and Plant Production,

Wrocław University of Environmental and Life Sciences

under scientific supervision of

Dr hab. Magdalena Szymura, assoc. prof. and Prof. Stefano Macolino

The review was based on the letter of Chairman of the Scientific Discipline Board for Agriculture and Horticulture of the Wrocław University of Environmental and Life Sciences, Prof. Cezary Kabała of June 28, 2023, in accordance with Art. 190 sec. 3 of the Act of July 20, 2018 – Law on Higher Education and Science (consolidated text, Journal of Laws of 2021, item 478) and the procedure for conferring a doctoral degree at the Wrocław University of Environmental and Life Sciences.

The reviewed PhD thesis has the form of a compact study, which includes a self-report and a homogeneous collection of two scientific publications. The self-report presented by Mr. Hassanali Mollashahi has 15 pages and contains the following chapters: 1. Introduction, 2. Material and methods (with subchapters), 3. Results (with subchapters) and 4. Discussion. In this part, Author also included conclusions and practical implications, acknowledgment, funding and references. The second part of the doctoral dissertation consists of four chapters: 1. Abstract in English, 2. Abstract in Polish, 3. Articles and 4. Author contribution statements.

The basis of Mr. Hassanali Mollashahi's doctoral dissertation are two scientific papers published in journals indexed in the Web of Science Core Collection database:

1. Mollashahi H., Szymura M., Szymura T.H., (2020). Connectivity assessment and prioritization of urban grasslands as a helpful tool for effective management of urban ecosystem services. PLOS ONE, 15(12), e0244452 (points = 140, IF = 3.7),

2. Mollashahi H., Szymura M., Perera P.C.D., Szymura T.H., (2023). The effect of grassland type and proximity to the city center on urban soil and vegetation coverage. *Environmental Monitoring and Assessment* 195:599 (points = 70, IF = 3.0).

The total score according to the announcement of the Minister of Education and Science of July 17, 2023 on the list of scientific journals and reviewed materials from international conferences is 210 points, while the total Journal Impact Factor according to the Web of Science Core Collection (as of August 10, 2023) is 6.7.

In the first chapter, Mr. Hassanali Mollashahi introduces the reader to the scope of his PhD dissertation, highlighting the various functions and ecosystem services provided by green infrastructure in urban areas, ranging from protecting biodiversity, maintaining landscape connectivity, health benefits, supporting roles (e.g. habitat for soil organisms) and a set of regulatory services such as nutrient and pollutant retention and release, carbon sequestration and water storage. After an interesting introduction, the PhD student presented research goals and hypotheses. Mr. Hassanali Mollashahi examined the ecological characteristic of urban grasslands, considering Wrocław city as a model object. The aim of the study was to improve urban grasslands management methods to increase green infrastructure ecosystem services, taking into account the connectivity of urban grassland patches in the urban landscape and the impact of grassland type and proximity to the city center on soil and vegetation characteristics. Mr. Mollashahi's research had a large practical aspect as it provides urban planners with ideas for improving ecosystem services and the permeability of the urban landscape to wildlife. The doctoral student tested the following hypotheses: 1) the spreading capacity of grassland plant species is limited by the spatial structure of urban grasslands in the city, 2) the characteristics of urban grasslands, such as soil properties and plant species richness, are influenced by the type of grassland patch and location.

Material and methods are written properly. The author described in detail the study area and data sources, connectivity analysis and patches prioritization, soil sampling and vegetation assessment as well as data analysis. The PhD student reported that a set of four scattering distances was established as follows: 2, 20, 44 and 100 m, according to approach of Hejkal et al. (2017). I understand that these distances were taken from Hejkal's research, but I would like to ask a question: Why were these specific distances chosen, and not, for example, equidistant values? What intrigues me the most is the choice of values 2 and 44 m. The cover of vegetation was assessed using a visual method in percentage scale, including the total as well as grass, herb, mosses, bare soil and litter cover for each plot. What botanical families were included in the herbs?

The results are the most extensive chapter of the PhD thesis, which Mr. Hassanali Mollashahi divided into two subchapters referring to the research hypotheses put forward in the introduction. In the first part, he described connectivity assessment and prioritization of urban grasslands based on the paper published in PLOS ONE, while in the second – urban soil and vegetation coverage based on the paper published in Environmental Monitoring and Assessment. In both subchapters, Author has included the most important figures containing data that verify the assumed research hypotheses.

In the discussion, Mr. Hassanali Mollashahi confronts the obtained results with the references used in the Author's publications and the introduction in the self-report. The Author emphasizes that the percentage of urban green area in Wrocław city is relatively high compared with other European cities. This approach gives the conducted research a practical dimension, because it can find a wider application, not only in the local scope. PhD student suggest that in the case of low-intensity management, urban grasslands with even small patches of habitats are valuable in maintaining the species richness of vascular plants. He also cites unpublished results showing that the small patches support also the biodiversity at the genetic level for vascular plants associated with urban grasslands (Mollashahi et al., in review). Unfortunately, this item is missing from references. Perhaps this publication would increase the value of the submitted doctoral dissertation.

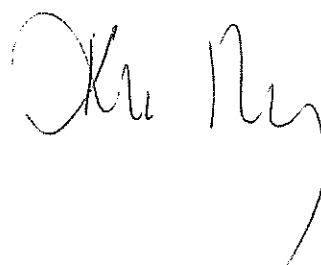
The next part of the PhD thesis consists of conclusions and practical implications. Mr. Hassanali Mollashahi showed that if it is not possible to expand the area and connect grasslands, especially in the city center, management should focus on improving their quality. This can be achieved by sowing seeds, mowing less often or developing alternative forms of grassland, such as green roofs and walls or green tram tracks. PhD student showed the positive impact of modern management on the species richness of the Wrocław city. Unfortunately, in connection with the second part of this conclusion – “...*which allows the establishment of herb species while increasing soil fertility increase the cover of grass species leading to a decrease in total vascular plant species richness*”, the whole is hardly understandable to me. The concentrations of heavy metals observed exceeded the permissible standards in patches located in the city center, which suggests the need for constant monitoring of heavy metals in urban soils. I think that in this part it is unnecessary to refer to the literature, which should be included in the discussion. The results and practical implications should be based only on the Author's research results.

The other parts are acknowledgment, funding and references. The doctoral dissertation is written very carefully and is graphically very well developed. Minor misspellings or different formatting of journal names are rare.

In the second part of the PhD thesis, Mr. Hassanali Mollashahi included an abstract in English and Polish, scientific articles and statements by the authors. A summary is comprehensive and contains all the major points of the original text. The basis of the doctoral dissertation are 2 scientific papers. It should be emphasized that the articles have been published in reputable journals indexed in the Web of Science database. PLOS ONE is in the second quartile in the category of multidisciplinary sciences, while Environmental Monitoring and Assessment – in the third quartile in the category of environmental sciences. At the end, the PhD student included statements about the percentage share of individual authors and information about the substantive detailed own contribution in both papers. It should be noted that Mr. Hassanali Mollashahi is the first and corresponding Author in both articles. The Author's contribution to the first paper included formal analysis, funding acquisition, investigation, methodology, software, writing original draft as well as review and editing. The PhD student's contribution to the second publication was similar, except that he also participated in developing the concept of the research.

To sum up, the assessed doctoral dissertation is a comprehensive and valuable study, which is a collection of two published and thematically related scientific articles. The subject of the PhD dissertation is an original solution for the application of the results of own scientific research in the economic and social sphere, because it can be used by urban planners to improve ecosystem services and the permeability of the city landscape to wildlife. Mr. Hassanali Mollashahi demonstrated both theoretical knowledge in the discipline of agriculture and horticulture as well as the ability to conduct field research, the results of which were used to write both scientific papers included in the doctoral dissertation. The PhD thesis expands knowledge about the ecological characteristic of urban grasslands in order to improve the methods of their management to increase the ecosystem services of green infrastructure. The doctoral dissertation written in English was accompanied by an abstract in Polish and the required statements of all co-authors of both scientific articles, specifying the individual contribution of each of them to its creation. It should be emphasized here that Mr. Hassanali Mollashahi was the leading author in both papers, making the greatest contribution to their creation. Therefore, a doctoral student meets all the requirements for candidates applying for a doctoral degree.

I believe that the PhD thesis entitled "*Management of urban grasslands in the context of green infrastructure ecosystem services*" meets the requirements for doctoral dissertations and the conditions set out in Art. 190 sec. 3 of the Act of July 20, 2018 – Law on Higher Education and Science (consolidated text, Journal of Laws of 2021, item 478). Therefore, I am applying to the High Scientific Discipline Board for Agriculture and Horticulture of the Wrocław University of Environmental and Life Sciences to admit Mr. Hassanali Mollashahi to the further stages of his PhD dissertation.

A handwritten signature in black ink, appearing to read "Dr. M." or similar, written in a cursive style.