

STATEMENT

by Assoc. Prof. Tsvetan Kotsev, PhD

National Institute of Geophysics, Geodesy and Geography – Bulgarian Academy of Sciences,

regarding the dissertation of Vanya Emilova Stoycheva entitled “Integrated assessment of regulating ecosystem services in urban areas”, submitted for the award of the educational and scientific degree of “Doctor” in professional field 4.4. Earth Sciences, scientific specialty “Physical Geography and Landscape Ecology”

This statement has been prepared pursuant to Order No. 01-168 of 23 July 2026 of the Director of NIGGG-BAS, which appointed the scientific committee for the dissertation defence procedure.

1. General information about the candidate and the dissertation

Vanya Emilova Stoycheva was enrolled as a full-time doctoral student in the Department of Geography at NIGGG-BAS on 1 February 2022, with Prof. Stoyan Nedkov, PhD, as scientific supervisor and Prof. Davide Geneletti of the University of Trento as scientific advisor. In 2025, the dissertation title was specified as “Integrated assessment of regulating ecosystem services in urban areas”, and the doctoral candidate completed the doctoral programme with the right to defend. The public defence procedure was opened in July 2026, and the defence itself is scheduled for 20 October 2026.

Since March 2025, Vanya Stoycheva has worked as an Assistant in the Applied Geoinformatics Section of NIGGG-BAS. Her research interests, publications, and participation in national and international projects are directly related to the mapping, modelling, and assessment of ecosystem services. In this respect, there is clear continuity between her previous work and the subject of the dissertation.

I have known Vanya Stoycheva personally since the period of her doctoral studies and have had the opportunity to follow her development as a young researcher at close hand. I have an excellent impression of her diligence and determination, her aspiration to maintain high academic standards in her work, and, at the same time, her modesty and collegial conduct.

The dissertation comprises 201 pages and is built around five interrelated scientific publications. They are arranged to follow the logic of the research – from a review of the scientific literature and assessment of the available data, through the modelling of individual services, to an overall assessment of several regulating ecosystem services.

2. Relevance, objective and methodological framework

The topic is relevant from both a scientific and a practical perspective. Regulating ecosystem services are particularly important in urban areas, where high population density, soil

sealing, air pollution, the urban heat island effect, and the risk of intense pluvial flooding increase the need for the regulating functions of green spaces.

The main objective is to develop an approach for the integrated assessment of regulating ecosystem services in urban areas. Four related tasks have been set to achieve this objective: to identify the priority services and the methods used to assess them; to evaluate the applicability of different models and data; to develop an assessment of the supply, demand, and balance of individual services; and to combine these assessments within a multi-tiered approach.

I consider it a strength of the dissertation that data and methods differing in type and level of detail are brought together within a common approach, rather than seeking a single universal model. At the final stage, six priority services are considered: PM10 filtration, noise attenuation, flood regulation, pollination, pest control, and local climate regulation.

3. Assessment of the publications and results

The first publication – A review of regulating ecosystem services in the context of urban planning – reviews 58 scientific papers. The authors compare types of ecosystem services, the spatial extent and level of detail of the data, the biophysical, social, and economic approaches used, elements of green infrastructure, and their links with urban planning. One important conclusion is that biophysical indicators predominate, while social and economic assessments are used less frequently. Service demand, relationships among services, possible trade-offs, and their joint occurrence are also less well studied. This publication is important to the dissertation because it identifies the questions developed in the subsequent stages of the research.

The second publication examines inconsistencies between the national ecosystem database of Bulgaria and the MAES framework. Its main importance for the dissertation lies in preparing a more reliable spatial basis for the subsequent assessments and models. The doctoral candidate's contribution concerns the processing and analysis of data for the territory of Sofia, verification of the results, their graphical presentation, and participation in preparing the article.

I consider the third publication – The performance of two urban flood regulation models using different input data – particularly important. It compares the InVEST Urban Flood Risk Mitigation and IMECOGIP Waterflow Regulation models using different spatial input data and rainfall scenarios. The results show that the assessment of the “flood regulation” service depends not only on the characteristics of the area, but also on the level of detail of the classification used, the quality of the soil information, and the way in which the respective model operates. InVEST responds to changes in rainfall amount and allows variation within the same land-cover class, whereas WRRM relies to a greater extent on predefined runoff coefficients.

The scientific contribution here does not lie in creating a new hydrological model, but in comparing and adapting existing models to specific urban conditions and in improving the input data. At the same time, it should be noted that the results were not independently validated against measured runoff or observed hydrographs. Therefore, in my view, the better performance

of InVEST should be understood as greater detail and better sensitivity to important physical characteristics, rather than as demonstrated higher accuracy in reproducing actual processes.

The fourth and fifth studies build on the individual assessments by incorporating service demand and balance and by applying an integrated multi-tiered approach. The final study applies this approach to the six selected services in Sofia and uses spatial statistical methods to identify areas with high and low values of supply, demand, and balance. At the time the dissertation was submitted, one of these two studies was under review and the other had been submitted for publication.

4. Scientific contributions

I consider the following to be the most significant contributions of the dissertation:

1. A coherent approach has been developed for the integrated assessment of the supply, demand, and balance of regulating ecosystem services in urban areas, allowing methods of different complexity and with different data requirements to be combined.
2. Spatial methods for assessing priority services, including InVEST and EnhancES, have been adapted and applied, demonstrating the importance of the level of detail and quality of the input data for the resulting assessment.
3. An integrated spatial assessment of six regulating ecosystem services has been carried out for Sofia, identifying areas with different relationships between the provision of services and the need for them.
4. A common spatial information base has been created, linking national ecosystem types, Urban Atlas, and other sources of land-cover and land-use information. It can also be used in future assessments of urban ecosystems.

These contributions broadly correspond to those stated by the author and, in my opinion, represent the most significant results of the dissertation without overstating the novelty of the existing models that were used.

5. Critical comments and questions

My comments mainly concern particular methodological choices and do not alter my overall positive assessment of the dissertation.

First, the update of Urban Atlas was assessed using a network of control points, with changes identified at about 13.4% of them, and by the reduction in the mean area of some polygons. These indicators provide information about the extent and level of detail of the changes made, but by themselves they do not show whether the accuracy of the map has actually improved. I would therefore like the author to explain how an independent assessment of accuracy before and after the update could be carried out, for example using an orthophoto map or another suitable reference source.

Second, spatial analysis and available soil samples were used to refine the hydrologic soil groups. The sand-to-clay ratio is a useful indicator, but it does not fully describe the soil's ability to absorb and transmit water. Was any assessment made of how the results might change if measured infiltration, hydraulic conductivity, depth to a low-permeability layer, and other soil-profile characteristics were included? It is also not sufficiently clear on what basis the extent of the alluvial soils was defined using a 20 m buffer along the river courses. Given that a slope of 0–3° was used to identify potential river floodplains, why were the boundaries of the alluvial soils not delineated according to the actual extent of these low-slope areas along the rivers, rather than by means of a fixed-width buffer that does not account for differences in the width and morphology of the river valleys?

Third, in my view, the interpretation of the results from the Optimized Outlier Analysis as synergies and trade-offs between individual ecosystem services requires clearer justification. In the study, Anselin Local Moran's I is applied to aggregated indicators of the balance of the services considered, rather than as a bivariate analysis of two individual services. To what extent can the identified spatial overlaps between cooling regulation and PM10 filtration be interpreted as synergies and trade-offs, given that the causal mechanism underlying changes in the two services has not been investigated?

6. Originality and conclusion

A statement of originality has been submitted with the dissertation, in which Vanya Stoycheva declares that the work is her own and that results used from other authors have been properly cited. The similarity report should also be considered in light of the fact that the dissertation is based on the doctoral candidate's own publications and includes parts of them. I find no grounds in the submitted materials to doubt the stated personal contribution.

The dissertation is a complete and coherent scientific study of a relevant problem in physical geography and landscape ecology. The work demonstrates that Vanya Stoycheva is able to formulate scientific tasks independently, work critically with spatial data, apply and adapt models, and synthesize the results within an integrated research approach. The publications and the stated personal contribution are directly related to the topic of the dissertation.

On the basis of the above, I give a positive assessment of the dissertation and support the award to Vanya Emilova Stoycheva of the educational and scientific degree of "Doctor" in professional field 4.4. Earth Sciences, scientific specialty "Physical Geography and Landscape Ecology".

Date: 2026

Member of the scientific committee: Assoc. Prof. Tsvetan Kotsev, PhD

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