Transilvania University of Brașov
INTERDISCIPLINARY DOCTORAL SCHOOL

ADMISSION TO DOCTORAL STUDIES **Session September 2024**

Field of doctoral studies: Environmental Engineering
Doctoral supervisor: Prof. Dr. Luminița ANDRONIC

TOPICS FOR THE ADMISSION TO DOCTORAL STUDIES

TOPIC 1: *Enhancing Urban Resilience and Water Quality Management through the Plant-Based Cellulose Adsorbents within Nature-Based Solutions (NbS)*

Contents / Main aspects to be considered

The PhD program focuses on leveraging plant-based cellulose adsorbents within Nature-Based Solutions (NbS) to enhance urban resilience and water quality management and offers a comprehensive and multidisciplinary approach to environmental engineering. This program is designed to equip students with the knowledge and skills necessary to address some of the most pressing environmental challenges faced by urban areas today, including pollution control, water quality improvement, and the development of sustainable urban green spaces.

Key components of this PhD program include:

1. Research on plant-based cellulose adsorbents: The study will investigate using plant-based cellulose adsorbents as a critical component of NbS. This research will explore how these natural materials can effectively remove pollutants from water, improving water quality in urban environments.
2. Integration of green urban infrastructure: The program emphasizes the importance of integrating green urban infrastructure into broader environmental strategies. This involves the planning and development of urban green spaces such as parks, gardens, and green roofs that can enhance biodiversity, improve air and water quality, and provide recreational benefits to urban populations.
3. Focus on urban resilience: A significant aspect of the research will be to assess how NbS can contribute to urban resilience against environmental stresses and climate change. This includes studying the potential of green infrastructures to mitigate the effects of extreme weather events, reduce urban heat island effects, and enhance the overall resilience of urban areas.
4. Impact of CO_2 on plant-based solutions: Research will include investigating how elevated levels of CO_2 affect the efficacy of plant-based cellulose adsorbents and other NbS in environmental remediation efforts. Understanding these dynamics is crucial for optimizing NbS under changing climate conditions and CO_2 levels.
5. Life Cycle Analysis (LCA) of CO_2 Emissions: Students will learn to conduct LCA to assess the carbon footprint of various urban development projects and NbS implementations. This comprehensive approach enables the evaluation of CO_2 emissions across different stages of project development and implementation, providing insights into how to minimize environmental impacts.

6. Collaboration with experts: Students will have the opportunity to collaborate closely with experts in environmental engineering, urban planning, and related fields. This interdisciplinary approach is crucial for developing innovative solutions that address the complexity of urban environmental challenges.

7. Practical fieldwork and data analysis: The program includes extensive fieldwork, data collection, and analysis to evaluate the effectiveness of NbS and plant-based adsorbents in real-world settings. Students will learn advanced techniques in environmental monitoring, data analysis, and model development.

8. Contribution to sustainable urban development: By focusing on the development and implementation of NbS, students will contribute to the advancement of sustainable urban development practices. Their research will help to demonstrate how cities can become more sustainable, livable, and resilient through the adoption of nature-based approaches.

Recommended bibliography:

Tsatsou, A.; Frantzeskaki, N.; Malamis, S. Nature-Based Solutions for Circular Urban Water Systems: A Scoping Literature Review and a Proposal for Urban Design and Planning. *J. Clean. Prod.* **2023**, *394*, 136325. https://doi.org/10.1016/j.jclepro.2023.136325.

Kisser, J.; Wirth, M.; De Gusseme, B.; Van Eekert, M.; Zeeman, G.; Schoenborn, A.; Vinnerås, B.; Finger, D. C.; Repinc, S. K.; Bulc, T. G.; Bani, A.; Pavlova, D.; Staicu, L. C.; Atasoy, M.; Cetecioglu, Z.; Kokko, M.; Haznedaroglu, B. Z.; Hansen, J.; Istenič, D.; Canga, E.; Malamis, S.; Camilleri-Fenech, M.; Beesley, L. A Review of Nature-Based Solutions for Resource Recovery in Cities. *Blue-Green Syst.* **2020**, *2* (1), 138–172. https://doi.org/10.2166/bgs.2020.930

Seddon, N.; Chausson, A.; Berry, P.; Girardin, C. A. J.; Smith, A.; Turner, B. Understanding the Value and Limits of Nature-Based Solutions to Climate Change and Other Global Challenges. *Philos. Trans. R. Soc. B Biol. Sci.* **2020**, *375* (1794). https://doi.org/10.1098/rstb.2019.0120

Prerequisites / Remarks: *While a background in Environmental Engineering, Materials Science, Chemistry, Biology, or Agronomy is recommended, candidates with related degrees or interdisciplinary backgrounds may also be considered based on their qualifications and research interests.*

x Scientific Doctorate (full-time only)

☐ Professional Doctorate – in the fields of Music and Science of sport and physical education (full-time or part-time)

x without tuition fee (state budget funded)

☐ with tuition fee or with funding from other sources than the state budget

TOPIC 2: *Development of solar-driven processes for the photocatalytic conversion of CO_2 into fuels and high-value chemicals*

Contents / Main aspects to be considered This research project focuses on the innovative development of a solar-driven process for the photocatalytic conversion of carbon dioxide (CO_2) into sustainable fuels and high-value chemicals, aligning with the Circular Economy and Environmental Sustainability principles. The escalating levels of CO_2 and the pressing need for renewable energy sources have propelled the search for efficient, environmentally friendly solutions that can mitigate climate change impacts while providing economic benefits. The project aims to harness solar energy to activate a photocatalytic process that transforms CO_2, a predominant greenhouse gas, into various valuable products such as methane, synthesis gas, and hydrocarbons. This approach not only seeks to reduce atmospheric CO_2 levels but also to create a sustainable raw material base for the chemical industry, thus contributing to a circular economy model. The project intends to improve the efficiency and selectivity of the CO_2 conversion process by developing and optimizing catalysts and identifying effective additives. This involves comprehensive research on environmental engineering, materials science, reaction mechanisms, and system integration to design a scalable and economically viable solar-powered recycling process. The outcomes of this project are expected to pave the way for groundbreaking advancements in CO_2 utilization technologies, offering a dual benefit of mitigating climate change and contributing to a sustainable, zero-emission economy. Through this initiative, we aim to demonstrate the feasibility of converting CO_2 into fuels and chemicals, thereby closing the carbon loop and fostering environmental resilience.

Recommended bibliography:

Ma, Y, Wang, S & Duan, X. 2023. Recent advances in direct gas–solid-phase photocatalytic conversion of CO_2 for porous photocatalysts under different CO_2 atmospheres. *Chemical Engineering Journal*. 455:140654. http://doi.org/10.1016/j.cej.2022.140654

Nascimento, LL, Carvalho Souza, RA, Zacour Marinho, J, Wang, C & Patrocinio, AOT. 2024. Light-driven conversion of biomass-derived compounds into green fuels and chemicals. *Journal of Cleaner Production*. 449:141709. http://doi.org/10.1016/j.jclepro.2024.141709.

Paulista, LO, Ferreira, AFP, Rodrigues, AE, Martins, RJE, Boaventura, RAR, Vilar, VJP & Silva, TFC V. 2024. Solar thermo-photocatalytic methanation using a bifunctional RuO_2:TiO_2/Z13X photocatalyst/adsorbent material for efficient CO_2 capture and conversion. *Journal of Environmental Chemical Engineering*. 12(3):112418. http://doi.org/10.1016/j.jece.2024.112418

Yuan, Z, Zhu, X, Gao, X, An, C, Wang, Z, Zuo, C, Dionysiou, DD, He, H, et al. 2024. Enhancing photocatalytic CO_2 reduction with TiO_2-based materials: Strategies, mechanisms, challenges, and perspectives. *Environmental Science and Ecotechnology*. 20:100368. http://doi.org/10.1016/j.ese.2023.100368.

Prerequisites / Remarks: *While a background in Environmental Engineering, Materials Science, or Chemical Engineering is recommended, candidates with related degrees or interdisciplinary backgrounds may also be considered based on their qualifications and research interests.*

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Doctoral supervisor,

Prof. Dr. Luminița ANDRONIC

Coordinator of the field of doctoral studies,

Prof. Dr. Luminița ANDRONIC