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Final Referee Report – PhD Dissertation Defense

Candidate: Esther Osei Akuo-ko

Title: *The Role of Geology Formation and Anthropogenic Activities in Radionuclide Distribution in Selected Regions in Ghana*

University: University of Pannonia
Doctoral School: Chemical Engineering and Material Sciences
Reviewer: Robert-Csaba Begy (PhD), Assoc. Prof., Babes-Bolyai University

The doctoral dissertation authored by Ms. Esther Osei Akuo-ko presents a scientifically robust and regionally significant investigation into the environmental distribution of radionuclides in Ghana. The research evaluates both naturally occurring radioactive materials (NORM) and technologically enhanced naturally occurring radioactive materials (TENORM) across multiple environmental media, including soil, sediment, water, indoor air, and tobacco products.

From a scientific standpoint, the work contributes novel regional data and interprets it using internationally standardized methodologies. While similar frameworks have been applied in other parts of the world, the originality of this dissertation lies in its geographic focus and the integration of multiple exposure pathways within a single research framework.

The candidate's research successfully meets all the scientific merit criteria expected of an independent researcher. The research and experiments are well-conceived, addressing a timely and region-specific problem of growing importance. The objectives are coherent, and the scope is ambitious yet effectively managed. The candidate employed appropriate analytical tools, including gamma and alpha spectrometry, radon detection systems, and multivariate statistical methods. The application of techniques such as Principal Component Analysis (PCA), Pearson correlation, and geospatial interpolation (IDW, OK, EBK) adds depth and credibility to the analysis.

Additionally, the results indicate that while certain regions—particularly near artisanal mining sites and some coastal zones—show elevated radioactivity levels, most measured values remain within internationally accepted safety thresholds. Notably, findings related to indoor radon and cigarette-related Po-210 exposure highlight potential public health risks that warrant regulatory and policy attention.

It is also the first known study in Ghana to:

- Map indoor radon distribution across the Greater Accra Region.
- Investigate Po-210 levels in commercial cigarettes sold in Ghana.
- Evaluate the radiation exposure and lung cancer risks associated with both environmental and lifestyle-related sources.

The research contributes baseline data valuable for national environmental monitoring programs, especially in the context of increasing unregulated mining and urban expansion in Ghana.

The submitted thesis adheres to academic norms, with a clear structure, well-organized figures and tables, and comprehensive appendices. The formatting aligns with the University of Pannonia's requirements.

Overall, this dissertation is original, thorough, and highly relevant to both academic and policy-making audiences in the field of environmental radioactivity. It expands the scientific understanding of radiation exposure in West Africa and lays the groundwork for future regulatory and health protection measures in Ghana and similar regions. The study clearly demonstrates how geological formations and human activities influence radionuclide distribution—a critical insight for assessing and mitigating radiation-related risks. The research also provides important baseline data for future environmental monitoring, public health protection, and informed decision-making.

The candidate has demonstrated her capability through high-quality publications and active scientific engagement. I find the dissertation scientifically sound and recommend its acceptance for the award of a PhD degree, contingent upon a successful defense.

Questions for the Candidate at the Defense

1. You used multiple spatial interpolation techniques (IDW, OK, EBK) to map indoor radon levels. Can you explain why EBK was selected as the most appropriate method, and how its output supports your recommendations?

2. How would you prioritize health interventions based on your findings—indoor radon exposure vs. cigarette-related Po-210 exposure—in terms of public health strategy?

3. Did you observe any consistent statistical or spatial relationships between soil and water radioactivity levels in mining regions that could suggest contaminant transfer? If so, how can this inform environmental monitoring?

Cluj-Napoca , 2025.06.17

dr. Begy Róbert-Csaba

Associate professor