

REVIEW

of the work by Yespolayeva Aikerim Ryskulovna on the topic “Assessment of the contribution of Oil and Gas production complex to the formation of the ecological state of Mangystau region”, submitted as a dissertation for the degree of Doctor of Philosophy (PhD) in the specialty 6D060800 – Ecology

№ п/п	Criteria	Compliance with the Criteria (underline one of the options)	Justification of the Official Reviewer’s Position (comments in italics)
1.	The Dissertation Topic (as of the Date of Its Approval) Complies with the Directions of Scientific Development and/or State Programs	<p>1.1 Compliance with Priority Directions of Scientific Development or State Programs:</p> <p>1) The dissertation was carried out within a project or target program funded from the state budget (indicate the name and number of the project or program);</p> <p>2) The dissertation was carried out within another state program (indicate the name of the program);</p> <p>3) The dissertation corresponds to a priority direction of scientific development approved by the Supreme Scientific and Technical Commission under the Government of the Republic of Kazakhstan (indicate the direction).</p>	<p>The present dissertation is part of the grant-funded project of the Ministry of Education and Science of the Republic of Kazakhstan No. 0589/GF4, which focuses on developing a method to objectify expert assessments of the contribution of individual pollution sources to a territory’s environmental state. The project was carried out in alignment with the national priorities for scientific and technological development in ecology and the rational use of natural resources.</p>
2.	Scientific Significance	The research makes /does not make a substantial contribution to science, and its importance is clearly/insufficiently substantiated.	The research provides a substantial contribution to the scientific field, and its relevance is clearly substantiated. The findings enable an objective evaluation of the influence of individual pollution sources on the overall environmental state, which represents a complex scientific

			challenge. The developed method provides a means for the practical application of the principle by quantitatively assessing the additional impact of oil and gas enterprises on the transformation of environmental components..
3.	Principle of Independence	Level of Independence: 1) High 2) Medium 3) Low 4) No independence	Importantly, the research is conducted in accordance with the Principle of Independence , ensuring that all assessments and interpretations are unbiased, objective, and free from external influence. This guarantees that the results can be relied upon for informed decision-making and fair implementation of environmental management policies.
4.	Principle of Internal Unity	4.1 Justification of the Relevance of the Dissertation: 1) substantiated 2) partially substantiated 3) not substantiated	Conventional regional environmental assessments based on monitoring data allow evaluation of the overall industrial impact but do not make it possible to determine the contributions of specific sectors or individual enterprises. This research addresses this gap by assessing the role of the oil and gas sector in shaping the environmental situation of the Mangystau region through a novel theoretical approach—the inverse problem of comprehensive environmental assessment—highlighting its relevance from both scientific and practical perspectives.
		4.2 The Content of the Dissertation Reflects the Topic of the Dissertation: 1) reflects 2) partially reflects 3) does not reflect	The content of the dissertation fully corresponds to its stated topic. The research results are documented in a monograph and a series of sixteen scientific publications, including two articles in journals indexed in SCOPUS and Web of Science , eight articles in publications recommended by the Committee for Quality Assurance in the Field of Science and Higher Education of the Ministry of Education and Science of the Republic of Kazakhstan , and four articles in the proceedings of international conferences.
		4.3. The Aim and Objectives Correspond to the Dissertation Topic: 1) correspond 2) partially correspond 3) do not correspond	The dissertation clearly establishes a logical and coherent connection between the theoretical framework of the research and the practical analysis performed, providing a solid basis for addressing the identified scientific and applied problems, as well as for defining the aim and objectives.

		<p>4.4 All Sections and Provisions of the Dissertation Are Logically Interconnected:</p> <ol style="list-style-type: none"> 1) fully interconnected 2) partially interconnected 3) not interconnected 	<p>All parts and propositions of the dissertation are logically and systematically arranged, providing complete alignment between the theoretical basis and the practical outcomes of the study.</p>
		<p>4.5 The New Solutions (Principles, Methods) Proposed by the Author Are Substantiated and Evaluated in Comparison with Known Solutions:</p> <ol style="list-style-type: none"> 1) critical analysis is provided 2) analysis is partial 3) analysis consists of citations rather than the author's own opinions 4) analysis is absent 	<p>The dissertation research presents the development of techniques for addressing the problem of comprehensive environmental assessment. The fundamental distinction of the proposed approaches from existing methods lies in the use of multidimensional models (objective functions in the form of multiple linear regression equations). The capabilities of these models significantly surpass those of the traditionally employed GIS overlay operations, which allow identification of intersections involving no more than three factors. The methodology proposed by the author demonstrates that, to achieve an acceptable level of assessment accuracy, at least five significant variables must be considered, ensuring a more precise and objective determination of the contribution of individual pollution sources, thereby emphasizing the novelty of the research.</p>
5.	Principle of Scientific Novelty	<p>5.1 Are the Scientific Results and Statements Novel?</p> <ol style="list-style-type: none"> 1) completely novel 2) partially novel (25–75% are new) 3) not novel (less than 25% are new) 	<p>The dissertation research provides novel scientific results and insights, notably the development of techniques for tackling the “inverse” problem of comprehensive environmental assessment, the application of multidimensional models for the quantitative evaluation of individual pollution sources, and the implementation of the “polluter pays” principle in the financial support of environmental protection measures. These approaches have not been previously applied in comparable studies and represent an original contribution to the field of science.</p>
		<p>5.2 Are the Conclusions of the Dissertation Novel?</p> <ol style="list-style-type: none"> 1) completely new 2) partially new (25–75% are new) 3) not new (less than 25% are new) 	<p>Developed algorithms for generalized and differentiated solutions of the inverse problem of comprehensive environmental assessment, enabling objective evaluation of the contribution of individual pollution sources to the overall environmental situation. Created an algorithm to transform a three-level groundwater</p>

			<p>assessment scale into the classical five-level scale using a groundwater vulnerability map.</p> <p>Constructed generalized and specific objective functions to quantify the contribution of oil and gas development companies (OGDC) to disturbances in relief, soils, vegetation, and groundwater in the Mangystau region, and provided an integrated solution for all environmental components.</p>
		<p>5.3 Are the Technical, Technological, Economic, or Managerial Solutions Novel and Substantiated?</p> <p>1) completely new 2) partially new (25–75% are new) 3) not new (less than 25% are new)</p>	<p>Technical and Technological Solutions:</p> <ul style="list-style-type: none"> Developed algorithms for generalized and differentiated solutions of the inverse problem of comprehensive environmental assessment, enabling precise quantification of individual pollution sources. Created a grid-based differentiated assessment method to delineate zones of influence of various anthropogenic sources, which can be applied in practice to monitor and manage environmental impacts. <p>Economic Solutions:</p> <ul style="list-style-type: none"> Proposed an approach for implementing the “polluter pays” principle, allowing for differentiated environmental charges based on the quantified contribution of oil and gas companies to environmental disturbances.
6.	Justification of the Main Conclusions	<p>All main conclusions are based/not based on substantial scientific evidence or are sufficiently well justified (for qualitative research and fields in arts and humanities).</p>	<p>All main conclusions of the dissertation are based on substantial scientific evidence and are sufficiently well justified. The conclusions are supported by:</p> <p>Analytical calculations and numerical experiments demonstrating the accuracy and reliability of the proposed models; Field data, including soil and vegetation sampling and laboratory analyses conducted in the UK; Comparative analysis of methodologies and validation against existing environmental assessment techniques; Integration of theoretical developments with practical application, ensuring the robustness and applicability of the results.</p>

7.	<p>Main Statements Proposed for Defense или Principal Propositions for Defense.</p>	<p>It is necessary to answer the following questions for each proposition separately:</p> <p>7.1 Is the proposition proven?</p> <ol style="list-style-type: none"> 1) proven 2) rather proven 3) rather not proven 4) not proven 5) it is impossible to verify the proposition in its current formulation <p>7.2 Is it trivial?</p> <ol style="list-style-type: none"> 1. yes 2. no 3. it is impossible to verify triviality in its current formulation <p>7.3 Is it novel?</p> <ol style="list-style-type: none"> 1. yes 2. no 3. it is impossible to verify novelty in its current formulation <p>7.4 Level of applicability:</p> <ol style="list-style-type: none"> 1. narrow 2. medium 3. broad 4. it is impossible to verify the level of applicability in its current formulation <p>7.5 Is it proven in the article?</p> <ol style="list-style-type: none"> 1. yes 2. no 3. it is impossible to verify whether 	<p>Proposition</p> <p>Algorithms for generalized and differentiated solutions of the inverse problem of comprehensive environmental assessment allow for objective determination of the contribution of individual pollution sources to the overall environmental situation.</p> <p>Evaluation:</p> <ul style="list-style-type: none"> • 7.1 Is the proposition proven? – 1) proven • 7.2 Is it trivial? – 2) no • 7.3 Is it novel? – 1) yes • 7.4 Level of applicability – 3) broad • 7.5 Is it proven in the article? – 1) yes <p>Proposition 2:</p> <p>Environmental assessment was conducted for various components of the natural environment, including relief, soils, vegetation, and groundwater. A comparison of methodologies was performed, confirming high assessment accuracy (error below 1.7%) and revealing that the impact of oil and gas production companies (OGPC) exceeds regional averages. These results were achieved using generalized and differentiated methods.</p> <p>Evaluation:</p> <ul style="list-style-type: none"> • 7.1 Is the proposition proven? – 1) proven • 7.2 Is it trivial? – 2) no • 7.3 Is it novel? – 1) yes • 7.4 Level of applicability – 3) broad • 7.5 Is it proven in the article? – 1) yes <p>Proposition 3:</p> <p>A differentiated environmental assessment was implemented, allowing identification of zones with varying degrees of oil and gas sector (OGS) impact and determination of blocks where the impact of other sources exceeds the sector's contribution. Measures for environmental regulation and</p>

		<p>it is proven in the article in its current formulation</p>	<p>optimization of the system of environmental payments were proposed. The grid-based approach was applied using generalized and differentiated methods.</p> <p>Evaluation:</p> <ul style="list-style-type: none"> • 7.1 Is the proposition proven? – 1) proven • 7.2 Is it trivial? – 2) no • 7.3 Is it novel? – 1) yes • 7.4 Level of applicability – 3) broad • 7.5 Is it proven in the article? – 1) yes
8.	<p>Principle of Reliability Reliability of Sources and Provided Information</p>	<p>8.1 Choice of Methodology – Is It Justified or Is the Methodology Described in Sufficient Detail:</p> <ol style="list-style-type: none"> 1) yes 2) no 	<p>The methodology is fully justified and described in sufficient detail. The dissertation provides a clear explanation of the generalized and differentiated methods used for environmental assessment, including algorithms for solving the inverse problem, construction of objective functions, numerical experiments, and field data collection. This ensures reproducibility of the research and allows independent verification of the results.</p>
		<p>The Results of the Dissertation Were Obtained Using Modern Scientific Research Methods and Data Processing and Interpretation Techniques with the Use of Computer Technologies:</p> <ol style="list-style-type: none"> 1) yes 2) no 	<p>The dissertation results were obtained using modern scientific research methods, including field sampling, laboratory analysis, numerical modeling, and statistical data processing. Advanced computer technologies were employed for processing large datasets, solving the inverse problem of comprehensive environmental assessment, and constructing multidimensional models, ensuring high accuracy, reliability, and reproducibility of the results.</p>
		<p>8.3 Theoretical findings, models, and identified interrelationships are validated and confirmed through experimental research (in educational fields, via pedagogical experiments):</p>	<p>The theoretical findings, models, and identified interrelationships were validated through extensive experimental research. This includes numerical simulations, analytical calculations, and field studies such as soil and vegetation sampling near oil and gas facilities. The results confirmed the accuracy of the models, the reliability of the generalized</p>

			and differentiated methods, and the validity of the identified contributions of individual pollution sources to the overall environmental situation.
		8.4 Important statements are supported / partially supported / not supported by references to relevant and reliable scientific literature.	Important statements in the dissertation are fully supported by references to relevant and reliable scientific literature. The work cites national and international studies, including peer-reviewed journal articles indexed in SCOPUS and Web of Science, publications recommended by the Ministry of Education and Science of the Republic of Kazakhstan, and conference proceedings. This ensures that the theoretical foundations, methodology, and results are grounded in established scientific knowledge..
		8.5 Are the sources of literature used sufficient/insufficient for the literature review?	The sources of literature used in the dissertation are sufficient for a comprehensive literature review. They include a balanced mix of national and international publications, peer-reviewed journal articles indexed in SCOPUS and Web of Science, recommended publications by the Ministry of Education and Science of the Republic of Kazakhstan, and conference proceedings. This ensures a thorough coverage of theoretical and methodological developments relevant to the research topic.
9	Principle of Practical Significance	9.1 Does the dissertation have theoretical significance? 1. yes 2. no	The dissertation research has theoretical significance, as it develops new approaches to solving the "inverse" problem of comprehensive environmental assessment, establishes methods for the quantitative evaluation of the contribution of individual pollution sources, and identifies patterns of the impact of the oil and gas production complex on components of the natural environment, thereby expanding theoretical understanding in the field of environmental science. The dissertation also has methodological significance, serving as a basis for assessing the impacts of various sources in different regions
		9.2 Does the dissertation have practical significance, and is there a high likelihood of applying the obtained results in practice? 1. yes	The dissertation has clear theoretical significance. It develops methods for solving the "inverse" problem of comprehensive environmental assessment, proposes multidimensional models for evaluating individual pollution sources, and identifies interrelationships between environmental components affected by oil and gas activities. These

		<p>2. no</p>	<p>contributions advance the theoretical understanding of environmental impact assessment and provide a basis for further scientific research in ecology and environmental management.</p>
		<p>9.3 Are the practical recommendations novel?</p> <ol style="list-style-type: none"> 1. completely new 2. partially new (25–75% are new) 3. not new (less than 25% are new) 	<p>The practical recommendations presented in the dissertation are novel. They include differentiated environmental assessment methods for identifying zones of varying impact from oil and gas activities, proposals for optimizing the system of environmental payments, and approaches for implementing the “polluter pays” principle based on quantified contributions of individual pollution sources. These recommendations have not been previously applied in similar studies and provide new tools for environmental management and regulation.</p>
10.	Quality of Academic Writing and Organization	<p>The quality of academic writing is:</p> <ol style="list-style-type: none"> 1. high 2. medium 3. below average 4. low 	<p>The dissertation is written in clear, precise, and academically appropriate language. Terminology is used consistently, complex concepts are explained logically, and the text demonstrates coherence and structure across all sections. Figures, tables, and references are properly integrated, contributing to readability and the professional presentation of the research.</p>
11.	Comments on the Dissertation	<p>The dissertation presents a comprehensive and well-structured study on the assessment of environmental impacts of the oil and gas sector in the Mangystau region. The research demonstrates a clear connection between theoretical development and practical application, with methods rigorously tested using field data, numerical modeling, and statistical analysis.</p> <p>The dissertation makes a significant contribution to both science and practice: Novel methods for solving the inverse problem of comprehensive environmental assessment were developed and validated.</p> <p>Differentiated and generalized environmental assessment methods provide reliable tools for quantifying the contribution of individual pollution sources.</p> <p>Practical recommendations for environmental management, including implementation of the “polluter pays” principle and optimization of environmental payments, are original and applicable.</p> <p>The writing is of high academic quality, and all important statements are well-supported by references to relevant literature. Figures, tables, and methodological descriptions are clearly presented, ensuring reproducibility of results.</p> <p>Overall, the dissertation demonstrates theoretical significance, practical applicability, and novelty, and it provides a solid foundation for further research in environmental assessment and management.</p>	

<p>Scientific Level of the Doctoral Candidate's Articles on the Research Topic (In the case of defending a dissertation in the form of a series of articles, official reviewers comment on the scientific level of each article by the doctoral candidate on the research topic)</p>	<p>The doctoral candidate's research addresses the assessment of the ecological state of territories in the Mangystau region based on various types of environmental monitoring. The work develops novel methods for solving the inverse problem of comprehensive and partial environmental assessment, enabling the quantification of individual sources' contributions to overall environmental impacts, which is essential for implementing the "polluter pays" principle.</p> <p>Two main approaches are proposed: a generalized integral assessment and a differentiated spatial assessment, both based on expert-derived environmental evaluation maps. The generalized method aggregates impacts across the entire territory, while the differentiated method provides block-level analysis, capturing spatial variability of anthropogenic influence. The methodology employs GIS-based transformation of cartographic data into quantitative formats, objective function modeling, and weighted averaging to ensure scientific rigor.</p> <p>The candidate's publications present the theoretical foundations, detailed calculations, and interpretation of results, demonstrating high scientific value, methodological novelty, and practical relevance. The research provides reliable tools for environmental management and constitutes a significant contribution to the theory and practice of ecological assessment.</p>
<p>Official Reviewer's Recommendation (as stipulated in clause 28 of the present Model Regulation)</p>	<p>It is recommended that Yespolayeva Aikerim Ryskulovna be conferred the degree of Doctor of Philosophy (PhD) in the specialty of 6D060800 Ecology.</p>

Official Reviewer

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Signature: _____



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