

## REVIEW

**of the work by Aikerim Ryskulovna Yespolayeva 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) <b>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);</b></p> <p>2) The dissertation was carried out within another state program (indicate the name of the program);</p> <p>3) <b>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).</b></p>	<p>The dissertation research was carried out within the framework of the grant-funded project of the Ministry of Education and Science of the Republic of Kazakhstan No. 0589/GF4, “Development of a Method for Objectifying Expert Assessments of the Contribution of Individual Pollution Sources to the Overall Environmental Situation of a Territory” This project was implemented in accordance with the priority direction of scientific development of the Republic of Kazakhstan in the field of ecology and rational use of natural resources.</p>
2.	Scientific Significance	The <b>research makes</b> /does not make a substantial contribution to science, and its importance is clearly/insufficiently substantiated.	The <b>research makes</b> a significant contribution to science, and its importance is clearly demonstrated. The results allow independent assessment of the contribution of individual pollution sources to the overall environmental situation, a task that is scientifically complex.

			The developed approach, based on the inverse problem of Quantitative Environmental Assessment (QEA), enables practical implementation of the “polluter pays” principle by quantifying the additional impact of oil and gas companies on the transformation of environmental components
3.	Principle of Independence	<p><b>Level of Independence:</b></p> <ol style="list-style-type: none"> <li>1) <b>High</b></li> <li>2) Medium</li> <li>3) Low</li> <li>4) No independence</li> </ol>	<p>Level of Independence:</p> <p><b>High</b></p> <p>Selected results and sections of the dissertation were presented and discussed at various international conferences during 2014–2016, including:</p> <p>Tempus I-Web, Al-Farabi Kazakh National University, “Integrating Water Cycle Management: Building Capability, Capacity and Impact in Education” (Almaty, 2015);</p> <p>“Current Problems of Hydrometeorology and Geoecology,” dedicated to the 75th anniversary of Professor V.S. Cherednichenko (Almaty, 2015);</p> <p>“Environmental Safety of Territories and Water Bodies: Regional and Global Challenges” (Kerch, 2016);</p> <p>VI International Scientific Conference on Fundamental and Applied Problems of Sustainable Development in the “Nature–Society–Human” System: Designing the Future World (Dubna, 2016).</p>
4.	Principle of Internal Unity	<p><b>4.1 Justification of the Relevance of the Dissertation:</b></p> <ol style="list-style-type: none"> <li>1) <b>substantiated</b></li> <li>2) partially substantiated</li> <li>3) not substantiated</li> </ol>	<p><b>Justification of the Relevance of the Dissertation:</b></p> <p>The relevance of the dissertation is determined by the fact that an independent assessment of the environmental situation in a region based on monitoring data allows one to evaluate the overall impact of all industries combined, but does not provide the possibility to determine the contribution of specific sectors or individual enterprises to total pollution. Therefore, the research topic, aimed at identifying the role of the oil and gas sector in shaping the environmental situation of the Mangystau region through solving a theoretical problem new to</p>

		environmental science—the inverse problem of comprehensive environmental assessment—is relevant from both scientific and practical perspectives.
	<p><b>4.2 The Content of the Dissertation Reflects the Topic of the Dissertation:</b></p> <ol style="list-style-type: none"> <li>1) reflects</li> <li>2) partially reflects</li> <li>3) does not reflect</li> </ol>	<p>The Content of the Dissertation Reflects the Topic of the Dissertation: The dissertation fully corresponds to the stated topic. The research results are presented in 1 monograph and 16 scientific publications, including:</p> <p>2 articles in journals indexed in SCOPUS and Web of Science;  8 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;  4 articles in the proceedings of international conferences.</p>
	<p><b>4.3. The Aim and Objectives Correspond to the Dissertation Topic:</b></p> <ol style="list-style-type: none"> <li>1) correspond</li> <li>2) partially correspond</li> <li>3) do not correspond</li> </ol>	<p>The aim and objectives of the dissertation research are clearly formulated and fully correspond to the topic of the work, ensuring a logical connection between the theoretical foundation of the study and the practical analysis.</p>
	<p><b>4.4 All Sections and Provisions of the Dissertation Are Logically Interconnected:</b></p> <ol style="list-style-type: none"> <li>1) fully interconnected</li> <li>2) partially interconnected</li> <li>3) not interconnected</li> </ol>	<p>All sections and statements of the dissertation are logically and consistently structured, ensuring complete interconnection between the theoretical foundations and the practical results of the work.</p>
	<p><b>4.5 The New Solutions (Principles, Methods) Proposed by the Author Are Substantiated and Evaluated in Comparison with Known Solutions:</b></p> <ol style="list-style-type: none"> <li>1) critical analysis is provided</li> </ol>	<p>The novelty of the dissertation research lies in the development of methods for solving a new theoretical problem—the “inverse” problem of comprehensive environmental assessment. The fundamental distinction of the proposed approaches from existing methods is the use of multidimensional models (target functions in the form of multiple</p>

		<ul style="list-style-type: none"> <li>2) analysis is partial</li> <li>3) analysis consists of citations rather than the author's own opinions</li> <li>4) analysis is absent</li> </ul>	<p>linear regression equations). The capabilities of these models significantly surpass the traditionally used GIS overlay operations, which allow identification of intersections of no more than three parameters. The methodology proposed by the author demonstrates that, to achieve acceptable assessment accuracy, at least five significant parameters must be considered, ensuring a more precise and objective determination of the contribution of individual pollution sources.</p>
5.	Principle of Scientific Novelty	<p>5.1 Are the Scientific Results and Statements Novel?</p> <ul style="list-style-type: none"> <li>1) <b>completely novel</b></li> <li>2) partially novel (25–75% are new)</li> <li>3) not novel (less than 25% are new)</li> </ul> <p>5.2 Are the Conclusions of the Dissertation Novel?</p> <ul style="list-style-type: none"> <li>1) <b>completely new</b></li> <li>2) partially new (25–75% are new)</li> <li>3) not new (less than 25% are new)</li> </ul> <p>5.3 Are the Technical, Technological, Economic, or Managerial Solutions Novel and Substantiated?</p> <ul style="list-style-type: none"> <li>1) <b>completely new</b></li> <li>2) partially new (25–75% are new)</li> <li>3) not new (less than 25% are new)</li> </ul>	<p>The dissertation research presents novel scientific results and propositions, in particular the development of methods for solving 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 economic support of environmental protection measures. These approaches have not been previously applied in similar studies and represent an original contribution to science.</p> <p>Calculations were carried out for various components of the natural environment (relief, soils, vegetation, groundwater), and a comparison of methodologies was performed. High accuracy of the assessments was confirmed (error less than 1.7%), and an increased impact of oil and gas companies was identified compared to average regional values</p> <p>The Technical, Technological, Economic, or Managerial Solutions Are Novel and Substantiated</p> <p>2The novelty of the proposed solutions lies in substantiating the role of the oil and gas sector in the socio-economic development of the region, identifying the limitations of existing environmental monitoring systems, and highlighting the need for comprehensive assessments. Approaches are proposed for implementing the “polluter pays” principle and utilizing modern mapping methods for conducting independent systemic assessments, which enhances their practical significance</p>

6.	Justification of the Main Conclusions	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><b>All main conclusions are based on substantial scientific evidence or are sufficiently well justified:</b></p> <p>All main conclusions of the dissertation are supported by substantial scientific evidence and are thoroughly justified. The obtained results allow the application of the developed methods for environmental regulation, planning of environmental protection measures, and differentiated ecological management in the region.</p>
7.	Main Statements Proposed for Defense или Principal Propositions for Defense.	<p>It is necessary to answer the following questions for each proposition separately:</p> <p><b>7.1 Is the proposition proven?</b></p> <ol style="list-style-type: none"> <li>1) proven</li> <li>2) rather proven</li> <li>3) rather not proven</li> <li>4) not proven</li> <li>5) it is impossible to verify the proposition in its current formulation</li> </ol> <p><b>7.2 Is it trivial?</b></p> <ol style="list-style-type: none"> <li>1. yes</li> <li>2. no</li> <li>3. it is impossible to verify triviality in its current formulation</li> </ol> <p><b>7.3 Is it novel?</b></p> <ol style="list-style-type: none"> <li>1. yes</li> <li>2. no</li> <li>3. it is impossible to verify novelty in its current formulation</li> </ol> <p><b>7.4 Level of applicability:</b></p> <ol style="list-style-type: none"> <li>1. narrow</li> <li>2. medium</li> <li>3. broad</li> <li>4. it is impossible to verify the level of applicability in its current</li> </ol>	<p><b>Proposition 1:</b></p> <p>Calculations were performed for various components of the natural environment (relief, soils, vegetation, groundwater), and a comparison of methodologies was conducted. The accuracy of the assessments was confirmed (error less than 1.7%), and an increased impact of the oil and gas sector (OGS) was identified compared to average regional values.</p> <p>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> <p><b>Proposition 2:</b></p> <p>Methods for generalized and differentiated environmental assessment were developed and tested for various components of the natural environment; a comparison of methodologies was carried out, high assessment accuracy was confirmed (error less than 1.7%), and an increased impact of the OGPC was identified compared to average regional values.</p> <p>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</p>

		<p>formulation</p> <p><b>7.5 Is it proven in the article?</b></p> <ol style="list-style-type: none"> <li>1. yes</li> <li>2. no</li> <li>3. it is impossible to verify whether it is proven in the article in its current formulation</li> </ol>	<p><b>7.5 Is it proven in the article?</b> – 1) yes</p> <p><b>Proposition</b> <span style="float: right;"><b>3:</b></span>  A differentiated environmental assessment was implemented, allowing identification of zones with varying degrees of OGS impact and determination of blocks where the impact of other sources exceeds the sector’s contribution; measures for environmental regulation and optimization of the system of environmental payments were proposed.</p> <p><b>7.1 Is the proposition proven?</b> – 1) proven</p> <p><b>7.2 Is it trivial?</b> – 2) no</p> <p><b>7.3 Is it novel?</b> – 1) yes</p> <p><b>7.4 Level of applicability</b> – 3) broad</p> <p><b>7.5 Is it proven in the article?</b> – 1) yes</p>
8.	<p><b>Principle of Reliability</b></p> <p><b>Reliability of Sources and Provided Information</b></p>	<p><b>8.1 Choice of Methodology – Is It Justified or Is the Methodology Described in Sufficient Detail:</b></p> <ol style="list-style-type: none"> <li>1) yes</li> <li>2) no</li> </ol> <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"> <li>1) yes</li> <li>2) no</li> </ol>	<p>The choice of research methodology is justified by the interdisciplinary nature of the study (GIS technologies, cartographic, field, and analytical methods), and is thoroughly described and supported by the obtained scientific results, ensuring the reliability and reproducibility of the conducted research. The methodology is described in sufficient detail.</p> <p>The research results were obtained using modern methods of data analysis and processing, including computer modeling and GIS technologies, which ensure accuracy, clarity, and the practical applicability of the developed approaches. The use of statistical analysis methods (mathematical statistics) confirms the reliability of the results.</p>

		<p>8.3 Theoretical findings, models, and identified interrelationships are validated and confirmed through <b>experimental research</b> (in educational fields, via pedagogical experiments):</p>	<p>The theoretical conclusions, developed models, and identified relationships and patterns are confirmed by the results of calculations and data analysis for various components of the natural environment, ensuring the scientific validity and practical applicability of the obtained results.</p>
		<p>8.4 Important statements <b>are supported</b> / partially supported / not supported by references to relevant and reliable scientific literature.</p>	<p>All key assertions of the dissertation are based on relevant and reliable scientific sources, including publications in peer-reviewed journals, materials from international conferences, and official reports on environmental monitoring, ensuring the scientific validity of the work.</p>
		<p>8.5 Are the sources of literature used <b>sufficient/insufficient</b> for the literature review?</p>	<p>The literature review of the dissertation is based on a wide range of relevant and reliable sources, including peer-reviewed journal articles, monographs, and materials from international conferences, ensuring a comprehensive and systematic analysis of the research topic. The number of primary sources used (118) from both domestic and foreign researchers is sufficient for the literature review.</p>
<p>9</p>	<p><b>Principle of Practical Significance</b></p>	<p>9.1 <b>Does the dissertation have theoretical significance?</b>  1. yes  2. no</p>	<p>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</p>
		<p>9.2 <b>Does the dissertation have practical significance, and is there a high likelihood of applying the obtained results in practice?</b>  1. yes  2. no</p>	<p>The dissertation research has high practical significance: the developed methods of environmental assessment and differentiated standardization can be used for planning environmental protection measures, managing ecological risks, and optimizing the system of environmental payments at the regional level. The obtained results make it possible to enhance the effectiveness of environmental regulation and the sustainable development of oil and gas regions. The likelihood of practical application of the results is high</p>

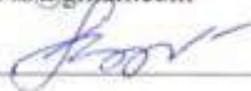
		<p><b>9.3 Are the practical recommendations novel?</b></p> <ol style="list-style-type: none"> <li>1. <b>completely new</b></li> <li>2. partially new (25–75% are new)</li> <li>3. not new (less than 25% are new)</li> </ol>	<p>The novelty of the practical recommendations lies in the application of the developed methods for environmental assessment and differentiated regulation for planning environmental protection measures, managing ecological risks, and optimizing the system of environmental payments. Some recommendations are based on the adaptation of existing approaches, while others are derived from the author’s new methodological developments.</p>
10.	<b>Quality of Academic Writing and Organization</b>	<p><b>The quality of academic writing is:</b></p> <ol style="list-style-type: none"> <li>1. <b>high</b></li> <li>2. medium</li> <li>3. below average</li> <li>4. low</li> </ol>	<p>The dissertation is written at a high academic level: the text is logically structured, the argumentation is consistent, the terminology corresponds to the scientific discipline, and the writing style allows the theoretical and practical results of the research to be presented clearly and coherently</p>
11.	<b>Comments on the Dissertation</b>	<ol style="list-style-type: none"> <li>1. To improve clarity, it is recommended to provide a more detailed description of the procedure for constructing target functions and the calculation algorithms.</li> <li>2. It is necessary to specify the data sources and the criteria for identifying zones with different levels of oil and gas production complex impact. This will make the reproducibility of the results more evident and facilitate the practical application of the proposed methods.</li> <li>3. It is recommended to clearly define the relationship between the generalized and differentiated assessment methods, their mutual advantages, and limitations.</li> <li>4. Consider providing a brief explanation of how the internal relationships between components of the natural environment are accounted for in the integral assessment to emphasize the scientific novelty of the approach and the validity of the applied methodologies.</li> </ol>	
12.	<p><b>Scientific Level of the Doctoral Candidate’s Articles on the Research Topic</b>  (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>All the doctoral candidate’s articles included in the dissertation demonstrate high scientific value and relevance to the research topic. The publications comprise articles in journals indexed in SCOPUS and Web of Science, articles in peer-reviewed journals recommended by the Ministry of Science and Higher Education of the Republic of Kazakhstan, as well as materials from international conferences. The articles present the theoretical justification of the methods, descriptions of the calculations performed, and interpretation of the results, confirming the high level of scientific analysis and the practical significance of the work</p>	

13.	Official Recommendation (as stipulated in clause 28 of the present Model Regulation)	Reviewer's It is recommended that Aikerim Ryskulovna Yespolayeva be conferred the degree of Doctor of Philosophy (PhD) in the specialty of 6D060800 Ecology.
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**Official Reviewer**

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