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ENVIRONMENTAL AUDIT AS AN ACCOUNTING AND ANALYTICAL TOOL FOR ENSURING SUSTAINABLE DEVELOPMENT IN THE REPUBLIC OF KAZAKHSTAN

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Annotation. The article considers environmental audit as an accounting and analytical tool for ensuring sustainable development in the Republic of Kazakhstan. The relevance of the study is due to increasing environmental challenges, growing requirements for the reliability of environmental reporting, the need to improve the transparency of environmental costs and the strengthening of the role of audit procedures in assessing environmental risks. The purpose of the study is to reveal the role of environmental audit as a tool for ensuring sustainable development in Kazakhstan, taking into account its accounting and analytical aspect. The methodological basis of the research consists of systematic, comparative, dynamic, structural, accounting-analytical and risk-oriented approaches. The empirical base of the study includes official statistical data of the Republic of Kazakhstan for 2020–2025, materials from the Bureau of National Statistics, regulatory legal acts and analytical sources on environmental protection, environmental reporting and audit. The results of the study showed that in 2020–2023 there was a decrease in pollutant emissions from stationary sources in Kazakhstan; however, in 2024 their growth was recorded. At the same time, the dynamics of environmental costs

was characterized by instability: after an increase in 2020–2023, they decreased in 2024–2025. This indicates that environmental audit should be considered not only as a compliance verification procedure, but also as an accounting and analytical mechanism for assessing the relationship between environmental impact, environmental costs, reporting quality and sustainable development priorities. The practical significance of the study lies in substantiating the need to strengthen the accounting and analytical component of environmental audit in order to improve the transparency of environmental information and support management decisions in the field of sustainable development.

Keywords: environmental audit, sustainable development, Republic of Kazakhstan, environmental reporting, environmental accounting, environmental costs, environmental risks, accounting and analytical analysis

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ҚАЗАҚСТАН РЕСПУБЛИКАСЫНДА ОРНЫҚТЫ ДАМУДЫ ҚАМТАМАСЫЗ ЕТУДІҢ ЕСЕПKE АЛУ-ТАЛДАУ ҚҰРАЛЫ РЕТІНДЕ ЭКОЛОГИЯЛЫҚ АУДИТ

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Аннотация. Мақалада Қазақстан Республикасында тұрақты дамуды қамтамасыз етудің есептік-талдамалық құралы ретінде экологиялық аудит қарастырылады. Зерттеудің өзектілігі экологиялық сын-қатерлердің күшеюімен, экологиялық есептіліктің сенімділігіне қойылатын талаптардың артуымен, экологиялық шығындардың ашықтығын қамтамасыз ету қажеттілігімен және экологиялық тәуекелдерді бағалауда аудит рәсімдерінің

рөлінің өсуімен айқындалады. Зерттеудің мақсаты - экологиялық аудиттің Қазақстандағы тұрақты дамуды қамтамасыз ету құралы ретіндегі рөлін оның есептік-талдамалық аспектісін ескере отырып ашып көрсету. Зерттеудің әдіснамалық негізін жүйелік, салыстырмалы, динамикалық, құрылымдық, есептік-талдамалық және тәуекелге бағдарланған тәсілдер құрайды. Зерттеудің эмпирикалық базасы 2020–2025 жылдардағы Қазақстан Республикасының ресми статистикалық деректерін, Ұлттық статистика бюросының материалдарын, нормативтік-құқықтық актілерді және қоршаған ортаны қорғау, экологиялық есептілік пен аудит мәселелері бойынша аналитикалық дереккөздерді қамтиды. Зерттеу нәтижелері 2020–2023 жылдары Қазақстанда стационарлық көздерден ластаушы заттар шығарындыларының төмендегенін, алайда 2024 жылы олардың қайта өскенін көрсетті. Сонымен қатар, қоршаған ортаны қорғауға жұмсалатын шығындар динамикасы тұрақсыз сипатқа ие болды: 2020–2023 жылдары өскеннен кейін, 2024–2025 жылдары олардың төмендеуі байқалды. Бұл экологиялық аудитті тек сәйкестікті тексеру рәсімі ретінде ғана емес, сонымен қатар қоршаған ортаға әсер, экологиялық шығындар, есептілік сапасы және тұрақты даму басымдықтары арасындағы байланысты бағалаудың есептік-талдамалық механизмі ретінде қарастыру қажеттігін көрсетеді. Зерттеудің практикалық маңыздылығы экологиялық ақпараттың ашықтығын арттыру және тұрақты даму саласындағы басқарушылық шешімдерді қолдау мақсатында экологиялық аудиттің есептік-талдамалық құрамдасын күшейту қажеттілігін негіздеумен айқындалады.

Түйін сөздер: экологиялық аудит, орнықты даму, Қазақстан Республикасы, Экологиялық есептілік, экологиялық есеп, табиғат қорғау шығындары, экологиялық тәуекелдер, есепке алу-Талдамалық талдау

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ЭКОЛОГИЧЕСКИЙ АУДИТ КАК УЧЕТНО-АНАЛИТИЧЕСКИЙ ИНСТРУМЕНТ ОБЕСПЕЧЕНИЯ УСТОЙЧИВОГО РАЗВИТИЯ В РЕСПУБЛИКЕ КАЗАХСТАН

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Аннотация. В статье рассматривается экологический аудит как учетно-аналитический инструмент обеспечения устойчивого развития в Республике Казахстан. Актуальность исследования обусловлена усилением экологических вызовов, ростом требований к достоверности экологической отчетности, необходимостью повышения прозрачности экологических затрат и возрастанием роли аудиторских процедур в оценке экологических рисков. Цель исследования заключается в раскрытии роли экологического аудита как инструмента обеспечения устойчивого развития в Казахстане с учетом его учетно-аналитического аспекта. Методологическую основу исследования составляют системный, сравнительный, динамический, структурный, учетно-аналитический и риск-ориентированный подходы. Эмпирическая база исследования включает официальные статистические данные Республики Казахстан за 2020–2025 годы, материалы Бюро национальной статистики, нормативно-правовые акты и аналитические источники по вопросам охраны окружающей среды, экологической отчетности и аудита. Результаты исследования показали, что в 2020–2023 годах в Казахстане наблюдалось снижение выбросов загрязняющих веществ от стационарных источников, однако в 2024 году был зафиксирован их рост. В то же время динамика затрат на охрану окружающей среды характеризовалась нестабильностью: после увеличения в 2020–2023 годах в 2024–2025 годах отмечалось их снижение. Это свидетельствует о необходимости рассматривать экологический аудит не только как процедуру проверки соответствия, но и как учетно-аналитический механизм оценки взаимосвязи между воздействием на окружающую среду, экологическими затратами, качеством отчетности и приоритетами устойчивого развития. Практическая значимость исследования заключается в обосновании необходимости усиления учетно-аналитической составляющей экологического аудита для повышения прозрачности экологической информации и поддержки управленческих решений в сфере устойчивого развития.

Ключевые слова: экологический аудит, устойчивое развитие, Республика Казахстан, экологическая отчетность, экологический учет, природоохранные затраты, экологические риски, учетно-аналитический анализ

Introduction. In modern conditions, sustainable development is becoming one of the key guidelines for public policy, corporate governance and scientific research. Increased environmental challenges, increased anthropogenic pressure, the need for rational use of natural resources and increased transparency requirements for reporting necessitate the development of effective environmental monitoring and analysis tools. One of these tools is environmental audit, which allows assessing not only compliance with environmental legislation, but also the quality of

environmental accounting, reliability of reporting, effectiveness of environmental costs and the level of environmental risks.

This problem is of particular relevance for the Republic of Kazakhstan. The country's economy is largely connected with industry, energy, mining, metallurgy, transport and municipal infrastructure. These industries place a significant burden on atmospheric air, water resources, land areas and the waste management system. In this regard, Kazakhstan's environmental policy should be based not only on regulatory and legal regulation, but also on reliable accounting and analytical information that allows assessing the real impact of economic activity on the environment. That is why environmental audit is becoming important not only as a control procedure, but also as a tool for sustainable management.

The relevance of the study is reinforced by the fact that in recent years, Kazakhstan's environmental indicators have shown mixed dynamics. On the one hand, in 2020-2023, there was a decrease in pollutant emissions from stationary sources, which may indicate positive changes in environmental protection activities. On the other hand, an increase in emissions was recorded in 2024, and the dynamics of environmental costs was characterized by instability. In addition, the data for 2025 Studies on municipal waste management, water supply and sanitation show that the environmental burden persists not only in the industrial sector, but also in the public utilities and infrastructure sector. In these circumstances, there is a need for a comprehensive analysis of environmental audit as a mechanism capable of combining environmental, financial and management data.

The scientific significance of the topic lies in the need to expand the traditional understanding of environmental audit. In most cases, it is considered as a tool for verifying the compliance of an enterprise's activities with environmental requirements. However, in the context of sustainable development, this approach is insufficient. An environmental audit should include an assessment of environmental accounting, environmental costs, environmental obligations, industrial environmental control data, reporting on emissions, waste, water use and sanitation. Therefore, environmental audit should be developed as an accounting and analytical system that ensures the reliability of environmental information and its use in management decisions.

Of particular importance is the relationship between environmental audit and environmental reporting. In modern conditions, enterprises and organizations must not only comply with environmental requirements, but also provide reliable information about the environmental impact, costs of environmental protection measures, emissions, waste, water consumption and wastewater. The quality of such reporting depends on the completeness of the primary accounting, the correctness of calculations, internal control and independent verification. In this regard, environmental audit is a tool for increasing the transparency of environmental information, reducing risks and building trust on the part of the state, society, investors and other stakeholders.

The purpose of the study is to reveal the role of environmental audit as a tool

for ensuring sustainable development in the Republic of Kazakhstan, taking into account its accounting and analytical aspect.

To achieve this goal, the following tasks are defined: to analyze theoretical approaches to understanding environmental audit in the context of sustainable development; to consider the relationship between environmental audit, environmental accounting and reporting; to study the dynamics of the main environmental indicators of Kazakhstan for 2020-2025; to determine the importance of emissions, environmental costs, waste, water supply and sanitation for the formation of an environmental audit system; to identify the main environmental risk zones; to propose an accounting and analytical model of environmental audit, focused on the sustainable development of enterprises.

The object of the study is the environmental audit system in the Republic of Kazakhstan. The subject of the research is the accounting and analytical aspects of environmental audit related to the assessment of environmental indicators, environmental costs, environmental obligations, reporting and risks of sustainable development.

The methodological basis of the research consists of systematic, comparative, dynamic, structural, accounting-analytical and risk-oriented approaches. The empirical base of the study includes official statistical data of the Republic of Kazakhstan for 2020-2025, materials from the Bureau of National Statistics, the Ministry of Ecology and Natural Resources, RSE Kazhydromet, as well as regulatory provisions in the field of environmental protection. The use of these methods allows us to consider environmental audit not only as a form of control, but also as an integrated mechanism for information support of sustainable development.

The scientific novelty of the study is the substantiation of environmental audit as an integrated accounting and analytical tool combining environmental, financial and management indicators. In contrast to approaches limited to regulatory compliance verification, the article considers environmental audit as a system that allows assessing the effectiveness of environmental costs, the reliability of environmental reporting, the completeness of accounting for environmental obligations and the level of environmental risks. The practical significance of the study lies in the possibility of using the proposed approach by enterprises, auditors and government agencies to improve the quality of environmental accounting, reporting and sustainable development management.

Thus, the study is aimed at a comprehensive disclosure of environmental audit as a tool for sustainable development of the Republic of Kazakhstan. Its accounting and analytical aspect allows us to move from formal control to a more meaningful assessment of environmental performance, the financial validity of environmental protection measures and the quality of management decisions in the field of environmental protection.

Literary review. The problems of environmental audit in modern research are considered in the broader context of sustainable development, environmental responsibility of business, the quality of non-financial reporting and the

transformation of accounting and analytical systems. In the scientific literature, environmental audit is interpreted not only as a tool for monitoring compliance with environmental requirements, but also as a mechanism for generating reliable information about the company's environmental impact, the effectiveness of environmental costs and the degree of environmental risks. This approach is especially relevant for countries with a high share of the industrial and raw materials sectors, where the environmental burden is directly related to issues of economic sustainability, social responsibility and the quality of government regulation.

In the classical sense, environmental audit was formed as a procedure for independent verification of the compliance of an enterprise's activities with environmental requirements, regulations, permits and internal environmental regulations. However, in modern conditions, this understanding is considered insufficient, since environmental problems require not only monitoring violations, but also evaluating management systems, accounting, reporting, and management decisions. In this regard, environmental audit is increasingly considered as a part of environmental management aimed at preventing environmental risks and improving the effectiveness of environmental activities. The International Organization for Standardization considers environmental management through a system of standards, including ISO 14001, where continuous improvement of environmental performance, internal audit and assessment of compliance with the organization's environmental policy are important (ISO, 2015). The official ISO materials also emphasize that international standards are formed as agreed expert solutions to improve the safety, quality and efficiency of processes in various fields of activity.

Considerable attention in scientific research is paid to the relationship between environmental audit and environmental accounting. Environmental accounting acts as the information basis of an audit, since it accumulates data on environmental costs, environmental obligations, emissions payments, waste management costs, remediation, modernization of wastewater treatment plants and other environmental measures. In the meta-synthesis of research on environmental accounting for 1995-2024. It is noted that environmental accounting is gradually turning from an auxiliary practice of information disclosure into an independent direction of sustainable corporate governance (Sundarasen, 2024). This means that an environmental audit should check not only the availability of environmental information, but also its completeness, comparability, reliability and suitability for making managerial decisions.

In modern literature, environmental accounting and environmental audit are increasingly considered as interrelated elements of a single accounting and analytical system. Environmental accounting ensures the collection and systematization of data, environmental analysis makes it possible to interpret indicators of environmental impact and environmental costs, and environmental audit evaluates the quality of these data and the degree of their compliance with regulatory, management and reporting requirements. A review of the literature on environmental and sustainability accounting, budgeting and reporting highlights

that research in this area is shifting from describing individual accounting practices to a comprehensive analysis of environmental reporting, budgeting, information disclosure, and management use of environmental data (Bisogno, 2025). This confirms the need to consider environmental audit as a tool integrated into the system of financial, managerial and non-financial accounting.

The concept of sustainable development plays a special role in the development of environmental audit. After the adoption of the UN 2030 Agenda, issues of business environmental responsibility began to be considered in connection with the achievement of sustainable development goals, rational use of resources, reduction of pollution and increased transparency of corporate reporting (United Nations, 2015). Research on corporate reporting on sustainable development goals notes that disclosure of environmental information is becoming an important element of companies' responsibility to the government, investors, society and other stakeholders (Awuah, 2024). Consequently, environmental audit acquires the importance of a tool for confirming the reliability of environmental data used in sustainable development reporting.

From the point of view of theoretical approaches, environmental audit can be explained through the theory of stakeholders, the theory of legitimacy and agent theory. The theory of stakeholders proceeds from the fact that an enterprise must take into account the interests not only of owners, but also of employees, the state, the local community, investors, consumers and future generations. In this case, an environmental audit acts as a mechanism to confirm that the company's activities do not create excessive environmental risks and meet the expectations of society. Legitimacy theory explains the desire of organizations to disclose environmental information as a way to maintain public trust and confirm the right to conduct business. The agency theory allows us to consider environmental audit as a tool to reduce information asymmetry between management, owners, government agencies and external users of reporting.

Corporate governance studies emphasize that environmental information is becoming part of the overall corporate responsibility system. The quality of environmental accounting and reporting depends on the corporate governance structure, the role of the board of directors, the audit committee, internal control, and the organization's willingness to disclose non-financial indicators. Modern work on green accounting and corporate governance shows that environmental accounting and corporate governance can have a positive impact on sustainable development, especially in the presence of well-developed corporate social responsibility mechanisms (Wati, 2024). This allows us to consider environmental audit as a tool not only for environmental control, but also for improving the quality of corporate governance.

An important area of research is the development of ESG reporting and independent confirmation of environmental information. Increased ESG disclosure requirements increase the need for reliable environmental data verification procedures. In international practice, this is due to the development of standards

for confirming sustainable financial statements and increasing requirements for the independence of auditors. In 2025 International professional organizations have strengthened their approaches to verifying companies' ESG statements, as the risk of selective disclosure of favorable information and "green camouflage" increases in the market (Reuters, 2025). For environmental audit, this means the need to move from formal verification of reporting forms to assessing the quality of data, the methodology of their formation and the reliability of internal control.

For Kazakhstan, the importance of environmental audit is determined not only by global trends, but also by national specifics of environmental regulation. The Environmental Code of the Republic of Kazakhstan establishes the legal foundations of environmental protection, environmental regulation, industrial environmental control, accounting and reporting. In the norms of legislation, environmental information is considered as an obligatory element of environmental impact management. The texts of regulatory materials related to environmental regulation emphasize the need for internal accounting and periodic reporting within the framework of environmental control. This creates an institutional framework for the development of environmental auditing as a procedure for verifying the reliability of environmental data and compliance with environmental legislation.

The new Environmental Code of Kazakhstan, signed on January 2, 2021, has become an important stage in the modernization of environmental regulation. Expert reviews note that the code was developed as a comprehensive package of strategic norms focused on international best practices and strengthening business requirements in the field of environmental protection (PwC Kazakhstan, 2021). This is of fundamental importance for environmental auditing, since strengthening the requirements for environmental responsibility of enterprises increases the role of accounting, reporting, industrial environmental control and conformity assessment.

In the Kazakh scientific literature, environmental accounting and audit are also considered as tools for increasing the environmental responsibility of enterprises and supporting management decisions. A study on the environmental accounting and auditing model as a management tool for industrial enterprises in Kazakhstan notes that environmental accounting and auditing are important for managing environmental costs and increasing business environmental responsibility (Korabayev, 2023). This approach corresponds to the logic of the present study, in which environmental audit is considered as a mechanism of communication between natural environmental indicators, financial expenses and management decisions.

Separate studies on Kazakhstan emphasize the role of environmental reporting and environmental audit in the development of a green economy. In particular, in the works devoted to the impact of environmental audit on green economic growth, it is noted that environmental reporting contributes to increased sustainability, resource efficiency, waste reduction and long-term economic stability of enterprises. Although such conclusions require further empirical verification, they show that

environmental audit can be considered as part of a broader model of transition to sustainable and resource-efficient development.

An analysis of the literature shows that environmental audit performs several key functions. The first function is a control function related to checking compliance with environmental legislation, permits, limits and regulations. The second function is accounting, aimed at verifying the completeness of the reflection of environmental costs, obligations and payments. The third function is analytical, involving an assessment of the dynamics of emissions, waste, water consumption, wastewater and the effectiveness of environmental protection measures. The fourth function is risk-based, related to the identification of the likelihood of environmental violations, fines, accidents, reputational losses and financial consequences. The fifth function is strategic, since environmental audit forms the information basis for sustainable development and ESG management.

At the same time, a number of problematic issues remain in the scientific literature. Firstly, there is no unified approach to distinguishing environmental accounting, environmental analysis, and environmental audit. Secondly, many studies focus on the disclosure of environmental information, but do not analyze the quality of primary data and the reliability of internal control sufficiently. Third, environmental indicators are often considered separately from financial and management data, which reduces the practical value of the audit. Fourth, in the context of developing economies, including Kazakhstan, there remains the problem of incomplete integration of environmental information into corporate reporting and managerial decision-making.

Thus, the literature review shows that environmental audit should be considered as a comprehensive accounting and analytical tool for sustainable development. Its current role is not only to verify compliance with environmental requirements, but also to ensure the reliability of environmental information, assess the effectiveness of environmental costs, identify environmental risks and support corporate reporting. For Kazakhstan, the integration of environmental audit with environmental accounting, industrial environmental control, statistical reporting and ESG approaches is of particular importance. This makes it possible to use environmental audit as a mechanism to increase transparency, environmental responsibility and sustainability of enterprises.

Materials and methods. The methodological basis of the study is formed taking into account the interdisciplinary nature of environmental audit, since this tool is located at the intersection of environmental management, accounting, management analysis, internal control, risk management and sustainable development. In the framework of the study, environmental audit is considered not only as a procedure for verifying compliance with environmental legislation, but also as an accounting and analytical mechanism that allows assessing the reliability of environmental information, the completeness of environmental costs and obligations, as well as the effectiveness of environmental activities of business entities.

The research materials were the official statistical data of the Republic of Kazakhstan for 2020-2025, regulatory legal acts in the field of environmental protection, publications of the Bureau of National Statistics of the Republic of Kazakhstan, materials of the Ministry of Ecology and Natural Resources of the Republic of Kazakhstan, newsletters of RSE Kazhydromet, as well as data characterizing pollutant emissions, environmental protection costs, municipal waste management, water supply, sanitation and the state of atmospheric air. Data usage for 2020-2025 It allowed us to trace the dynamics of the main environmental indicators and determine their importance for the development of environmental audit in the accounting and analytical aspect.

The empirical basis of the study included indicators of pollutant emissions from stationary sources, volumes of environmental protection costs, data on the collection and disposal of municipal waste, indicators of sorting, processing and disposal of waste, volumes of water supplied to the grid and released to consumers, data on leakage and unaccounted for water consumption, volumes of wastewater discharged, purification indicators. wastewater, as well as information on monitoring the quality of atmospheric air. This set of indicators allowed us to consider environmental audit as a comprehensive system for verifying not only financial, but also natural environmental data.

The research methodology included several successive stages. At the first stage, the collection and systematization of official statistical and regulatory materials reflecting the state of the environmental sphere of Kazakhstan was carried out. At the second stage, the indicators were grouped according to the main areas of environmental audit: pollutant emissions, environmental costs, waste, water use, sanitation, environmental reporting and environmental risks. At the third stage, a comparative dynamic analysis of the indicators for 2020-2025 was carried out, which made it possible to identify the main trends and problem areas. At the fourth stage, an accounting and analytical interpretation of the results was carried out from the perspective of environmental audit and sustainable development. At the fifth stage, an environmental audit model was developed, focused on the integration of environmental, financial and management indicators.

The study used methods of system analysis, comparative analysis, dynamic analysis, structural grouping, economic and statistical generalization, regulatory analysis and analytical interpretation. The system analysis method allowed us to consider environmental audit as an element of a broader system of sustainable development, including environmental regulation, accounting, reporting, internal control and corporate governance. Comparative analysis was used to compare environmental indicators by year, while dynamic analysis was used to identify changes in emissions, environmental costs, waste management, and water use.

The structural grouping method was used to distribute indicators across the main environmental audit facilities. In particular, all the data were combined into several analytical blocks: the atmospheric pollution block, the environmental cost block, the waste management block, the water supply and sanitation block, the

environmental reporting block and the environmental risk block. This approach allowed us to determine which areas should be included in the accounting and analytical system of environmental audit of enterprises in Kazakhstan.

The accounting and analytical approach was of particular importance in the study. It allowed us to consider environmental indicators not in isolation, but in connection with the financial and managerial parameters of enterprises. Within the framework of this approach, pollutant emissions, waste volumes, water consumption and wastewater were analyzed as natural indicators of environmental impact, while environmental costs, environmental payments, fines, compensations and obligations were analyzed as financial and accounting indicators. This logic made it possible to justify the need to integrate environmental accounting into the overall accounting, management and non-financial accounting system of the enterprise.

Absolute and relative indicators of change were used to assess the dynamics of environmental indicators. The absolute change was calculated as the difference between the indicator value in the reporting and base periods:

$$\Delta X = X_t - X_{t-1},$$

where X_t is the value of the indicator in the reporting year, X_{t-1} is the value of the indicator in the previous year, ΔX is the absolute change in the indicator.

The growth rate of the indicator was determined by the formula:

$$T_r = \frac{X_t}{X_{t-1}} \times 100\%$$

where T_r is the growth rate of the indicator, X_t is the indicator value in the reporting year, and X_{t-1} is the indicator value in the previous year.

The growth rate was calculated as follows:

$$T_p = \frac{X_t - X_{t-1}}{X_{t-1}} \times 100\%$$

where T_p is the growth rate of the indicator. This indicator was used to determine the direction and intensity of changes in environmental and financial parameters.

To assess the accounting and analytical effectiveness of environmental audit, the study used the principle of comparing three groups of data: environmental, financial and managerial. Environmental data reflected the actual impact on the environment; financial data characterized costs, payments and obligations; management data showed the existence of environmental protection measures, internal controls, environmental policies and reporting procedures. This approach allowed us to consider environmental audit as a tool for a comprehensive assessment of the sustainability of the enterprise.

As part of the study, the following logic of accounting and analytical assessment of environmental audit was proposed:

$$EA=f(E,F,M),$$

where EA is environmental audit as an accounting and analytical tool; E is environmental indicators, including emissions, waste, water consumption, wastewater, and air pollution; F - financial indicators, including environmental costs, environmental payments, fines, compensations, and obligations; M - management indicators, reflecting environmental measures, internal controls, reporting, and environmental risks.

This model shows that the effectiveness of an environmental audit is determined not by a separate set of environmental data, but by the degree of consistency between the environmental burden, financial resources and management decisions. If environmental indicators deteriorate with an increase in environmental costs, this indicates the need for an audit of cost effectiveness. If environmental obligations are not accounted for, there is a risk of misstatement of the financial statements. If internal control does not ensure the reliability of environmental data, the quality of corporate and statistical reporting decreases.

A risk-based approach was used to disclose the accounting and analytical aspect of the environmental audit. It allowed us to identify the main environmental risk areas subject to audit: excess of emission standards, unreliability of data on pollutants, incomplete waste accounting, high volume of landfills, leaks and unaccounted for water consumption, insufficient wastewater treatment, late reflection of environmental obligations, as well as low transparency of environmental reporting. This approach corresponds to the modern audit logic, which focuses not only on the facts of the violation, but also on the likelihood of environmental, financial and reputational consequences.

The study also applied a regulatory and legal analysis, which made it possible to determine the institutional foundations of environmental audit in Kazakhstan. Within the framework of this method, the provisions of the Environmental Code of the Republic of Kazakhstan, requirements for environmental reporting, environmental protection measures, industrial environmental control and responsibility for violation of environmental requirements were analyzed. This made it possible to justify that the environmental audit should be related not only to external control, but also to the internal management system of the enterprise.

The modeling method was used to summarize the results of the study. Based on it, an accounting and analytical model of environmental audit was formed, including informational, control, accounting, analytical, reporting, risk-oriented and recommendation stages. This model allows you to structure an environmental audit as a sequential process aimed at collecting data, verifying their reliability, assessing compliance with legislation, analyzing financial and natural indicators,

identifying environmental risks and developing management recommendations.

Thus, the research methodology is based on a combination of statistical, regulatory, accounting, analytical and risk-based approaches. Such a set of methods allowed not only to describe the dynamics of Kazakhstan's environmental indicators for 2020-2025, but also to determine the practical importance of environmental audit to improve the quality of environmental accounting, reliability of reporting, effectiveness of environmental costs and the formation of a sustainable model of corporate environmental governance.

Results. The conducted research showed that in 2020-2025, environmental audit in the Republic of Kazakhstan gradually transformed from a predominantly control procedure into a comprehensive accounting and analytical tool for sustainable development. If, in the traditional sense, environmental audit was focused mainly on detecting violations of environmental legislation, verifying permits and complying with environmental impact standards, then in modern conditions its functional content is significantly expanded. Environmental audit becomes a mechanism for verifying the quality of environmental accounting, the reliability of statistical and non-financial reporting, the completeness of environmental costs, the correctness of the formation of environmental obligations and environmental risk assessment.

The system analysis showed that environmental audit in Kazakhstan should be considered as an element of a broader system of sustainable development, including environmental regulation, industrial environmental control, accounting and management accounting, internal control, risk management and corporate reporting. In this system, environmental audit performs a connecting function, since it allows you to compare the actual impact of an enterprise on the environment with financial resources allocated to environmental protection measures and management decisions taken to reduce the environmental burden.

The results of the dynamic analysis indicate the continued significant anthropogenic impact on the environment of Kazakhstan. In 2020, the volume of pollutant emissions from stationary sources amounted to 2,441.0 thousand tons, in 2021 - 2,407.5 thousand tons, in 2022 - 2,314.7 thousand tons, in 2023 - 2,257.5 thousand tons, and in 2024 - 2,271.4 thousand tons. In 2020-2023, there was a consistent decrease in emissions, but in 2024, an increase of 0.6% was recorded compared to the previous year. These dynamics show that reducing the environmental burden is not a stable process and requires constant audit assessment of the causes of changes in pollution indicators.

Table 1 — Dynamics of pollutant emissions from stationary sources in the Republic of Kazakhstan in 2020-2025

Year	Emissions of pollutants, thousand tons	Absolute change from the previous year, thousand tons	Growth rate, %	Scientific and analytical interpretation
2020	2 441,0	-	-	High baseline level of industrial environmental impact
2021	2 407,5	-33,5	-1,4	Moderate emission reduction, requiring an assessment of production factors
2022	2 314,7	-92,8	-3,9	A more pronounced decrease, requiring comparison with production volumes and modernization
2023	2 257,5	-57,2	-2,5	The minimum indicator for the period 2020-2024.
2024	2 271,4	+13,9	+0,6	The resumption of emissions growth, indicating the need for an in-depth audit of the causes of the deterioration in dynamics
2025	Data on waste, water supply, sanitation, and air monitoring have been published in certain areas.	-	-	Expansion of the environmental audit information base due to natural environmental load indicators

Dynamic analysis of emissions showed that in 2020-2024 their total volume decreased from 2,441.0 to 2,271.4 thousand tons, that is, by 169.6 thousand tons, or about 6.9%. At the same time, the increase in the indicator in 2024 after a three-year decline indicates the instability of the positive dynamics. Therefore, the environmental audit should not be limited to recording the absolute reduction of emissions over the period. It is more important to identify the reasons for the change in indicators: the reduction in emissions could be associated with modernization and increased environmental efficiency, as well as with a decrease in production activity. Therefore, as part of the audit, it is necessary to additionally calculate specific pollution indicators per unit of production, per unit of revenue, per employee, as well as compare emissions with environmental costs.

The results of the analysis of environmental costs indicate the presence of volatile dynamics. In 2020, the amount of environmental protection costs amounted to 384.0 billion tenge, in 2021 - 417.0 billion tenge, in 2022 - 444.0 billion tenge, in 2023 - 610.0 billion tenge, and in 2024 - 456.1 billion tenge. Thus, in 2020-2023, there was a consistent increase in environmental financing, but in 2024 it decreased by 153.9 billion tenge compared to 2023.

Table 2—Dynamics of environmental costs in the Republic of Kazakhstan in 2020-2024

Year	Environmental protection costs, billion tenge	Absolute change from the previous year, billion tenge	Growth rate, %	Accounting and analytical value
2020	384,0	-	-	Basic level of environmental financing
2021	417,0	+33,0	+8,6	Rising costs reinforce the need to assess their effectiveness.
2022	444,0	+27,0	+6,5	Continued growth requires more detail on the types of environmental protection measures.
2023	610,0	+166,0	+37,4	The maximum indicator of the period; an audit of the effectiveness of expenses is required
2024	456,1	-153,9	-25,2	Significant cost reduction requires an analysis of the impact on environmental sustainability

The results show that an increase in environmental costs does not always ensure a sustainable reduction in emissions. The comparison of 2023 and 2024 is the most significant: in 2023, costs reached a maximum value of 610.0 billion tenge, but in 2024 they decreased to 456.1 billion tenge, while emissions increased by 0.6%. This indicates the need to move from formal cost accounting to an assessment of their environmental impact. As part of an environmental audit, it is necessary to determine which part of the costs were allocated to real environmental protection measures, equipment modernization, waste and wastewater treatment, and waste management, and which was of an administrative, compensatory or ongoing nature.

Taking into account the research methodology, an analysis of the consistency of environmental and financial indicators was carried out. For this purpose, the principle of comparing three blocks was used: environmental, financial and managerial. The environmental block reflects the actual impact on the environment; the financial block shows the amount of costs, payments and obligations; the management block characterizes the effectiveness of environmental protection solutions, internal control and reporting. The results of this comparison are presented in table 3.

Table 3 — Comparison of environmental, financial and management indicators of environmental audit

Analytical block	Key indicators	The revealed result	Importance for environmental audit
Environmental block	Emissions, waste, water consumption, wastewater, air pollution	There is still a significant burden on the environment	Verification of the reliability of natural environmental data
Financial block	Environmental costs, payments, fines, compensations, obligations	Costs have volatile dynamics and are not always directly related to reducing emissions.	is required, and an audit of cost effectiveness and completeness of obligations is required.
Management Unit	Environmental protection measures, internal control, environmental policy, reporting	The link between environmental goals and management decisions needs to be strengthened	An audit should evaluate not only the data, but also the quality of the management system.

The results of the structural grouping showed that the environmental audit in Kazakhstan should cover not one, but several interrelated inspection objects. These include pollutant emissions, environmental costs, environmental obligations, waste, water use, sanitation, environmental reporting, and environmental risks. This structure allows us to move from a narrow understanding of auditing as a verification of compliance with regulations to a more comprehensive model focused on sustainable development.

The data for 2025 are of particular analytical importance, as they expand the empirical base of the study due to natural indicators of environmental impact. In 2025, there were 846 enterprises and organizations operating in Kazakhstan that collected and exported municipal waste. The total volume of waste collected, including waste from self-collection enterprises, amounted to 5,465,071 tons, of which municipal waste - 4,095,091 tons, and household waste - 2,083,647 tons. These data show that the waste management system is a significant object of environmental audit, requiring verification of the completeness of accounting, correctness of classification, reliability of reporting and effectiveness of further waste management.

An analysis of the subsequent movement of waste showed that in 2025, 278 organizations were engaged in waste sorting, disposal and disposal. The volume of waste received amounted to 4,650,243 tons, sorted waste - 1,534,843 tons, waste sent to third-party organizations for processing - 398,993 tons, waste sent for burial - 826,612 tons. The volume of waste processed to produce products or secondary raw materials amounted to 436,831 tons, disposed of waste - 351,994 tons, and the volume of waste disposed of during the reporting year - 2,895,272 tons.

Table 4 — Waste management indicators in the Republic of Kazakhstan in 2025

Indicator	Meaning	Analytical interpretation
Enterprises for the collection and disposal of municipal waste	846 units	A broad institutional framework for waste management has been formed
Total amount of waste collected	5 465 071 tons	High load on the waste accounting, transportation and disposal system
Collected municipal waste	4 095 091 tons	A significant amount of the municipal sector in the general waste system
Household waste	2 083 647 tons	A significant household component of the environmental burden
Organizations for sorting, recycling and burial	278 units	A limited number of waste management organizations regarding the volume of waste collected
Sorted waste	1 534 843 tons	Sorting covers a significant but insufficient amount of waste
Processed to produce products or secondary raw materials	436 831 tons	The potential of the circular economy has been partially realized
Received waste for disposal	2 895 272 tons	There remains a high dependence on landfill waste disposal

The calculation of relative indicators shows that the volume of sorted waste amounted to about 28.1% of the total volume of collected waste, while the volume of waste processed to produce products or secondary raw materials amounted to

about 8.0%. At the same time, the volume of waste received for disposal amounted to about 53.0% of the total volume of waste collected. These ratios indicate that, despite the availability of sorting and recycling infrastructure, the waste management system remains significantly dependent on burial. For an environmental audit, this means that it is necessary to verify not only the fact of waste collection, but also the effectiveness of their further processing, the use of recycled materials and the reduction of landfill disposal.

In the field of water supply and sanitation in 2025, indicators were identified that are essential for accounting and analytical environmental audit. The number of enterprises and their divisions related to water supply facilities amounted to 1,055 units, the number of water supply facilities - 4,476 units, and the length of water supply networks - 112,311.3 km. The volume of water supplied to the grid amounted to 2,658,396 thousand cubic meters, the volume of water released to consumers - 1,417,494.6 thousand cubic meters, including the population - 715,489.5 thousand cubic meters. Leakage and unaccounted for water consumption amounted to 180,717.3 thousand cubic meters. m, or 6.8% of the total volume of water supplied to the network.

Table 5 — Indicators of water supply and sanitation in the Republic of Kazakhstan in 2025

Indicator	Meaning	Importance for environmental audit
Enterprises and divisions of water supply	1 055 units	Determine the scale of the water infrastructure audit facility
Water supply facilities	4 476 units	They require a technical condition check and accounting
Length of water supply networks	112 311,3 km	Creates risks of losses, accidents and unaccounted expenses
Water supply to the network	2 658 396 thousand cubic meters	Basic indicator of water use
Water released to consumers	1 417 494,6 thousand cubic meters	Characterizes the actual consumption
Water released to the public	715 489,5 thousand cubic meters	Reflects a socially significant component of water consumption
Leakage and unaccounted for water consumption	180 717,3 thousand cubic meters	It is an indicator of technical and accounting risks.
The proportion of leaks and unaccounted for consumption	6,8%	Requires increased internal control and audit of losses
Sewage disposal system enterprises	293 units	Define the institutional framework for the audit of sanitation
Water disposal facilities	670 units	They require an operational condition check.
Waste water passed through	761 681,8 thousand cubic meters	The basic indicator of the load on the drainage system
Passed through sewage treatment plants	663 337 thousand cubic meters	Shows the coverage of wastewater treatment
The proportion of treated wastewater	87,1%	Characterizes the cleaning efficiency
Normatively treated wastewater	446 404,5 thousand cubic meters	Shows the amount of wastewater that meets the standards
Insufficiently treated wastewater	16 605,8 thousand cubic meters	Creates a zone of increased environmental risk

The analysis of water supply and sanitation showed that an environmental audit should include checking not only the volume of water consumption and sanitation, but also the quality of loss accounting, the technical condition of networks, the reliability of wastewater treatment data and compliance with discharge standards. The presence of 16,605.8 thousand cubic meters of insufficiently treated wastewater indicates the continuing risks of exposure to water bodies. In this regard, an audit of wastewater disposal should include verification of technological processes of purification, laboratory control, reporting data and compliance with discharge quality standards.

The results of the risk-based analysis allowed us to identify the main environmental risk zones that should be the priority objects of the audit. These include increased emissions after a period of decline, the volatility of environmental costs, a low proportion of waste recycling relative to the total volume of waste generation and collection, a significant amount of waste disposal, leaks and unaccounted for water consumption, the presence of insufficiently treated wastewater, as well as the possible incompleteness of environmental obligations in accounting.

Table 6 — Risk-based assessment of environmental audit facilities

Audit object	Identified problem	Potential risk	Audit priority
Emissions of pollutants	Emissions growth in 2024 after reduction in 2020-2023	Deterioration of environmental dynamics, exceeding standards	Tall
Environmental costs	Cost reduction in 2024 after the maximum level of 2023	Insufficient financing of environmental protection measures	Tall
Wastes	High volume of waste disposal	Accumulation of environmental damage and increased load on landfills	High
Waste recycling	Low share of recycling in the total volume of waste collected	Insufficient development of the circular economy	Average/High
Water supply	Leakage and unaccounted for water consumption 6,8%	Loss of resources and distortion of accounting data	Average
Water disposal	The presence of insufficiently treated wastewater	Risk of water pollution	Tall
Environmental reporting	Possible discrepancies between internal and external data	Reducing the reliability of reporting	Tall
Environmental obligations	Possible incomplete reflection of payments, fines and compensations	Financial and reputational consequences	Tall

Summarizing the results allowed us to confirm the applicability of the environmental audit model proposed in the methodology, expressed as ($EA = f(E, F, M)$), where environmental audit is determined by the interaction of environmental, financial and management indicators. Environmental indicators form an idea of the actual impact on the environment; financial indicators reflect costs, payments, fines and obligations; management indicators characterize the quality of internal

control, environmental protection measures and reporting. Inconsistency between these blocks is a sign of increased audit risk. For example, an increase in costs in the absence of an improvement in environmental performance requires a cost-effectiveness check, and a decrease in costs with an increase in emissions may indicate a weakening of environmental protection activities.

Table 7 — Practical interpretation of the model ($EA = f(E, F, M)$)

Model component	Content	Analysis results	Audit value
(E) - environmental indicators	Emissions, waste, water consumption, wastewater, air pollution	A high environmental burden remains in a number of areas	Verification of the reliability of natural data
(F) - financial indicators	Environmental costs, environmental payments, fines, compensations	Costs are unstable and require an efficiency assessment.	is required, an audit of the financial reflection of environmental activities is required
(M) - management indicators	Internal control, environmental policy, reporting, risk management	The importance of managerial responsibility for environmental outcomes is increasing	Integration of audit into the corporate governance system is required
(EA) - environmental audit	Comprehensive verification of environmental, financial and management data	Audit is a tool for sustainable development	The basis for increasing transparency and environmental performance is being formed.

Based on the results obtained, three levels of application of environmental audit in the system of sustainable development of the Republic of Kazakhstan can be distinguished. The first level is regulatory and control and is associated with the verification of compliance with the requirements of environmental legislation, permits, regulations, limits, environmental payments and mandatory reporting. The second level is accounting and analytical and is aimed at assessing the reliability of environmental accounting, the completeness of environmental costs, the correctness of the formation of environmental obligations and the effectiveness of environmental protection measures. The third level is strategic and is related to the integration of environmental audit into the corporate governance system, the ESG approach, sustainable development and long-term environmental risk management.

Table 8 — Levels of environmental audit application in the sustainable development system

Level	Content	The main result
Regulatory control	Verification of compliance with environmental legislation, permits, limits, and reporting	Identification of violations and inconsistencies
Accounting and analytical	Analysis of environmental costs, obligations, waste, water use and accounting data	Improving the reliability of accounting and the quality of management information
Strategic	Integration of audit into ESG, corporate governance and sustainable development	Reducing long-term environmental, financial and reputational risks

Thus, the research results obtained using systematic, dynamic, structural, accounting, analytical and risk-based approaches confirm that environmental audit in Kazakhstan should be developed as an integrated mechanism for ensuring sustainable development. Its importance lies not only in verifying compliance with environmental requirements, but also in forming a reliable information base for making managerial decisions. Data for 2020-2024 They show the need to strengthen audit analysis of emissions and environmental costs, while data for 2025 expand the subject of audit to include waste, water supply, sanitation, and atmospheric air monitoring. As a result, environmental audit can be considered as a tool for early detection of environmental risks, increasing transparency of reporting, evaluating the effectiveness of environmental expenditures and forming a sustainable model of corporate environmental governance.

Discussion. The results obtained allow us to consider environmental audit in the Republic of Kazakhstan as one of the key tools for the transition from formal environmental control to a more complex system of accounting and analytical support for sustainable development. If the traditional environmental audit is mainly aimed at verifying compliance with regulations, permits and reporting requirements, then modern conditions require the expansion of its functions. In particular, an environmental audit should assess not only the fact of compliance with legislation, but also the quality of environmental accounting, the reliability of primary data, the completeness of environmental costs and obligations, the effectiveness of environmental protection measures, as well as the degree of environmental risks to the enterprise and its territory of operation.

The results of the dynamic analysis of pollutant emissions show that in 2020-2023, Kazakhstan experienced a consistent decrease in emissions from stationary sources, but in 2024, the reverse trend was recorded. This fact has important scientific and practical significance. On the one hand, the reduction of emissions in 2020-2023 may indicate the positive impact of environmental protection measures, technological modernization, strengthening environmental regulation and industrial environmental control. On the other hand, emissions will increase in 2024. It shows that the achieved results are not sustainable and may change under the influence of production, investment, technological and organizational factors. Therefore, it is not enough to use only absolute emission indicators to assess environmental efficiency; it is necessary to additionally analyze specific pollution indicators, production structure, output volumes, the state of wastewater treatment plants and the effectiveness of environmental costs.

It is especially important to compare the dynamics of emissions with the dynamics of environmental costs. In 2020-2023, environmental protection costs consistently increased and peaked in 2023, but in 2024 they decreased while emissions increased. This situation confirms the need to move from formal accounting of environmental expenditures to an assessment of their environmental impact. By itself, an increase in costs does not guarantee a reduction in the negative impact on the environment, unless the costs are aimed at technological renewal, emission

reduction, efficient wastewater treatment, waste recycling and the introduction of resource-saving solutions. Therefore, within the framework of an environmental audit, it is necessary to analyze not only the amount of environmental costs, but also their structure, purpose, effectiveness and relationship to actual environmental indicators.

The data for 2025 expand the subject of discussion, as they show that environmental audits should not be limited only to emissions and environmental costs. Indicators for municipal waste management, water supply and sanitation indicate the need for a more comprehensive approach to environmental performance audit. The significant volume of waste collected, the high proportion of waste received for disposal, the relatively low volume of recycling for secondary raw materials, the presence of leaks and unaccounted for water consumption, as well as insufficiently treated wastewater indicate that environmental risks are formed not only in the industrial sector, but also in the municipal, infrastructural and resource sectors. In this sense, environmental audit should be focused on a wide range of objects: waste, water, wastewater, atmospheric air, environmental reporting, internal control and environmental obligations.

From a scientific point of view, the results obtained confirm the validity of the accounting and analytical approach to environmental audit. This approach assumes that environmental indicators should not be considered in isolation, but in relation to financial and managerial data. For example, indicators of emissions, waste, water consumption, and wastewater reflect the natural environmental burden; environmental costs, environmental payments, fines, and compensations characterize the financial consequences of environmental activities.; and internal control, environmental policy, industrial environmental control and corporate reporting reflect the managerial level of environmental responsibility. Only the combination of these three blocks makes it possible to assess the real state of environmental management at the enterprise.

The $EA=f(E,F,M)$ model proposed in the study, where environmental audit is determined by the interaction of environmental, financial and managerial indicators, allows us to reveal the applied importance of environmental audit for sustainable development. If environmental indicators deteriorate with an increase in environmental costs, this may indicate cost inefficiency or insufficient effectiveness of management decisions. If environmental costs decrease with increased emissions or increased waste volumes, there is a risk of weakening the company's environmental policy. If environmental obligations are not accounted for or disclosed incompletely, the risk of misstatement of financial and non-financial statements increases. Therefore, environmental audit should perform not only a verification, but also a diagnostic function.

An important aspect of the discussion is the issue of the quality of environmental reporting. In the context of sustainable development, enterprises are increasingly required to disclose information not only about financial results, but also about environmental impacts, environmental protection measures, emissions, waste,

water consumption, environmental risks and measures to reduce them. However, the reliability of such reporting depends on the quality of primary environmental accounting and internal control. If the data is generated in fragments, is not compared between business units, or is not documented, then environmental reporting loses its analytical value. Therefore, an environmental audit should include checking data sources, calculation methods, completeness of disclosure, comparability of indicators, and compliance of reporting information with actual data from industrial environmental control.

The results of the study also confirm the need to develop a risk-based environmental audit. The most significant risk areas are increased emissions after the reduction period, reduced environmental costs, high volume of waste disposal, insufficient recycling of secondary raw materials, leaks and unaccounted for water consumption, insufficiently treated wastewater, as well as possible incomplete reflection of environmental obligations. The priority of these risks is due to the fact that they can have not only environmental, but also financial, legal and reputational consequences. For enterprises, this can result in fines, additional payments, the need for compensation measures, a deterioration in investment attractiveness and a decrease in trust from the state, the public and partners.

In the context of Kazakhstan, the institutional role of environmental audit is of particular importance. The country has significant industrial and raw material potential, which makes environmental policy an important part of economic security and sustainable development. At the same time, the transition to a green economy and increased environmental reporting requirements require greater transparency in the activities of enterprises. Environmental audit can become a tool that ensures comparability of data between government statistical observations, industrial environmental control, corporate reporting and internal accounting systems. This is especially important in conditions when national environmental indicators are formed on the basis of data from enterprises and organizations, and the quality of such data affects the reliability of environmental policy as a whole.

The results obtained are consistent with the provisions of modern scientific literature, where environmental audit is considered as part of the environmental management system, sustainable reporting and corporate governance. International approaches emphasize that environmental performance cannot be ensured solely by external control; it requires built-in procedures for internal audit, monitoring, risk analysis, and continuous improvement. In this regard, Kazakhstan's practice should develop towards the integration of environmental audit with internal control systems, ESG management, industrial environmental control and strategic planning. This approach will improve not only formal compliance with legal requirements, but also the real environmental performance of enterprises.

The connection of environmental audit with the ESG approach deserves special attention. In modern conditions, investors, government agencies and society increasingly evaluate enterprises not only by financial indicators, but also by environmental, social and managerial criteria. In this system, an environmental

audit can serve as a confirmation of environmental information disclosed in non-financial statements. This reduces the risk of formal or selective disclosure of data, increases confidence in reporting, and contributes to a more objective assessment of business sustainability. This area is especially relevant for Kazakhstan due to the need to attract investments, increase the competitiveness of enterprises and adapt to international requirements for sustainable development.

The practical significance of the study lies in the fact that the proposed accounting and analytical approach can be used by enterprises, auditors, government agencies and researchers to improve environmental control and reporting. For enterprises, it allows them to build an internal accounting system for environmental costs, waste, emissions, water consumption, and obligations. For auditors, it is important to identify key audit areas and create a risk-based audit program. It is important for government agencies to improve the quality of data used in the development of environmental policy. For scientific research, it is necessary to expand the theoretical basis of environmental audit by integrating environmental, financial and managerial analysis.

However, the results of the study allow us to identify a number of limitations. Firstly, not all statistical indicators for 2025 are presented in a comparable form with previous years, which limits the possibility of building full dynamics in all areas. Secondly, official statistics reflect aggregated indicators, whereas environmental audit at the enterprise level requires more detailed data on the types of pollutants, sources of emissions, waste generation facilities, types of environmental costs and specific environmental measures. Thirdly, the analysis does not cover differences between regions and industries, although the environmental burden in Kazakhstan has pronounced territorial and sectoral specifics. These limitations form the directions for further research.

The prospects for further study of the topic are related to the development of industry-specific environmental audit techniques for industry, energy, mining, municipal infrastructure and the agro-industrial complex. In addition, it is advisable to conduct a regional analysis of environmental risks, compare enterprise data with monitoring of atmospheric air and water bodies, and develop integrated environmental performance indicators. An important area is the formation of a methodology for assessing the effectiveness of environmental costs, which makes it possible to determine how much financial resources actually contribute to reducing emissions, reducing waste, increasing recycling, reducing water losses and improving wastewater quality.

Thus, the discussion of the results confirms that environmental audit in the Republic of Kazakhstan should be developed as a comprehensive accounting, analytical and risk-oriented tool for sustainable development. Its main task is not only to identify violations, but also to form a reliable information base for environmentally responsible management. In modern conditions, environmental audit should ensure the verification of natural, financial and managerial indicators, evaluate the effectiveness of environmental protection measures, identify

environmental risks and promote transparency in corporate and government environmental reporting.

Conclusion. The conducted research allowed us to establish that environmental audit in the Republic of Kazakhstan in modern conditions should be considered not only as a tool for verifying compliance with environmental legislation, but also as a comprehensive accounting and analytical mechanism for ensuring sustainable development. Its importance is determined by the ability to combine environmental, financial and managerial indicators, form a reliable information base for decision-making and identify areas of environmental, financial and reputational risk.

An analysis of theoretical approaches has shown that environmental audit is gradually being transformed from a control procedure into an element of an environmental management system, sustainable reporting and corporate governance. In the context of increasing requirements for environmental responsibility of enterprises, it must ensure the verification of not only permits and regulations, but also environmental accounting, environmental costs, obligations, accounting data, internal registers and environmental risk management system.

The results of the analysis of official data for 2020-2025 confirmed the existence of ambiguous environmental dynamics in Kazakhstan. In 2020-2023, there was a decrease in pollutant emissions from stationary sources, but their growth was recorded in 2024. This indicates that the positive dynamics is not stable and requires constant audit support. At the same time, the dynamics of environmental costs showed instability: after an increase in 2020-2023, they decreased in 2024. This combination of factors confirms the need to assess not only the amount of financing for environmental protection measures, but also their effectiveness.

Data for 2025 on municipal waste management, water supply and sanitation allowed us to expand the subject of environmental audit. The significant amounts of waste collected, continued dependence on landfill, relatively limited recycling levels, the presence of leaks and unaccounted-for water consumption, as well as the volume of insufficiently treated wastewater show that an environmental audit should cover a wide range of facilities. These include emissions, waste, water use, sanitation, wastewater treatment, environmental reporting, environmental costs, and environmental obligations.

The accounting and analytical approach allowed us to substantiate that the environmental audit should be based on a comparison of three groups of indicators: environmental, financial and managerial. Environmental indicators reflect the actual impact on the environment; financial indicators characterize costs, payments, fines, compensations and obligations; management indicators show the existence of environmental policies, internal controls, environmental protection measures and reporting procedures. The inconsistency between these blocks indicates the presence of audit risks and the need for a deeper audit.

The study confirmed the importance of risk-based environmental audit. The most significant risks for Kazakhstan include increased emissions after a period of decline, unstable environmental costs, a high proportion of waste sent to landfill,

insufficient recycling, leaks and unaccounted-for water consumption, insufficiently treated wastewater, and possible incompleteness of accounting for environmental obligations. These risks can lead not only to environmental consequences, but also to financial losses, fines, reduced investment attractiveness and deterioration of the reputation of enterprises.

The proposed accounting and analytical model of environmental audit includes informational, control, accounting, analytical, reporting, risk-oriented and recommendation stages. This model allows us to consider environmental audit as a consistent process aimed at collecting and verifying data, assessing compliance with legal requirements, analyzing financial and natural indicators, identifying risks and developing recommendations for improving environmental performance. Its application can contribute to improving the quality of environmental reporting, strengthening internal control, and making more rational use of environmental resources.

The practical significance of the study lies in the fact that the proposed approach can be used by enterprises of Kazakhstan in the organization of internal environmental control, preparation of environmental and ESG reports, assessment of the effectiveness of environmental costs and environmental risk management. For audit organizations, the results of the study can serve as the basis for the formation of environmental audit programs aimed at verifying not only regulatory compliance, but also the quality of accounting and analytical information. For government agencies, this approach can be useful in improving environmental statistics, monitoring, and regulation.

Thus, environmental audit is an important tool for the sustainable development of the Republic of Kazakhstan. Its further development should be linked to the strengthening of the accounting and analytical function, integration with environmental accounting, industrial environmental control, ESG reporting and risk management. Only with this approach, environmental audit will be able to perform not a formal, but a substantive role - to ensure the reliability of environmental information, increase the effectiveness of environmental protection measures, reduce environmental risks and facilitate the transition of enterprises in Kazakhstan to a more sustainable development model.

References

Republic of Kazakhstan (2021) *Environmental Code of the Republic of Kazakhstan dated January 2, 2021, No. 400-VI*. Astana. Retrieved from <https://adilet.zan.kz/rus/docs/K2100000400> (in Eng.)

Bureau of National Statistics of the Republic of Kazakhstan (2026) *Environmental statistics: Key indicators, publications, electronic tables and dynamic series*. Astana. Retrieved from <https://stat.gov.kz/ru/industries/environment/stat-eco/> (in Eng.)

Bureau of National Statistics of the Republic of Kazakhstan (2025) *On atmospheric air protection in the Republic of Kazakhstan in 2024*. Astana. Retrieved from <https://stat.gov.kz/ru/industries/environment/stat-eco/publications/346638/> (in Eng.)

Bureau of National Statistics of the Republic of Kazakhstan (2025) *On environmental protection expenditures in the Republic of Kazakhstan in 2024*. Astana. Retrieved from <https://stat.gov.kz/ru/industries/environment/stat-eco/> (in Eng.)

Bureau of National Statistics of the Republic of Kazakhstan (2026) *On municipal waste management in the Republic of Kazakhstan, 2025: Electronic statistical table*. Astana. Retrieved from <https://stat.gov.kz/ru/industries/environment/stat-eco/spreadsheets/> (in Eng.)

Bureau of National Statistics of the Republic of Kazakhstan (2026) *On the operation of water supply and wastewater disposal facilities in the Republic of Kazakhstan, 2025: Electronic statistical table*. Astana. Retrieved from <https://stat.gov.kz/ru/industries/environment/stat-eco/spreadsheets/> (in Eng.)

Ministry of Ecology and Natural Resources of the Republic of Kazakhstan (2025) *National report on the state of the environment and the use of natural resources in the Republic of Kazakhstan for 2024*. Astana. Retrieved from <https://www.gov.kz/memleket/entities/ecogeo/documents> (in Eng.)

Kazhydromet (2026) *Information bulletin on the state of the environment of the Republic of Kazakhstan for 2025*. Astana: Republican State Enterprise “Kazhydromet”. Retrieved from https://www.kazhydromet.kz/uploads/calendar/277/year_file/699fc2766ea09informacionnyy-byulleten-por-rk-za-2025-god_28-01-2026.pdf (in Eng.)

Kazhydromet (2025–2026) *Monthly information bulletins on the state of the environment*. Astana: Republican State Enterprise “Kazhydromet”. Retrieved from <https://www.kazhydromet.kz/ru/ecology/ezhemesyachnyy-informacionnyy-byulleten-o-sostoyanii-okruzhayuschey-sredy> (in Eng.)

United Nations (2015) *Transforming our world: The 2030 Agenda for Sustainable Development*. New York: United Nations. Retrieved from <https://sdgs.un.org/2030agenda> (in Eng.)

International Organization for Standardization (2015) *ISO 14001: Environmental management systems — Requirements with guidance for use*. Geneva: ISO. Retrieved from <https://www.iso.org/standard/60857.html> (in Eng.)

International Organization for Standardization (2018) *ISO 19011: Guidelines for auditing management systems*. Geneva: ISO. Retrieved from <https://www.iso.org/standard/70017.html> (in Eng.)

PwC Kazakhstan (2021) *How will the new Environmental Code impact your business?* Almaty: PricewaterhouseCoopers Kazakhstan. Retrieved from <https://www.pwc.com/kz/en/pwc-news/tareports/tax-legal-alert-fy19/81-february-2021.html> (in Eng.)

Sundarasan S. (2024) Environmental accounting and sustainability: A meta-synthesis of review-based research, 1995–2024. *Sustainability*, 16(21). — 9341 p. <https://doi.org/10.3390/su16219341> (in Eng.)

Bisogno M. (2025) Environmental and sustainability accounting, budgeting and reporting: A literature review. *Journal of Accounting Literature*. <https://doi.org/10.1108/JAL-06-2024-0145> (in Eng.)

Korabayev B. (2023) The model of environmental accounting and auditing as a tool for management decisions of industrial enterprises in Kazakhstan. Retrieved from <https://tou.edu.kz/arm/storage/files/6757f0ec1d0933.50037243.pdf> (in Eng.)

Auwah B. (2024) *Corporate reporting on the Sustainable Development Goals: A structured literature review*. Bournemouth University. Retrieved from <https://eprints.bournemouth.ac.uk/39001/> (in Eng.)

Wati Y. (2024) Green accounting, corporate governance and sustainable development: The moderating effect of corporate social responsibility. *International Journal of Accounting and Research*. Retrieved from <https://ijar-iaikapd.or.id/index.php/ijar/article/view/786> (in Eng.)

Reuters (2025) *Auditors get tougher guidelines on judging firms' environmental claims*. Retrieved from <https://www.reuters.com/sustainability/auditors-get-tougher-guidelines-judging-firms-environmental-claims-2025-01-27/> (in Eng.)

International Auditing and Assurance Standards Board (2024) *International Standard on Sustainability Assurance 5000: General requirements for sustainability assurance engagements*. New York: IAASB. Retrieved from <https://www.iaasb.org/> (in Eng.)

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