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# IMPROVING MODELS FOR CONDUCTING ENVIRONMENTAL AUDITS



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**Abstract:** This article examines modern approaches to improving models for conducting environmental audits. The study proposes a risk- and outcome-oriented, digitally evidence-based regional environmental audit model. The model serves to identify environmental risks, enhance monitoring, and improve the effectiveness of management decisions. Additionally, mechanisms for introducing an environmental audit compliance index under water scarcity are justified, scientific conclusions aimed at sustainable development and the rational use of resources are formulated, and practical recommendations are developed for enterprises, which is of significant scientific and practical importance for enterprise, regional management, and policy planning.

**Key words:** Environmental audit, audit model, risk-based approach, digital evidence, water scarcity, sustainable development.

**Annotatsiya:** Ushbu maqolada ekologik audit o'tkazish modellarini takomillashtirishning zamonaviy yondashuvlari tadqiq etiladi. Tadqiqotda riskka va natijaga yo'naltirilgan, raqamli dalillarga asoslangan hududiy ekologik audit modeli taklif qilinadi. Model ekologik xavflarni aniqlash, monitoringni kuchaytirish hamda boshqaruv qarorlarining samaradorligini oshirishga xizmat qiladi. Shuningdek, suv tanqisligi sharoitida ekologik audit muvofiqlik indeksini joriy etish mexanizmlari asoslab berilib, barqaror rivojlanish va resurslardan oqilona foydalanishga qaratilgan ilmiy xulosalar shakllantiriladi hamda amaliy tavsiyalar ishlab chiqiladi korxonalar, hududiy boshqaruv va siyosiy rejalashtirish uchun muhim ilmiy-amaliy ahamiyat kasb etadi.

**Kalit so'zlar:** ekologik audit, audit modeli, riskga yo'naltirilgan yondashuv, raqamli dalillar, suv tanqisligi, barqaror rivojlanish.

**Аннотация:** В данной статье рассматриваются современные подходы к совершенствованию моделей проведения экологических аудитов. В исследовании предлагается ориентированная на риски и результаты, основанная на цифровых данных региональная модель экологического аудита. Модель служит для выявления экологических рисков, усиления мониторинга и повышения эффективности управленческих решений. Кроме того, обосновываются механизмы внедрения индекса соответствия экологическому аудиту в условиях дефицита водных ресурсов, формулируются научные выводы, направленные на устойчивое развитие и рациональное использование ресурсов, а также разрабатываются практические рекомендации для предприятий. что имеет важное научное и практическое значение для предприятий, регионального управления и планирования политики.

**Ключевые слова:** экологический аудит, модель аудита, подход, основанный на оценке рисков, цифровые доказательства, дефицит водных ресурсов, устойчивое развитие.

## INTRODUCTION

In the context of the green economy, the environmental dimension of business entities' operations is no longer limited to enforcement and permits but is increasingly becoming an integral factor of corporate competitiveness, resource efficiency, and investment attractiveness. Therefore, updating the methodology for organizing and conducting environmental audits requires moving beyond the traditional "compliance checking" function and adopting a risk-oriented, results-driven approach based on digital evidence.

During the research, it became clear that environmental audits do not reveal the causes and effects in technological processes and management systems. They mainly record final outcomes such as emissions and waste volumes. Currently, in our country, systematic use of Udel (intensive) indicators, industry-wide benchmarking, as well as enterprise resource planning (ERP), manufacturing execution system (MES), online monitoring mechanisms integrated with information systems such as laboratory information management systems (LIMS) are lacking. Furthermore, the mathematical foundations of consistency of working documents, materiality criteria, and sampling rules often remain unclear. These shortcomings reduce the impact of environmental audits on management decisions and weaken the linkage with internal audit, the ISO 14001 environmental management system, enterprise resource planning systems, and Sustainability (GRI) reporting.

## REVIEW OF RELEVANT LITERATURE

The theoretical and methodological foundations of environmental audit have evolved at the intersection of internal control theory, sustainable development, and environmental risk management. Early research in post-Soviet academic literature emphasized the integration of audit procedures with enterprise-level control systems. In this regard, V.V. Burtsev (2000) conceptualized internal control as a systemic mechanism ensuring reliability, compliance, and efficiency within commercial organizations. His framework highlighted the importance of structured planning, documentation, and risk-oriented control procedures, which later became essential elements in designing environmental audit models.

Building upon internal audit technology, K.B. Akhmedjanov (2015) analyzed the preparation, planning, and implementation of internal audit in conditions of economic diversification. Although focused on financial audit, his approach to audit process optimization—particularly the emphasis on technological standardization and phased audit planning—provides methodological groundwork applicable to environmental auditing models. Similarly, O.N. Juraev (2010) explored organizational aspects of internal audit services within enterprises, stressing institutional independence and professional competence. These principles are directly transferable to environmental audit units, especially in ensuring objectivity and environmental compliance verification.

Sector-specific accounting and audit methodologies were further developed by A.K. Ibragimov (2002), who examined production cost accounting and auditing mechanisms. His work underscored the need for accurate cost allocation and verification procedures, which are particularly relevant when assessing environmental expenditures, ecological liabilities, and sustainable production costs within environmental audit frameworks.

A more explicit environmental dimension was introduced by T.N. Guseva and S.Yu. Daiman (2000), who analyzed environmental impact assessment (EIA) methodologies and ecological audit practices in industrial enterprises. Their research identified methodological inconsistencies in environmental audits and proposed structured evaluation mechanisms linking environmental impact assessment with audit verification procedures. Expanding this perspective, S.Yu. Daiman (2000) developed methodological approaches to ecological auditing that emphasized systematic environmental risk evaluation, compliance analysis, and integration with state environmental policy.

From a broader ecological security standpoint, V.I. Danilov-Danilyan, M.Ch. Zalikhanov, and K.S. Losev (2001) formulated general principles of environmental safety, highlighting preventive regulation, systemic environmental risk management, and state responsibility. Their conceptualization of ecological security supports the argument that environmental audits should move beyond compliance checks toward strategic environmental risk governance models.

Internationally, environmental audit frameworks have been shaped by globally recognized standards and governance models. The Committee of Sponsoring Organizations of the Treadway Commission (COSO) developed the Internal Control–Integrated Framework, which provides a structured risk-based approach applicable to environmental audit systems. The International Organization for Standardization (ISO) introduced the International Organization for Standardization ISO 14001 standard, which institutionalizes environmental management systems (EMS) and requires periodic internal environmental audits as part of compliance and continuous improvement cycles.

Additionally, the International Organization of Supreme Audit Institutions (INTOSAI) developed environmental auditing guidelines for public-sector institutions, promoting sustainability-oriented audit

practices. The International Federation of Accountants (IFAC) has also emphasized sustainability assurance and environmental reporting within its international standards framework.

Contemporary literature increasingly integrates environmental auditing with ESG (Environmental, Social, and Governance) reporting models. Scholars such as Robert Gray and Jan Bebbington argue that environmental auditing must evolve from traditional compliance-based verification toward sustainability assurance and stakeholder accountability models. Furthermore, the World Bank and the Organisation for Economic Co-operation and Development (OECD) advocate risk-based environmental governance models that incorporate audit mechanisms into broader regulatory and economic sustainability strategies.

Overall, the literature demonstrates three dominant approaches:

1. Institutional–control-based models grounded in internal audit theory.
2. Compliance-oriented environmental audit methodologies linked to environmental impact assessment.
3. Risk-based sustainability frameworks integrating environmental auditing into ESG and environmental management systems.

However, despite substantial theoretical contributions, methodological fragmentation remains evident. Many studies focus either on financial control mechanisms or environmental impact assessment, without fully integrating technological innovations such as digital audit tools, real-time monitoring systems, and data analytics. Consequently, improving environmental audit models requires synthesizing internal control theory, environmental risk management, ISO-based management systems, and digital transformation instruments to ensure effectiveness, transparency, and sustainability alignment.

## RESEARCH METHODOLOGY

This article employed theoretical and comparative analysis, the study of normative documents, and empirical case methods.

## ANALYSIS AND RESULTS

In our view, in order to widely apply environmental auditing in our country, it is necessary to introduce regional environmental auditing (based on our country's administrative-territorial divisions). This procedure involves replicating and coordinating at the regional level the "Risk-Based, Results-Oriented, and Digital Evidence-Supported Environmental Audit (RBRD-EA)" model developed at the level of economic operators, i.e., systematically monitor environmental risks across the region by integrating individual enterprise indicators and management cycles into a single information-analytical framework for district, city, or regional environmental management, aiming to strengthen impact mechanisms and increase resource-use efficiency. The core principles of the scientific approach are the cause-and-effect approach, reliance on materiality and per-unit indicators, forming an open and verifiable evidence base and integrating the ISO 14001 Plan-Do-Check-Act (PDCA) cycle into regional governance. [1]

In the first phase, the normative and methodological foundation for ecological audits at the regional level is created. Here, national legislation and administrative guidelines are harmonized with international approaches, the glossary of terms and indicators is clarified, and also, the subject of regional audit—industrial complexes, transportation corridors, urban infrastructure, municipal waste landfills, water bodies, and green spaces—is divided into meaningful categories. At the same time, enterprise-level environmental passports, permits, laboratory protocols, and waste emission intensity indicators are mapped to the common set of indicators at the regional level. This mapping practice reduces interpretation differences and enables comparative benchmarking across the region.

The second stage is aimed at reliably establishing the regional data flow. From the corresponding systems at the level of business entities - enterprise resource planning system, manufacturing operations management system, laboratory information system, and on-site sensors - incoming streams are collected into a single spatial database along with regulatory data. This database guarantees the traceability of evidence and the ability to recall it for re-examination. Data cleansing, calibration, and synchronization algorithms are applied to the processes to ensure an adequate quality level for subsequent analysis. In cases of data deficiency, gaps are filled with control measurements and focused inspections. Error limits are explicitly documented, and uncertainty intervals are indicated in the final conclusions.

The third stage is dedicated to scientifically constructing a regional risk map. The integrated risk score concept is adapted to the regional level, selecting factors such as impact intensity, probability of occurrence, detectability, and compliance costs; Their weights are calibrated based on the region's network structure, demographic density, wind and hydrological conditions, and socially sensitive zones. As a result, the region's "red," "yellow," and "green" zones are defined, linked to specific providers and resources. This map not only

prioritizes audit resources but also conducts in-depth inspections in high-risk corridors and “hot spots,” while analytical monitoring is deemed sufficient in low-risk zones.

In the fourth stage, a regional indicator system is established. The amount of harmful gas emissions, water and energy use efficiency, waste recycling rate, Criteria such as particulate matter in the air, water body quality, noise, and vibration levels are calculated in relative units and assessed against sector-wide comparative standards. These indicators are linked to the regional management planning and accountability cycle, with annual improvement targets set and automatic alerts triggered when threshold deviations are detected. The linkage of indicators to economic outcomes is of particular importance, with monetary benefits calculated in the form of resource savings, reduced risk of fines, and lower sanitary-epidemiological risks resulting from audit recommendations. These values are assessed through the profitability of environmental investments.

The fifth stage selects the audit sample and determines the audit design. A stratified approach is applied, taking into account the dispersion of regional outputs and the available variability. In high-risk layers, substantive testing is used; in medium-risk layers, a combination of procedures; and in low-risk layers, analytical reviews and trend monitoring. The sample size is calculated on a scientific basis but may be recalibrated based on practical conditions, and in such cases the limits of sampling error are clearly indicated in the auditor’s conclusions.

In the sixth phase, audit findings are incorporated into the regional management mechanisms through the Plan–Do–Check–Act (PDCA) cycle. During the planning phase, objectives and indicators are determined based on the risk map. In the execution phase, investments such as resource reallocation, technological modernization, and filter and purification facilities are carried out. During the review phase, the degree of achievement is assessed based on indicators and compliance metrics, while in the action phase, corrective and incentive mechanisms are implemented. Thus, the audit conclusion transforms from a “one-time report” into a mechanism for continuous management improvement.

The seventh stage is focused on monitoring and public communication. Key indicators are published in open format via a regional information dashboard, and an interactive channel is established for public complaints and suggestions. Transparency, independent assessment, and external verification mechanisms are supported. This increases public trust and accelerates the implementation of audit recommendations. Additionally, in cooperation with higher education and scientific institutions, a network of regional laboratories and professional development programs are established to continuously improve the competence of personnel.

The eighth stage concerns financing and economic incentives. The enterprise’s financial resources, budget funds, international grants and credit lines are financing schemes for regional environmental projects. In incentive mechanisms, tax incentives, “green” tariffs, or accelerated depreciation measures may be applied to enterprises that have achieved significant improvements in indicators. At the same time, administrative measures will be gradually strengthened for non-compliance with audit recommendations in high-risk zones.

The ninth stage consists of evaluation and recalibration. From the first year of implementation, results are analyzed annually, baseline values for the indicators are updated, the risk map is reassessed, and the audit program is adjusted accordingly. When necessary, the methodology details are clarified—for example, materiality thresholds, per-unit indicator formulas, or verification procedure areas are updated to reflect changes in the scope.

It should be noted separately that the proposed scientific approach to establishing a regional ecological audit harmonizes the methods and indicators developed at the enterprise level on a regional scale. It supports decision-making with reliable data and rapid notification mechanisms, and transparently demonstrates the economic efficiency of environmental measures. As a result, emission and waste intensity are steadily reduced, water and energy efficiency improve, permit violations are sharply decreased, and the implementation rate of audit recommendations rises to a higher level. A scientific and practical foundation for implementing environmental audits, grounded in digital evidence and oriented toward territorial management, risk, and results, must be established. [6]

Unlike traditional corporate environmental audits, this innovation is aimed at conducting environmental audits at the level of entire regions (for example, provinces, districts). The region’s environmental, economic, and social conditions are comprehensively examined, environmental risks are identified, and recommendations for their mitigation are developed. This contributes to regional sustainable development.

Alongside the introduction of ecological audits at the regional level, a proposal has been developed to use an ecological audit compliance index adapted to water scarcity conditions.

In our opinion, first, at a time when the demand for water for industrial, agricultural, and domestic purposes is growing in the regions, the volume of available resources is not stable and fluctuates sharply under the influence of climatic factors. Under these conditions, simple “compliance check” methods (relying solely on permits and reports) cannot adequately support management decisions regarding water use intensity, the stability of wastewater quality, share of reuse, and drought risk adaptation measures in an integrated system.

Secondly, the problem of regional governance is multifaceted, and the interplay among enterprises, utility networks, irrigated areas, and natural water bodies complicates the chain of cause and effect. Therefore, consolidating a set of indicators that rely on digital evidence, measure outcomes, and prioritize risk into a single index streamlines management and clearly defines accountability.

The proposed compliance index essentially serves as a “multi-factor thermometer adapted for water scarcity conditions.” It provides a regional overview of water use efficiency, the balance of water intake and discharge, wastewater treatment efficiency, the share of reuse, water losses, the rate of replenishment of reservoirs and groundwater, as well as indicators related to physical-geographic risks such as drought and salinization. Importantly, all indicators are presented in an intensive format – for example, water consumption per unit of product or income, clean water supply per capita, or the ratio of pollutants per cubic meter of wastewater to the regulatory limit. This approach allows for comparative analysis across regions and sectors, as differences in enterprise size or population do not distort the results.

The index is built in stages. First, a reliable database must be established for each indicator. On-site meters and sensors, laboratory protocols, enterprise resource planning systems, utility service registries, and regulatory forms are consolidated into a single regional repository. A mechanism for data quality checks, calibration, and filling gaps with focus measurements is implemented. Then the indicators are normalized to the 0–1 range. Here, “0” denotes minimal compliance (poor condition) and “1” denotes full compliance (good condition), and benchmark ranges that account for network and climatic characteristics are defined. The normalized indicators are combined using a weighted average, and the weights are determined scientifically based on the real impact channels of water scarcity (drinking water safety, ecosystem recovery capacity, potential economic damage) and public health criteria. The resulting single score, ranging from 0 to 1, indicates the level of spatial conformity for each district or city, and is displayed on maps as “green–yellow–red” zones.

The management effect of this index is that it is directly linked to the plan–do–check–act cycle. During the planning phase, year-on-year improvement intervals are set for the indicators in the index. In the implementation phase, technological modernization, water-saving equipment, wastewater treatment modernization, reuse projects and measures to reduce network losses are implemented, and during the monitoring phase, the index’s temporal trend, seasonal fluctuations, and differences between regions are evaluated. In the action phase, targeted programs are launched for the “red zones” with low scores, while high-performing regions are incentivized. The index allows each measure to be evaluated from a “value chain” perspective, as follows: water savings, reduction of fines and environmental risks, improvement of drinking water quality, disease prevention, and reduced production disruptions are calculated in monetary terms and linked to investment decisions.

Table 1 below presents the main indicators of the regional water scarcity-adjusted environmental audit compliance index and their formulas (Table 1).

**Table 1. Regional Water Scarcity-Adjusted Environmental Audit Compliance Index – Formula**

1. Main indicators and their formulas (area h, time t)

Indicator name	Sign	Formula (Word eq.)	Note
Water Use Efficiency (to revenue)	SFS	$SFS_{h,t} = \frac{(Water\ consumption_{h,t}(m^3))}{(Revenue_{h,t}(million\ soms))}$	Low is good
Net load on the water balance	SBL	$SBL_{h,t} = \frac{(Water\ withdrawal_{h,t} - Return_{h,t})}{(Annual\ recovery_h)}$	Low is good
Efficiency of wastewater treatment	OTS	$OTS_{h,t} = 1 - \frac{If.\ load\ (output)_{h,t}}{If.\ load\ (input)_{h,t}}$	0–1, high is good
Share of reuse	QFU	$QFU_{(h,t)} = \frac{Reused\ water_{h,t}}{Collected\ wastewater_{h,t}}$	0–1, high is good
Share of losses (municipal)	YU	$YU_{h,t} = \frac{(Network\ input_{h,t} - Calculated\ consumption_{h,t})}{(Network\ input_{h,t})}$	Low is good

Groundwater recovery rate	YST	$YST_{(h,t)} = \frac{\text{Groundwater recharge}_h}{\text{Groundwater withdrawal}_{h,t}}$	≥1 is close to the target
Drought impact indicator	QT	$QT_{h,t} = \psi(\text{SPEI}_{h,t}) \in [0,1]$	Climate indicator, 1 - good
Stability of population supply	ATB	$ATB_{h,t} = \frac{\text{Clean drinking water} \left( \frac{\text{m}^3}{\text{person}} \right)_{h,t}}{\text{Minimum standard} \left( \frac{\text{m}^3}{\text{person}} \right)}$	≥1 is good
Level of legal compliance	QMD	$QMD_{(h,t)} = 1 - \frac{\text{Number of serious violations}_{h,t}}{\max(1, \text{Inspected objects}_{h,t})}$	0–1, high is good

2. Normalization (0–1 range)

2.1. Goal-oriented normalization (0–1)

For each indicator X, a lower value is defined as “bad” and a higher value as “good,” or vice versa. The target (ideal)  $U_X$  and the minimum acceptable  $L_X$  thresholds are determined based on the region’s climate zone and the sector’s characteristics.

For indicators of the “less is better” type (e.g., SFS, SBL, YU):

$$S_X = \text{clamp} \left( \frac{U_X - X}{U_X - L_X}, 0, 1 \right)$$

For “the more, the better” type indicators (e.g., OTS, QFU, YST, ATB, QMD):

$$S_X = \text{clamp} \left( \frac{X - L_X}{U_X - L_X}, 0, 1 \right)$$

If the drought indicator is pre-mapped to 0–1:

$$S_{QT} = QT$$

The idea of the index we are proposing is that positive results (recycling, reuse, supply, groundwater recharge) are high, the score increases; as pressures (water scarcity, pollution, drought) intensify, the score decreases; and compliance (permit violations) affects the final score through a multiplier coefficient.

CONCLUSIONS AND SUGGESTIONS

Using the above index makes decision-making transparent. Governing bodies, businesses, and the public communicate in the same “language of measurement.” It becomes easier to clearly see which indicators are dragging down the overall score, pinpoint the source of the problem, and identify the responsible parties. Moreover, the index’s open methodology paves the way for external verification. Independent evaluators or research institutions can review the results and offer suggestions for improvement. In this way, the index becomes not just a simple ranking, but a management tool that encourages continuous improvement.

Of course, the methodology also has limitations, namely: the continuity and quality of data, synchronization between different sources, and the short-term impact of seasonal factors and emergencies on the index, which require constant attention. Therefore, the normalization ranges and weights are reviewed annually, and the index’s fractional composition is recalibrated to account for climate change trends, new technologies, and sanitary standards. If necessary, regions apply separate benchmark values by climate zone, ensuring comparative fairness.

In summary, the introduction of an ecological audit compliance index adapted to regional water scarcity practically strengthens the risk- and outcome-oriented, digital evidence-based approach outlined in the introduction. The index integrates management into a holistic information loop, sets clear priorities for improving resource-use efficiency, and links investment and policy measures to economic efficiency. Most importantly, it transforms audit findings from a “report” into an “action.” Through transparent criteria, rapid alerts, and a continuous feedback mechanism, it helps strengthen regional water security.

**List of used literature:**

1. Ахмеджанов К.Б. Иқтисодиётни диверсификациялаш шароитида ички аудит текшируви технологиясини тайёрлаш, режалаштириш ва ўтказишни такомиллаштириш. “Иқтисодиёт ва инновацион технологиялар” илмий электрон журнали. № 6, ноябрь-декабрь, 2015 йил. [www.iqtisodiyot.uz](http://www.iqtisodiyot.uz)
2. Бурцев В.В. Организация системы внутреннего контроля коммерческой организации. – М.: Экзамен, 2000. – 320 с.
3. Жўраев О.Н. Корхоналарда ички аудит хизматини ташкил этиш борасидаги мулоҳазалар // Ҳозирги шароитда бухгалтерия ҳисоби, иқтисодий таҳлил, аудит ва мутахассислар тайёрлашни такомиллаштириш. Республика илмий-амалий конференцияси. – Т.: ТДИУ, 2010. – Б. 41-43.
4. Ибрагимов А.К. Ишлаб чиқариш харажатлар ҳисоби, аудити ва қишлоқ хўжалик маҳсулотлари таннархини аниқлашни такомиллаштириш. и.ф.д. илмий даражасини олиш учун ёзилган дисс. автореф. – Т.: 2002. – 41 б.
5. Гусева Т.Н., Дайман С.Ю. Оценка воздействия на окружающую среду и экологический аудит промышленных предприятий: Анализ методологий //Химические технологии. - 2000. - №4. - с.34-43.
6. Дайман С.Ю. Развитие методологии экологического аудита промышленных предприятий. /Автореферат диссертации. — Российская академия государственной службы при Президенте РФ. - 2000.
7. Данилов-Данильян В.И., Залиханов М.Ч., Лосев К.С. Экологическая безопасность. Общие Принципы и российский аспект. — М., 2001.

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