Environment Protection Engineering

Vol. 52 2026 No. 1

DOI: 10.37190/epe/217237

BAO SHAN JIA (ORCID: 0009-0001-6653-5628)[1]
YAN LI (ORCID: 0009-0004-8259-2421)[2]

RESEARCH ON PROBLEMS AND COUNTERMEASURES OF ENVIRONMENTAL MONITORING QUALITY MANAGEMENT IN THE NEW ERA

This paper systematically examines the challenges and countermeasures in quality management of environmental monitoring in the new era. As global ecological governance deepens and the importance of environmental data grows, quality management in environmental monitoring has become crucial for ensuring data accuracy, supporting scientific decision-making, and facilitating international cooperation. The study first outlines the significance of environmental monitoring quality management in providing a basis for policy-making, improving governance efficiency, enhancing public trust, and promoting a green economy. It then analyzes major existing issues, including an inadequate management system, insufficient professional expertise, outdated equipment, lack of comprehensive quality control, and external interference as well as regional disparities. In response, the paper proposes a series of optimization strategies such as establishing a sound quality management system, enhancing personnel training, promoting equipment renewal and technological innovation, strengthening whole-process quality control, and advancing informatization and intelligent development. Finally, the study emphasizes the need to strengthen international standard alignment and technical cooperation in the future, promoting the evolution of environmental monitoring quality management toward greater intelligence, transparency, and globalization, thereby supporting the development of an efficient and equitable global environmental governance system.

1. INTRODUCTION

With the proposal of the Carbon Peak, Carbon Neutrality goals [1, 2] and the impetus from international initiatives such as the United Nations Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol, the Paris Agreement, the Glasgow Climate Pact, and the European Green Deal, the importance of environmental monitoring has become increasingly prominent [3]. Environmental monitoring refers to the technical activ-

[1]Research Institute of Science and Technology, Changhum University of Science and Technology, Changchun, China, corresponding author, email address: bsjia@163.com
[2]College of Liberal Arts, Changchun University, Changchun, China.

ity of systematic and continuous observation, analysis, and evaluation of various pollutants and other environmental elements to provide a scientific basis for environmental management, pollution control, and ecological protection. Environmental monitoring quality management involves specialized regulatory authorities treating the environment of a specific region as the object of surveillance, followed by sampling surveys, improvement screening, detailed management, and comprehensive analysis. It entails the comprehensive collection of information on the monitoring object, real-time monitoring of various regional environments, recording key change information, and conducting scientific research. Scientific and accurate conclusions about environmental quality are drawn through environmental investigation and comprehensive data analysis. Environmental monitoring quality management includes three aspects: firstly, quality management of monitoring methods, establishing standardized and compliant environmental monitoring methods to ensure accurate and traceable results; secondly, management of the specialized equipment used for monitoring and their quality, ensuring equipment is in good condition, calibration status is valid, and metrological characteristics meet requirements; thirdly, management of monitoring personnel and managers, ensuring their competence based on appropriate education, training, and work experience for relevant environmental monitoring positions and management tasks.

By advancing environmental monitoring quality management and adjusting various factors, the management level of environmental monitoring and the capability for environmental protection can be enhanced. The quality of environmental monitoring data directly affects the formulation and implementation effectiveness of environmental governance measures. Therefore, strengthening environmental monitoring quality management and improving data credibility have become top priorities in current environmental management work. Most countries have established environmental monitoring systems and made progress in network construction, technical equipment, and personnel, but numerous quality issues remain to be resolved. This paper systematically reviews the problems existing in current environmental monitoring quality management and proposes corresponding optimization strategies to promote its comprehensive improvement.

2. SIGNIFICANCE OF ENVIRONMENTAL MONITORING QUALITY MANAGEMENT

Environmental monitoring quality management is the core link of environmental monitoring work and the fundamental guarantee for ensuring the representativeness, accuracy, comparability, and completeness of monitoring data. Against the backdrop of an increasingly deepening global environmental governance system and severe transboundary environmental issues such as climate change and biodiversity loss, high-quality environmental monitoring has become a core issue of common concern for the international community. It is not only the technical basis for countries to fulfill their international en-

vironmental responsibilities but also crucial support for achieving the Sustainable Development Goals (SDGs) and addressing the global ecological crisis. Environmental monitoring quality management is not merely a technical task; it is an important foundation for supporting environmental management decisions, improving governance efficiency, and enhancing public trust.

2.1. PROVIDING SCIENTIFIC BASIS FOR ENVIRONMENTAL DECISION-MAKING

Environmental monitoring data is the most basic and critical source of information in environmental management. Accurate and reliable data can truly reflect environmental quality status, pollution source emission characteristics, and changing trends, providing a scientific basis for the formulation of environmental policies, the development of environmental protection plans, the selection of governance measures, and the evaluation of implementation effectiveness. Accurate and credible environmental data are also the fundamental basis for formulating transnational environmental policies, assessing the effectiveness of global agreements, and early warning of cross-border pollution and ecological risks. If data quality cannot be guaranteed, environmental decisions based on such data will lose pertinence and effectiveness, potentially leading to policies deviating from reality, wasted governance resources, and ultimately affecting the achievement of overall environmental protection goals [4]. Monitoring data lacking unified quality management will also undermine the fairness and effectiveness of international climate negotiations. Only through high-standard quality control can the comparability and authority of data at the international level be ensured, thereby assisting international bodies like the Intergovernmental Panel on Climate Change (IPCC) and Intergovernmental Science – Policy Platform on Biodiversity and Ecosystem Services (IPBES) in completing scientific assessments and providing a common knowledge base for global environmental governance. For example, when formulating action plans for air pollution prevention and control, precise monitoring data of pollutants such as $PM_{2.5}$, SO_2, and NOx are essential to identify key regions, key periods, and key source categories, thus enabling differentiated control strategies. If data contain systematic biases or random errors, accurately determining the causes of pollution becomes difficult, and governance measures are unlikely to be effective. The Paris Agreement requires countries to regularly submit Nationally Determined Contributions (NDCs) and participate in global stocktakes, the foundation of which is comparable and verifiable greenhouse gas emission data.

Therefore, strengthening whole-process quality management and ensuring quality control throughout the chain from sampling, analysis, to reporting is an inevitable requirement for enhancing the scientific nature of environmental decision-making.

2.2. ENHANCING ENVIRONMENTAL GOVERNANCE EFFICIENCY

Environmental governance requires “speaking with data”, and high-quality data are the prerequisite for improving the refinement of governance. By establishing a sound

quality management system, precise identification of pollution sources, objective assessment of pollution levels, and timely early warning of pollution trends can be achieved, thereby helping management departments optimize governance pathways and improve the pertinence and effectiveness of governance measures. Environmental pollution and ecological degradation often transcend national borders. Addressing issues such as transboundary river basin air pollution, marine plastic litter, and persistent organic pollutants (POPs) requires regional and even global coordination. High-quality environmental monitoring data enable countries to identify pollution sources, assess transboundary impacts, jointly formulate emission reduction strategies, and track governance progress.

In practice, quality management includes not only analytical quality control within the laboratory but also covers field sampling, sample preservation, transportation, data processing, and review. Only by achieving fully standardized and regulated operations throughout the entire process can environmental monitoring results truly reflect the state of the environment, avoiding data distortion caused by improper operations or human interference. Building on this, integrating modern information technologies such as big data and the Internet of Things (IoT) enables dynamic monitoring and intelligent analysis of environmental quality, further improving the response speed and processing efficiency of environmental governance, and promoting a shift from passive response to active early warning and precise governance. In Europe, the European Union has established a unified environmental monitoring and reporting system, enabling the sharing and comparison of air, water, and other data among member states, thus effectively implementing regional policies like the Industrial Emissions Directive and the Water Framework Directive. Southeast Asian countries also collaborate to address forest fire haze through the ASEAN Agreement on Transboundary Haze Pollution, relying on a quality-controlled air quality monitoring network. Without quality-assured monitoring, international cooperation will lack mutual trust, and governance measures will be difficult to implement accurately.

2.3. ENHANCING PUBLIC TRUST AND PARTICIPATION

Environmental quality concerns public health and social stability. The openness and transparency of environmental information are key to building public trust, promoting corporate accountability, and facilitating the participation of non-governmental organizations and citizens in international environmental supervision. High-quality environmental monitoring data can objectively demonstrate environmental conditions and governance effectiveness, helping the public understand the real situation and avoiding misunderstandings and panic caused by incomplete or inaccurate information. By proactively releasing air quality forecasts, water quality monitoring reports, corporate pollutant discharge information, etc., governments respond to public concerns and accept social supervision. This not only enhances government transparency and authority but also promotes the implementation of corporate environmental responsibility. All of this is based on the authenticity, reliability, and comparability of environmental monitoring data. Once data

quality is questioned, it can not only damage the government's image but also weaken public support and willingness to participate in environmental protection efforts [5]. In the era of global information interconnection, the public, environmental organizations, and investors increasingly demand high environmental data quality. Open data also provides a basis for social supervision, conducive to forming a co-governance pattern involving government, enterprises, and the public. Data lacking credibility can not only harm government credibility but also trigger international disputes or trade barriers. Some countries have faced international criticism due to insufficient or distorted environmental data disclosure, even affecting their international image and access to green investment. Conversely, establishing an open and high-quality national environmental data platform enhances not only the transparency of domestic environmental governance but also international confidence in the country's environmental commitments. Global platforms such as the Earth System Data promoted by the United Nations Environment Programme (UNEP) also rely on high-quality data provided by countries. These data help global civil society track the implementation of environmental commitments and participate in international supervision, truly forming a new pattern of Earth governance that combines top-down and bottom-up approaches.

2.4. SUPPORTING THE GREEN ECONOMY AND GLOBAL ENVIRONMENTAL TECHNOLOGY COOPERATION

In the context of the global transition towards a low-carbon and circular economy, environmental monitoring quality is also directly related to the international certification of green technologies, the implementation of carbon market mechanisms, and the realization of ecological product value. For instance, international carbon credit mechanisms (like Verified Carbon Standard (VCS), Gold Standard) strictly require the monitoring, reporting, and verification (MRV) of project emission reductions, where data quality directly affects market credibility and transaction fairness. Similarly, in areas such as control of transboundary movement of pollutants and international registration of chemicals (e.g., Stockholm Convention), reliable testing and monitoring capabilities are prerequisites for a country's participation in the global green supply chain. Building high-quality environmental monitoring capacity has become a key area for international development assistance and South-South cooperation, helping developing countries improve their data production capabilities and integrate into the global environmental governance system. Environmental monitoring quality management has far exceeded the scope of domestic affairs; it is the "infrastructure" of the global environmental governance system. Without high-quality, comparable, and internationally recognized environmental data, any global agreement or policy will be difficult to implement effectively. As humanity jointly faces ecological and climate crises, strengthening environmental monitoring quality management, promoting mutual recognition of international standards, and building global data sharing mechanisms are not only technical tasks but also ethical requirements for fulfilling

the responsibilities of global citizenship and achieving a sustainable future. Countries should work together to continuously improve the quality and transparency of environmental monitoring data, providing solid support for building a greener, fairer, and more coordinated global ecological governance system.

3. MAIN PROBLEMS FACING ENVIRONMENTAL MONITORING QUALITY MANAGEMENT UNDER THE NEW SITUATION

In recent years, with the deepening of ecological construction and the continuous improvement of the environmental governance system, significant progress has been made in environmental monitoring quality management, but many deep-seated problems remain, restricting the improvement of monitoring data quality and international credibility. Especially against the background of the accelerating restructuring of the global environmental governance system and the deepening advancement of the green and low-carbon transition, these problems have become more prominent. The challenges currently faced in the quality management of environmental monitoring are systematic and interrelated, primarily manifested in the following five aspects, covering areas such as management systems, personnel competence, monitoring equipment, quality control procedures, and the impact of external interference.

3.1. INCOMPLETE MANAGEMENT SYSTEM

Currently, the environmental monitoring quality management system in some institutions is still not perfect, and its systematicness and standardization need strengthening. Some environmental monitoring agencies have not yet established standardized quality management systems, lacking complete quality manuals, procedure documents, and work instructions, leading to inconsistent operations and insufficient standardization in the monitoring process. Particularly in local-level monitoring agencies, the phenomenon of *emphasizing data output over process management* and *emphasizing hardware investment over system construction is still common* [6]. Quality supervision is often perfunctory, and internal audit and management review mechanisms are unsound, making it difficult to achieve effective control and continuous improvement of the entire monitoring process. The ISO/IEC 17025 standard (General requirements for the competence of testing and calibration laboratories) provides a basis for environmental monitoring agencies to establish strict quality certification and data review systems, achieving international mutual recognition of monitoring data. In some agencies that have established quality management systems according to ISO/IEC 17025, the system documentation may be well-written but disconnected from actual workflows; the serious phenomenon of "two skins" – system documents versus system operation – exists. The purpose of establishing a quality management system in some agencies may be merely *to obtain a certificate*

rather than truly using it for continuous improvement. Problems such as insufficient capacity of grassroots personnel and vicious competition in the third-party market persist, and the path of continuous improvement remains long.

3.2. INSUFFICIENT PROFESSIONAL COMPETENCE OF PERSONNEL

Environmental monitoring is a highly specialized field with rapidly updating technology. The professional competence of monitoring personnel directly affects the quality of environmental monitoring data. Currently, teams in some environmental monitoring agencies face issues such as an unreasonable professional structure, insufficient technical training, and varying levels of responsibility awareness. Especially in some county-level or remote monitoring stations, personnel aging is severe, knowledge structure updates are slow, and the ability to accept and apply new technologies, such as emerging pollutants, automatic monitoring equipment, and big data analysis, is weak. Some personnel lack systematic pre-job training and continuing education, often relying on experience in practical operations, making it difficult to strictly implement standard methods.

3.3. OUTDATED MONITORING EQUIPMENT AND INADEQUATE MAINTENANCE

Monitoring equipment is a crucial tool for obtaining environmental data, and its condition directly determines data accuracy. Currently, many environmental monitoring stations still use overdue, technologically outdated equipment, which often has low precision, poor stability, and frequent failures [7]. Particularly in some economically underdeveloped countries and regions, due to limited funding, equipment renewal is slow, difficult to meet the increasingly refined monitoring requirements. On the other hand, daily maintenance, regular calibration, and performance verification of equipment have not received sufficient attention. Problems such as incomplete maintenance records, non-standard calibration cycles, and chaotic spare parts management are widespread, further exacerbating data quality risks. The popularization of advanced technologies such as sensor networks and remote sensing monitoring is still relatively low, leaving significant room for improvement in equipment intelligence and networking.

3.4. LACK OF QUALITY CONTROL LINKS

Environmental monitoring is a chain consisting of multiple links, such as sampling, transportation, preservation, pretreatment, analysis, and data processing. Loss of control in any link may lead to distortion of the final data [8]. In reality, quality control measures are not adequately implemented in multiple links. During the sampling stage, problems such as unreasonable sampling point layout, inappropriate sampling timing, and contamination of sampling appliances occur frequently. During sample transportation and preser-

vation, conditions like temperature control and timeliness are not strictly followed, leading to sample deterioration or loss of representativeness. Within the laboratory, quality control measures such as standard curve control, blank tests, parallel sample analysis, and spike recovery are not strictly implemented, making it difficult to ensure data accuracy. Furthermore, issues like non-standard filling of original records and lack of data review mechanisms directly affect the authenticity and integrity of the data.

3.5. EXTERNAL INTERFERENCE AND REGIONAL DIFFERENCES

Environmental monitoring is conducted in complex natural and social environments and is susceptible to various external factors. Significant differences exist among regions in terms of topography, climate, pollution source structure, and economic development level, which require monitoring programs to have strong regional adaptability [9]. However, many current monitoring plans still adopt a *one-size-fits-all* model, lacking differentiated designs for different regions, resulting in insufficient representativeness and usability of monitoring data. Meanwhile, human intervention in monitoring, such as selective site placement and avoiding sampling during high pollution periods, still exists in some areas, severely damaging the objectivity and credibility of the data. Additionally, complex pollution, background interference, and emergencies pose higher requirements for monitoring quality. The U.S. Environmental Protection Agency (EPA) has established monitoring guidelines for different ecological regions, emphasizing the spatial representativeness and timeliness of data, which is worth referencing for other countries.

Table 1

Classification of environmental monitoring quality management issues and international response strategies

Category	Main manifestations	International advanced practices
Management system	incomplete system, superficial supervision	widespread adoption of ISO/IEC 17025, emphasizing certification and audit
Personnel quality	aging grassroots staff, insufficient training	implementation of qualification certification and continuous education systems
Equipment technology	outdated equipment, inadequate maintenance	promotion of intelligent and networked monitoring technologies
Quality control	lack of whole-process control	establishment of legalized and standardized quality control procedures
External interference	poor regional adaptability, human interference	formulating differentiated monitoring plans, strengthening data transparency

Table 1 presents the types of problems, their manifestations, and advanced international practices in the field of environmental monitoring quality management among some environmental monitoring agencies.

4. OPTIMIZATION COUNTERMEASURES FOR ENVIRONMENTAL MONITORING QUALITY MANAGEMENT

To comprehensively enhance the systematicity and effectiveness of environmental monitoring quality management, it is imperative to adopt comprehensive measures from multiple dimensions and establish a more scientific, standardized, and efficient quality assurance mechanism. This chapter systematically proposes optimization strategies for environmental monitoring quality management in five aspects: system construction, personnel training, equipment upgrades, process control, and digital transformation, aiming to promote the high-quality development of environmental monitoring.

4.1. ESTABLISHING A SOUND QUALITY MANAGEMENT SYSTEM

Efforts should be accelerated to build a comprehensive and standardized environmental monitoring quality management system. Quality management manuals, procedure documents, and work instructions should be developed and improved to clarify responsibilities and operational specifications for each link. The implementation of the ISO/IEC 17025 international standard in monitoring agencies should be actively promoted, along with laboratory accreditation and proficiency testing, to enhance standardization. Simultaneously, sound internal audit and management review mechanisms should be established, conducting regular quality supervision inspections and system assessments to achieve closed-loop control and continuous improvement of quality management. Learning from the EU experience, establishing cross-regional, cross-departmental quality coordination mechanisms to promote the unification of monitoring standards, data formats, and quality control requirements is recommended to enhance data comparability and synergy.

4.2. STRENGTHENING PERSONNEL TRAINING AND TEAM BUILDING

Personnel are the most dynamic factor in quality management. Regular, multilevel technical training and assessment mechanisms should be established. Monitoring personnel should be regularly organized to participate in training on standard methods, instrument operation, quality control, and new technology applications, accompanied by an assessment-based post-qualification system. To address the aging knowledge of grassroots personnel, continuing education in such forms as targeted training, online learning, and practical training exchanges, can be conducted in cooperation with universities and research institutions. Actively introducing high-level talents with backgrounds in environmental science, data analysis, and intelligent equipment operation can optimize the team structure. A scientific performance appraisal and incentive mechanism should also be established to enhance the sense of responsibility, mission, and motivation of monitoring personnel. In countries like Germany and the USA, environmental monitoring personnel require strict qualification certification and continuous education to ensure their competence matches job requirements.

4.3. PROMOTING EQUIPMENT UPDATING AND TECHNOLOGICAL INNOVATION

Financial investment in environmental monitoring should be increased, with special funds established for equipment renewal, to gradually phase out backward and outdated equipment and promote the application of high-precision, high-stability, and intelligent monitoring instruments. Particular attention should be paid to updating and upgrading key network equipment such as automatic air stations, automatic water quality stations, and online pollution source monitoring systems. A whole-life-cycle management system for equipment should be established and improved, perfecting equipment files, and developing and strictly implementing daily maintenance, regular calibration, and performance verification plans. Meanwhile, advanced technologies such as drone remote sensing, sensor networks, satellite remote sensing, and the Internet of Things should be actively introduced to promote the development of environmental monitoring towards automation, intelligence, and networking, enhancing the efficiency and accuracy of data collection [10].

4.4. STRENGTHENING WHOLE-PROCESS QUALITY CONTROL

The focus of environmental monitoring quality control is the refined management and strict control of the entire monitoring process. During the sampling stage, point layout schemes should be scientifically optimized, sampling operations standardized, and sampling conditions and environmental parameters recorded in detail. In the sample transportation and preservation stage, requirements for cold chain transportation, light-proof preservation, and timeliness control must be clarified to prevent sample deterioration or contamination. Within the laboratory, standard analytical methods must be strictly followed, comprehensively implementing quality control measures such as blank tests, parallel sample determination, and spike recovery rate calculation. In the data processing and review stage, a sound data verification and review system must be established to promptly trace and re-check abnormal data [11]. The U.S. EPA's Quality Assurance Project Plan (QAPP) achieves standardization and documentation of whole-process control. The EU, through regulations like the Environmental Noise Directive and the Water Framework Directive, has clarified statutory requirements for whole-process quality control. The standardization and enforcement in this aspect are worth referencing for other countries.

4.5. PROMOTING INFORMATIZATION AND INTELLIGENT CONSTRUCTION

A unified national environmental monitoring big data platform should be constructed to integrate various monitoring resources, achieving real-time data collection, networked reporting, centralized storage, and shared application [12]. Utilizing technologies such as artificial intelligence (AI) and machine learning, intelligent analysis tools for automatic data verification, outlier identification, and trend prediction should be developed to enhance the efficiency and accuracy of data review. By constructing environmental quality

early warning and decision support systems, rapid response and precise management of pollution processes and emergencies can be achieved. Meanwhile, the application of new technologies like blockchain in data traceability and tamper prevention should be promoted to further enhance the credibility and transparency of monitoring data [13]. The EU's "Copernicus" Earth observation program provides an example of large-scale environmental data sharing and intelligent analysis, from which other countries can actively learn [14].

5. CONCLUSION AND OUTLOOK

This paper systematically analyzed the main problems facing environmental monitoring quality management in the new era, including an incomplete management system, insufficient professional competence of personnel, outdated monitoring equipment, a lack of quality control links, and external interference and regional differences. Corresponding optimization countermeasures were proposed. Research indicates that environmental monitoring quality management is not only a technical issue but also fundamental work related to the scientific nature of environmental decision-making, the improvement of governance efficiency, public trust, and international cooperation. Against the backdrop of the accelerating restructuring of the global environmental governance system, the internationalization of environmental monitoring quality management has become an irreversible trend. In the future, further efforts should be made to enhance the alignment and mutual recognition of international standards, promote the implementation of international standards like ISO/IEC 17025 in more countries and regions, improve the international comparability and credibility of environmental data, and foster transnational and cross-regional environmental monitoring cooperation and data integration. Technological innovation will be a key driver for improving environmental monitoring quality management. The widespread application of technologies such as the Internet of Things (IoT), artificial intelligence (AI), and blockchain will enable the intellectualization, real-time capability, and transparency of environmental monitoring, significantly enhancing the efficiency and reliability of data collection, processing, and review. Furthermore, international assistance to developing countries in equipment, technology, and personnel capacity building should be strengthened to promote the balanced development of the global environmental monitoring system.

Looking ahead, environmental monitoring quality management will place greater emphasis on whole-process, all-element, and all-participant quality control, gradually forming a modern governance pattern led by the government, coordinated by multiple parties, and involving public participation. Only through continuous international cooperation and technological innovation can a greener, fairer, and more efficient global environmental governance system be built, providing solid data support and decision-making basis for addressing global ecological and climate crises.

REFERENCES

[1] ZHANG C., ZHENG Y.J., LING H., *China's "Double Carbon" goal and practice: formation logic, realistic challenges, social risks and the way forward*, J. Hohai University, Philos. Soc. Sci., 2022, 24 (6), 78–87. DOI: 10.3876/j.issn.1671-4970.2022.06.010 (in Chinese).

[2] ZHANG Z., HU G.W., MU X.Z., *From low carbon to carbon neutrality: a bibliometric analysis of the status, evolution and development trend*, J. Environ. Manage., 2022, 322, 116087. DOI: 10.1016/j.jenvman. 2022.116087.

[3] SUN Y.P., HU L., *Reconstruction of global climate governance model and China's action strategy*, Nanjing J. Soc. Sci., 2017, 6, 29–37. DOI: 10.15937/j.cnki.issn1001-8263.2017.06.005 (in Chinese).

[4] LI Y.S., YAN J., *On the evidence effectiveness of monitoring data of pollution sources*, J. Hohai Univ., 2021, 23 (6), 102–108. DOI: 10.3876/j.issn.1671-4970.2021.06.014 (in Chinese).

[5] LIU H.T., WANG G., JIAO C.Y., WU M.M., *Practice and reflection on the construction of the legal system of ecological environment monitoring in China*, Environ. Monit. China, 2023, 39 (6), 27–31. DOI: 10.19316 /j.issn.1002-6002.2023.06.03 (in Chinese).

[6] PENG G.H., YIN Q., KANG C.G., LI X.Y., ZHANG Z.H., CAI Q., OU Y.T., ZHONG H.Y., CHEN Y., XIA X., *Construction and practice of environmental monitoring quality management system in multisite laboratory*, Environ. Monit. China, 2024, 40 (3), 27–33. DOI: 10.19316/j.issn.1002-6002.2024.03.04 (in Chinese).

[7] TONG Y., *Environmental monitoring instruments and equipment fault rule and management maintenance*, Die & Mould Manuf., 2024, 24 (12), 227–229. DOI: 10.13596/j.cnki.44-1542/th.2024.12.075 (in Chinese).

[8] ZHOU L.Q., *Implementing the "five characteristics" requirements for environmental monitoring data quality*, Environ. Dev., 2018, 30 (6), 156–158. DOI: 10.16647/j.cnki.cn15-1369/X.2018.06.092 (in Chinese).

[9] WU J., *Influencing factors and control measures of sampling quality of environmental monitoring site*, Environ. Dev., 2020, 32 (10), 179–181. DOI: 10.16647/j.cnki.cn15-1369/X.2020.10.102 (in Chinese).

[10] ZHU N.H.N.W., YOU D.A., XU N.N., ZHANG J., TENG J.H., *Research on the ecological environment remote sensing monitoring system of integration of "Space-Air-Ground-Sea"*, Environ. Monit. China, 2025, 41 (3), 7–13. DOI: 10.19316/j.issn.1002-6002.2025.03.02 (in Chinese).

[11] LIAO D.B., LI J.K., *Discussion on common problems and countermeasures for realizing traceability of ecological environment monitoring data*, Environ. Prot., 2019, 47 (15), 17–20. DOI: 10.14026/j.cnki. 0253-9705.2019.15.004 (in Chinese).

[12] GUO C.R., SU J.J., *Thoughts on constructing eco-environment monitoring system in the new era*, Environ. Prot., 2019, 47 (Z1), 71–76. DOI: 10.14026/j.cnki.0253-9705.2019.z1.012 (in Chinese).

[13] YANG G.Q., *Research on the path to enhancing the capability of environmental monitoring technology in the new era*, China Tire Resour. Recycl., 2025, (7), 181–183. DOI: 10.19307/j.cnki.ctrr.2025.07.050 (in Chinese).

[14] ASCHBACHER J., MILAGRO-PÉREZ M.P., *The European earth monitoring (GMES) programme: Status and perspectives*, Remote Sens. Environ., 2012, 120 (5), 3–8. DOI: 10.1016/j.rse.2011.08.028.