Application of Environmental Monitoring Technology in Environmental Governance

Xubo Sun [1,2,3,4,5,*], Hong Cao [1,2,3,4,5]

[1]Shaanxi Provincial Land Engineering Construction Group Co., Ltd. , China

[2]Institute of Land Engineering and Technology, Shaanxi Provincial Land Engineering Construction Group Co., Ltd. , China

[3] Key Laboratory of Degraded and Unused Land Consolidation Engineering, the Ministry of Natural Resources, China

[4]Shaanxi Provincial Land Consolidation Engineering Technology Research Center, China

[5]Land Engineering Quality Testing of Shaanxi Land Engineering Construction Group Co., Ltd., China

Abstract

In recent years, environmental governance has gradually attracted widespread attention, and various advanced environmental detection technologies have emerged, which can obtain precise data in real-time detection and effectively identify and control pollution sources, thereby promoting the implementation of scientific governance methods. In view of this, this paper provides a brief analysis of the typical environmental detection technologies currently in widespread use, and discusses the promotion role of environmental detection technology in environmental governance, summarizing the pathways for rationally applying environmental detection technology to enhance environmental governance effectiveness for reference by relevant personnel.

Keywords

Environmental detection technology; environmental governance; promotion role.

1. Introduction

Environmental monitoring technology mainly includes physical, chemical, and biological means, based on physical, chemical, and biological principles, relying on precision instruments, and using data processing technology to efficiently detect the concentration, distribution, and trend of pollutants. It has been widely applied in pollution source identification, pollution monitoring, and optimization of pollution control schemes. The effective application of environmental monitoring technology and technical upgrading in the process of environmental governance can promote the improvement of environmental governance effects and provide strong support for building an efficient and green environmental governance system.

2. Typical environmental monitoring technologies widely used at present

2.1. Physical detection technology

Physical detection technology has the characteristics of strong real-time performance, intuitive data, and easy operation, mainly relying on acoustics, optics, and electromagnetic technologies to detect the concentration, intensity, and trend of physical pollutants in the environment. The application of this technology in environmental monitoring mainly includes data collection and data transmission. In data collection, physical detection technology uses high-precision instruments for on-site data detection. For noise detection, sound level meters and noise

analyzers can accurately measure decibels and display them in real time. The equipment captures the characteristics of sound waves and analyzes the specific location and waveform changes of the noise source. For dust detection, the instruments mainly use optical particle counters, which can precisely detect the concentration of suspended particles in the air in the method of light scattering and display the dust content and fluctuation situation in real time. In the data transmission stage, relying on modern network technology, physical detection equipment can transmit data to the central monitoring system through wireless networks or wired networks for real-time aggregation and remote analysis. In the data transmission process, based on encryption and transmission protocols, the stability and security of information transmission can be guaranteed, making the upload of environmental data have a higher reliability. This real-time data transmission can connect the on-site detected environmental conditions with the back-end system seamlessly. Once the data reaches an abnormal threshold, the monitoring system will automatically issue an alert, allowing the detection personnel to respond in a timely manner.

2.2. Chemical detection technology

The main application method of chemical detection technology is sampling, analysis, and detection, using advanced means such as chromatographic analysis, spectroscopic

Presently, qualitative and quantitative detection of pollutants is carried out. In the sampling stage, chemical detection techniques select air, surface water, or soil samples based on the type of pollutant and environmental conditions, and use sampling devices to fix and seal the samples, ensuring stability of the samples during transportation and storage to avoid interference from the outside that affects detection accuracy. In the analysis and detection process, chromatography and spectroscopy, etc. precision instruments can separate and identify pollutant components, gas chromatograph and liquid chromatograph can separate specific pollutant components in complex samples, and combine mass spectrometer to achieve accurate identification of components. In the spectroscopic analysis, atomic absorption spectrometer and ultraviolet-visible spectrophotometer can use the absorption characteristics of pollutants at specific wavelengths to quantitatively analyze heavy metals, pesticide residues, and organic pollutants, ensuring the accuracy of detection results [2]. In the application of electrochemical analysis, based on ion selective electrodes, sensors, etc. equipment, the concentration of ions in the solution is detected in real time, often used for rapid analysis of water quality for pollutants such as ammonia nitrogen and sulfides.

2.3. Biological detection technology

Ecotoxicity testing is an important tool for evaluating the degree of impact of pollutants on biological bodies. Research in this field can reveal the complex interactions between pollutants and biological bodies, providing scientific basis for environmental protection and management. In soil pollution investigation and solid waste management, biotoxicity testing can more accurately evaluate the ecological risks of polluted soil and the potential biotoxicity of solid waste treatment processes. In the process of using biotoxicity testing methods for soil pollution investigation, representative soil samples need to be selected first, and the natural environment in the laboratory is simulated to observe the effects of pollutants on soil microorganisms, plants, etc. Biological bodies, and the changes in their structures are analyzed to understand the effects of pollutants on biological bodies. In solid waste management, the disposal and incineration of solid waste may produce various toxic and harmful substances, which can cause serious harm to biological bodies once released into the environment. Therefore

It is necessary to screen out more environmentally friendly solid waste treatment technologies by comparing the toxic effects generated by different solid waste treatment methods [3].

3. The Role of Environmental Detection Technologies in Environmental Governance

3.1. Improving the Efficiency of Pollution Source Identification

Environmental detection technologies show obvious advantages in improving the efficiency of pollution source identification. They can quickly and accurately locate and analyze the characteristics of pollution sources by relying on physical, chemical, and biological detection technologies. Physical detection technologies can conduct real-time detection of physical pollutants in the environment. Among them, sound level meters and noise analyzers can accurately locate the distribution areas of noise pollution sources, optical particle counters can reflect the dust concentration in the air, and electromagnetic detectors have the characteristics of high sensitivity and accuracy in the identification of radiation pollution sources. The combination of data collection and real-time transmission can significantly improve the identification efficiency of physical detection technologies for pollution sources such as noise and dust [4].

By making full use of gas chromatographs and liquid chromatographs, chemical detection technologies can separate the chemical components in complex samples and identify them in combination with mass spectrometry, so as to accurately identify the types of pollutants in the air, soil, and water quality, which helps to shorten the time for pollution source identification. Especially in water body and soil pollution investigations, it can detect the concentrations of ions such as ammonia nitrogen and sulfides in real time and further improve the detection sensitivity of pollutants.

When applying biological detection technologies, ecological toxicity testing is mainly carried out. By observing the impact of pollutants on living organisms, the potential hazards of pollution sources are revealed. Biological toxicity testing in soil and solid waste management can simulate the impact of the polluted environment on living organisms and quickly evaluate the ecological risks of different pollution sources. For example, in soil pollution investigations, testing the growth of microorganisms and plants in polluted soil in the laboratory helps to accurately judge the ecological toxicity level of pollutants. This biological detection method provides an important ecological effect basis for pollution source identification, making the detection results more comprehensive.

3.2. Improving the Precision of Environmental Pollution Monitoring

Improving the precision of environmental pollution monitoring is an important role played by environmental detection technologies in pollution treatment. Relying on the synergy of physical, chemical, and biological detection means, it can achieve multi-angle and high-precision monitoring of pollution sources and support the efficient implementation of scientific decision-making.

Physical detection technologies can capture the dynamic changes of physical pollutants such as noise, dust, and radiation in real time, generate high-resolution pollution change trend charts, and accurately locate the positions of noise sources. Optical particle counters can identify the concentration of particulate matter in the air and provide data support for grasping the diffusion trend of dust pollution. Efficiently integrating and analyzing data can achieve rapid early warning when pollution sources are abnormal, thereby significantly improving the accuracy of pollution detection.

Chemical detection technologies focus on the detection of chemical pollutants in water quality, air, and soil. Gas chromatographs and liquid chromatographs can separate specific components such as organic pollutants and heavy metal ions in complex samples and identify the components through mass spectrometers to ensure the accuracy and stability of pollution data. Spectral analysis technologies can achieve high-precision analysis of pollutants such as heavy

metals and organic substances. Electrochemical analysis technologies can understand the changes in the concentrations of ions such as ammonia nitrogen and sulfides in water in real time through ion-selective electrodes and sensor devices and achieve rapid detection of water body pollution. Chemical detection technologies can ensure the accuracy of pollutant component data and achieve continuous tracking of pollution changes.

In soil pollution monitoring, biological detection technologies can observe the impact of pollutants on microbial communities, plants, and other biological structures and accurately judge the ecological risks of pollutants. In solid waste treatment detection, biological toxicity testing can simulate the treatment processes such as solid waste landfill and incineration, evaluate the potential toxicity of harmful substances released under specific environmental conditions to living organisms, and thus screen out low-pollution treatment technologies to ensure the safety of the ecosystem.

Therefore, the comprehensive application of various detection technologies can provide a solid technical support for efficient pollution treatment and scientific environmental management [5].

3.3. Promoting the Scientification of Environmental Governance Methods

Through high-precision detection means, environmental detection technologies can provide accurate data for the identification and analysis of pollutants, thus providing support for the scientific decision-making of governance measures.

Physical detection technologies can effectively measure the concentrations and distribution situations of physical pollutants such as noise, dust, and radiation with the help of precision instruments. Governance plans can be adjusted according to the specific characteristics of physical pollution sources to ensure that governance measures are more precise.

Chemical detection technologies can accurately identify the components and concentrations of chemical pollutants in water, soil, and air. In view of the characteristics of different pollutants, scientific governance methods can be adopted. For heavy metal or organic pollution, detailed component and content information can be provided to ensure that the selection of governance materials and processes conforms to the chemical characteristics of pollutants and effectively improve the governance efficiency.

Biological detection technologies can evaluate the toxic effects of pollutants on living organisms such as microorganisms and plants and reveal the ecological hazards of pollutants. Based on the detection results at the ecological level, the selection of governance methods with low environmental risks can be supported, providing scientific guidance for soil remediation and solid waste treatment.

Overall, the high-precision data of physical, chemical, and biological detection technologies provide a scientific basis for environmental governance, which can help decision-makers accurately formulate and optimize pollution control strategies and realize the scientification of environmental governance.

4. Paths to Reasonably Apply Environmental Detection Technologies to Enhance the Effect of Environmental Governance

4.1. Optimizing Technology Selection and Improving the Adaptability to Application Scenarios

The selection of environmental detection technologies needs to fully consider the nature of pollutants and their distribution characteristics.

In the treatment of air pollution, high-sensitivity optical particle counters, gas chromatographs and other precision instruments can achieve rapid detection and concentration tracking of

components such as particulate matter and volatile organic compounds. For noise pollution scenarios, sound level meters and noise analyzers have the function of accurately capturing sound wave frequencies, can detect the waveform changes of different sound sources, effectively evaluate the activity patterns and distribution characteristics of noise pollution sources, and thus achieve accurate data collection in environmental governance.

In water quality detection, selecting appropriate detection equipment according to the environmental conditions can improve the detection efficiency. For pollutants such as heavy metals and ammonia nitrogen in water bodies, equipment like atomic absorption spectrometers, ion-selective electrodes and sensors have the characteristics of rapid response and can achieve accurate quantitative detection of pollutants in on-site analysis. For surface water and groundwater detection, a combination of portable chemical analyzers and online detection equipment can be adopted to achieve long-term tracking of water pollution sources and ensure the continuity and stability of data collection.

In solid waste and soil treatment, the selection of biological toxicity testing technologies needs to be based on the pollution types and soil properties. Ecotoxicity testing can be carried out by using biological indicator species with strong adaptability (such as microorganisms and plant roots). The potential threats of pollutants to the ecosystem can be observed through a combination of laboratory simulation and on-site detection, and the optimal remediation technologies can be screened out. The selection of reasonable detection technologies can not only ensure the accuracy and integrity of data but also provide support for formulating scientific environmental governance plans and enhance the governance effect in diverse application scenarios.

4.2. Strengthening the Synergy of Multiple Technologies to Improve Detection Precision

Strengthening the synergy of multiple technologies can significantly improve the precision and comprehensiveness of environmental detection. The combined application of physical, chemical, and biological detection means can achieve multi-angle and all-round monitoring of pollution sources.

In air pollution detection, the application of optical particle counters and gas chromatographs can accurately detect suspended particulate matter and volatile organic compounds and realize real-time identification and concentration monitoring of various pollution components. Combined with lidar technology to further expand the detection range, three-dimensional imaging of the distribution of pollutants in the atmosphere can be achieved, providing more comprehensive scientific data for air quality assessment.

In water quality detection, the coordinated cooperation of electrochemical sensors and spectral analyzers can quickly analyze components such as heavy metal ions and ammonia nitrogen in water bodies. By using the synergy of multiple technologies to achieve a balance between precision and response speed, the real-time reliability of pollutant data can be ensured.

For soil and solid waste pollution detection, the synergy of biological toxicity testing and chemical analysis can deeply evaluate the ecotoxicity of pollutants and achieve the complementarity of qualitative and quantitative data. Biological toxicity testing can evaluate the potential impact of soil or solid waste treatment on organisms. Combined with chemical detection to obtain the specific concentrations and types of pollutants, the scientific nature of the data can be ensured.

4.3. Improving the Data Feedback Mechanism to Strengthen Real-time Governance

Improving the data feedback mechanism can effectively promote the real-time response and optimization of environmental governance. Establishing an efficient and accurate feedback

system can detect and quickly process pollution data in real time and achieve scientific management of sudden pollution incidents.

Firstly, environmental detection technologies need to directly transmit the collected data to the central monitoring system. With the help of wireless sensor networks and edge computing technologies, the time for data transmission and processing can be shortened to ensure the timeliness of feedback. Detection technologies can set warning thresholds in practical applications. When pollution data exceeds the standards, the system can automatically generate alarm information and send it to relevant governance departments to achieve a rapid response. In data processing and feedback, relying on big data analysis and artificial intelligence technologies to conduct modeling analysis on historical detection data helps to accurately predict the diffusion trend of pollutants and guide the implementation of governance plans. The detection system converts key indicators such as air quality, water pollution, and soil quality into charts or curves through the visual display of data, intuitively presenting the change trajectory of pollutant concentrations and providing a governance basis for environmental managers. The feedback mechanism also needs to have the function of multi-platform data synchronization to push the detection data to mobile terminals so that managers can grasp the environmental situation anywhere and at any time.

Secondly, optimizing the data feedback mechanism needs to be linked with intelligent control technologies to achieve the automatic control of pollution treatment equipment. By connecting the detection data with the control system, the working parameters of pollution treatment devices can be adjusted in real time, such as adjusting the dosage of chemicals in water treatment equipment or controlling the operation intensity of air purification equipment, ensuring the immediacy and effectiveness of the governance process and thus realizing the high efficiency of environmental governance.

5. Conclusion

To sum up, environmental detection technologies have achieved efficient management of pollution sources in environmental governance through multi-dimensional detection, data feedback, and precise control. The rational application of environmental detection technologies can optimize the monitoring means and operation strategies in the governance process and improve the stability and scientific nature of the governance effect. In the long run, China should actively improve the adaptability of technology application and continuously promote the development of environmental governance towards intelligence and precision, providing a solid technical guarantee for the sustainable improvement of the ecological environment.

References

[1] Bakker, Karen, and Max Ritts. "Smart Earth: A meta-review and implications for environmental governance." Global environmental change 52 (2018): 201-211.

[2] Liu, Hai-Ying, et al. "A conceptual approach to a citizens' observatory–supporting community-based environmental governance." Environmental Health 13 (2014): 1-13.

[3] Bridge, Gavin, and Tom Perreault. "Environmental governance." A companion to environmental geography (2009): 475-497.

[4] Li, Wanxin. "Environmental governance: Issues and challenges." Envtl. L. Rep. News & Analysis 36 (2006): 10505.

[5] He, Guizhen, et al. "Changes and challenges: China's environmental management in transition." Environmental Development 3 (2012): 25-38.