Development and Thinking of Ecological Environmental Audit in China

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Abstract In this paper, the development course of ecological environmental audit in China was described, and the evolution of its policy support, technical means and coverage was analyzed. At the same time, in view of the problems such as low data quality and credibility, limited scope of audit and lagging informatization construction in audit work, some specific suggestions were put forward to better support the ecological civilization construction in China by optimizing the ecological environmental audit work.

Key words Ecological environmental audit; Policy support; Ecological civilization

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Ecological environmental audit means that audit institutions independently and objectively evaluate the activities of public departments, enterprises, institutions and other organizations in resource utilization, pollution control and environmental governance in accordance with relevant laws and regulations. Its core objectives are to assess the rationality of resource development and utilization, the effectiveness of environmental protection measures and the implementation effect of related policies, provide a basis for government decision-making, and promote the coordinated development of the economy and the environment. Ecological environmental audit covers a wide range of topics, including the audit of the effectiveness of traditional environmental pollution sources (such as wastewater, waste gas and solid waste), as well as emerging environmental issues (such as carbon emissions, biodiversity conservation and natural resource asset management).

The formulation and promulgation of relevant laws and regulations in China have promoted the development of ecological environmental audit[1]. For example, the *Environmental Protection Law of the People's Republic of China*, *the Audit Law of the People's Republic of China* and other laws and regulations have provided an important legal basis for the implementation of ecological environmental audit[2]. In addition, the *Regulations on Auditing Leading Cadres' Natural Resource Assets after Leaving Office* (*Trial*) issued in 2017 further clarified the scope and responsibilities of ecological environmental audit. These policies not only strengthen the responsibility of each subject to protect natural resources, but also emphasize the audit responsibility of audit departments to the ecological environmental responsibility of leading cadres, laying an important position for the ecological environmental audit work.

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1 Development course and policy support of ecological environmental audit in China

Since the 1990s, China's ecological environmental audit has mainly gone through three stages of development[3], and the audit work has been moving forward from exploratory practice to institutionalization and standardization. At the same time, this development process benefits from the strong support of policies and continuous improvement of technology.

1.1 Initial stage The period from the 1990s to 2010 was the initial exploration stage of ecological environmental audit in China. In 1989, China promulgated the *Environmental Protection Law of the People's Republic of China*, in which the environmental protection responsibilities of different entities are clearly stipulated. In 2007, China issued the *Environmental Monitoring Management Measures*, which mainly involves environmental monitoring work, but can also provide certain guidance for ecological environmental audit. At this stage, China's ecological environmental audit work mainly focuses on exploration and pilot. The audit work has obvious experimental nature, and the audit scope and technical level are relatively limited; policy support has taken shape. The National Audit Office has begun to take polluting enterprises as key audit objects, aiming to check their compliance with pollutant discharge permits and payment of pollutant discharge fees.

During this period, the audit work was mainly focused on areas with a high degree of industrialization, and priority was given to key industries with high pollution and energy consumption such as steel, chemicals, and cement. Water pollution and air pollution should be paid more attention to, and the legality and standardization of enterprises' discharge behaviors should be verified. The audit technology mainly relies on traditional manual audit, and the audit work is completed through on-site verification, document review and data collection. The audit work usually focuses on the analysis of data reports and lacks the ability of real-time dynamic monitoring.

1.2 Deepening stage The period from 2011 to 2015 is the deepening stage of China's ecological environmental audit. As the concept of ecological civilization construction has gradually gained popular support, ecological environmental audit ushered in rapid development at this stage. The policy and institutional framework became clearer, and the audit scope and technical level were significantly improved. In 2011, the national "12th Five-Year Plan" clearly proposed to strengthen the construction of ecological civilization, and clearly listed ecological environmental protection as a binding indicator, providing guidance for the audit work. In 2014, China revised the *Environmental Protection Law*, added more substantive and operable provisions to the content, highlighted environmental responsibility, and proposed a lifetime accountability system for leading cadres for ecological environmental damage. The *Overall Plan for the Reform of the Ecological Civilization System* was released in 2015, proposing to include ecological environmental audit in the audit of leading officials' natural resource assets after leaving office. The *Measures for Holding Party and Government Leading Cadres Accountable for Ecological Environmental Damage* (*Trial*) issued in the same year also made clear provisions on the responsibilities of Party and government leading cadres in ecological environment and resource protection[4].

In this period, the scope of audit work gradually expanded from enterprises to regional ecological environment, and key areas (such as watershed management and wetland protection) were systematically audited. Meanwhile, the audit of natural resources assets was also introduced, and the audit of leading cadres' responsibility in ecological environmental protection was gradually explored. In terms of audit technology, remote sensing image and geographic information system (GIS) technology have been applied to analyze changes in ecological environment through satellite images and then provide data support for audit. Initial pilot of big data technology was used to analyze the correlation between the amount of pollutants discharged by enterprises and the actual environmental quality.

1.3 Overall promotion stage Since 2016, China's ecological environment audit has been comprehensively promoted. The policy is more clear and specific, and the technology is developing in the direction of intelligence and real-time. The social influence and governance effect of audit are significantly enhanced. In 2017, China issued the *Regulations on Auditing Leading Officials' Natural Resource Assets after Leaving Office* (*Trial*), which included natural resource assets and ecological environment audit into the scope of audit work. In addition, the *General Technical Guidelines for Ecological and Environmental Health Risk Assessment* issued in 2020 and the *Opinions on Pollution Prevention and Control* issued in 2022 provide guidance for the audit work.

The audit work in this period focuses on the implementation effect of pollution control and ecological restoration policies, and takes the governance effect of key regions as the audit focus[5]. In terms of audit technology, Internet of Things technology and UAV monitoring have been gradually applied to achieve dynamic data acquisition in key areas. The application of blockchain technology in ecological environmental auditing is further explored to enhance data traceability and tamper-proof capabilities, thereby improving the reliability of data. At the same time, artificial intelligence technology is used to assist pollution source identification and audit report generation to improve audit efficiency.

In short, China's ecological environmental audit has experienced a development process from local pilot to institutionalization and technology since the beginning. Each stage is continuously improved under the dual drive of policy support and technological development.

2 Problems in China's ecological environmental audit

2.1 Data quality and reliability are not high Data quality is the basis of ecological environmental audit. However, there are problems of data source disunity, data distortion and so on in the audit practice. Some units may manipulate data for profit, which affects the objectivity and credibility of audit results. Besides, because the environmental data in some areas are not updated in time, the relevant data is difficult to accurately reflect the real situation of the current ecological environment, thereby influencing the accuracy and effectiveness of audit results.

2.2 Audit scope has limitations At present, the ecological environmental audit mainly focuses on traditional pollution sources, such as waste gas, sewage and solid waste, but less on air pollution, soil degradation, mineral resource exploitation and marine ecological protection. The coverage of the audit is narrow, and it is difficult to fully reflect the effectiveness of environmental governance and meet the needs of ecological civilization construction in the new era.

2.3 The information construction of audit lags behind Informatization is an important way to improve the quality and efficiency of audit, but the informatization level of ecological environmental audit is low at present[6]. Some regions lack integrated and unified data platforms, and the phenomenon of information silo is serious, so that the efficiency of sharing and analyzing audit data is low. In addition, the lack of technical personnel also makes the existing information systems difficult to play a full role.

3 Improvement suggestions

In order to give full play to the role of ecological environmental audit and complete the goal of ecological environment governance in China faster, the audit work should be improved comprehensively from the aspects of data management, audit scope, information construction and so on.

3.1 Strengthening data quality management High-quality data is the key to high accuracy and credibility of audit results[7]. Firstly, unified standards for collection and management of ecological environmental data should be established to ensure reliable data sources and standardized formats. Secondly, it is needed to promote data sharing and interconnection among various depart-

ments, reduce the phenomenon of information silo, use blockchain technology to build a transparent data management system, and improve the traceability of data. Finally, the dynamic update and real-time monitoring of data should be strengthened to ensure that the audit can reflect the changes of ecological environment in a timely manner.

3.2 Broadening the coverage scope of audit Ecological environmental issues are complex and diverse, so the scope of audit needs to be expanded from traditional pollution control to a wider range of ecological fields[8]. For example, it is needed to strengthen the audit of response to climate change, focus on assessing the implementation of carbon reduction targets, conduct special audits on emerging issues such as biodiversity conservation, soil pollution remediation, and marine resource management, pay attention to the development and utilization of forest resources and water resources, and ensure the sustainability of resource development.

3.3 Accelerating the informatization construction of audit Informatization is an important way to improve audit efficiency and quality. The government should increase investment to establish an information platform covering the whole country for ecological and environmental audit, and integrate advanced technologies such as remote sensing monitoring and big data analysis into the audit process. At the same time, it is necessary to strengthen the construction of technical personnel, set up professional training courses, and improve auditors' ability to use information tools[9]. In addition, artificial intelligence technology should be introduced to develop an early warning model of audit risk, optimize the allocation of audit resources and improve the accuracy of audit work.

3.4 Improving laws, regulations and policy guarantees It is needed to further improve the relevant laws and regulations on ecological environmental audit, and clarify the scope of powers and responsibilities and work standards of audit to provide a more solid legal basis for audit work. The accountability mechanism for ecological environmental damage should be strengthened, and illegal acts found during audits should be seriously dealt with in accordance with the law and regulations. Through the revision and improvement of relevant laws and regulations, the mandatory and independent nature of ecological environment audit will be enhanced to ensure that the audit work exerts greater binding force and regulatory effect.

3.5 Promoting public participation and oversight Public participation is an important part of ecological environment audit. The openness and transparency of audit results should be further improved, and mechanisms for releasing audit reports and giving feedback to the public should be established to ensure that the public can obtain audit information in a timely manner. All sectors of society should be guided to pay attention to and participate in environmental governance by organizing hearings and conducting environmental protection education. At the same time, with the help of social organizations and the media, the problems found in the audit should be supervised, and a diversified governance pattern should be formed.

3.6 Strengthening international cooperation and exchange of experience China can learn from the advanced experience of international ecological environmental audit especially in the aspects of information technology, cross-regional audit coordination and coping with global environmental problems[10]. China should cooperate with international audit institutions and environmental protection organizations to enhance the internationalization of audit work and jointly address global challenges such as climate change and biodiversity loss.

4 Conclusions

Driven by both policy promotion and technological progress, China's ecological environment audit has gradually developed from exploration and pilot to institutionalization and intelligence, providing an important guarantee for ecological environment governance. At the same time, there are also some deficiencies in ecological environmental audit in China. In the future, it is needed to further strengthen data management, expand the scope of audit, promote the informatization construction of audit, establish and improve related systems, and actively promote public participation and international cooperation, so as to further improve the quality and efficiency of ecological environmental audit work, and provide stronger support for China's ecological civilization construction.

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