

Information Security Management of Associated Data Publishing and Sharing for Academic Journals

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Abstract

[Purpose] Scientific data constitutes a crucial foundation for technological development, and information security serves as a prerequisite for scientific data publishing and sharing. Systematically reviewing the information security management of associated data publishing and sharing in Chinese academic journals can facilitate the advancement of scientific data publishing and sharing initiatives. **[Method]** Based on the evolutionary process of scientific data publishing and sharing in China, as well as the current status and development of scientific data sharing within the geographical resources journal cluster, this study analyzes the publication and security management of research article associated data. **[Results]** To maximize the value of scientific data as a public social resource, China has established a top-down scientific data sharing system, encompassing network infrastructure, databases, data centers, data service platforms, etc., formulated a series of data acquisition and management standards, and enacted relevant laws to safeguard the information security of scientific data. **[Conclusion]** Scientific data publishing and sharing should be built upon a foundation of security. Following the initial large-scale construction phase, data publishing and sharing, along with their security management, should transition toward a “quality enhancement and efficiency improvement” stage, ensuring data quality and increasing utilization efficiency. Emphasis should be placed on the infusion of advanced technologies and the cultivation of specialized professionals.

Full Text

Preamble

Information Security Management of Data Publishing and Sharing in Academic Journals

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Abstract

[Objective] Scientific data constitutes a critical foundation for scientific and technological development, while information security serves as a prerequisite for scientific data publication and sharing. Systematically reviewing the information security management of associated data publishing and sharing in Chinese academic journals will facilitate the advancement of these practices. **[Methods]** Based on the evolutionary trajectory of scientific data publishing and sharing in China, and examining the current status and development of geographic and resource journal clusters in this domain, this study analyzes the publication and security management of journal-associated data. **[Results]** To maximize the value of scientific data as a social public resource, China has established a top-down scientific data sharing system encompassing network infrastructure, databases, data centers, and data service platforms. The country has formulated a series of data acquisition and management standards, along with relevant laws to safeguard scientific data and information security. **[Conclusion]** Scientific data publishing and sharing must be built upon a foundation of security. Following the initial large-scale construction phase, data publishing, sharing, and their security management should transition toward a “quality and efficiency enhancement” stage, ensuring data quality while increasing utilization efficiency. This transition requires attention to the integration of advanced technologies and the cultivation of specialized talent.

Keywords: academic journals; scientific data; data publishing; data sharing; information security management

1. Background

With the advancement of science and technology and the advent of the data era, China has increasingly prioritized the development and application of data. In 2015, the State Council issued the *Outline for Promoting Big Data Development*, proposing a comprehensive action plan for advancing big data development and application nationwide. In 2016, the national *13th Five-Year Plan for National Economic and Social Development* was released, calling for the implementation of a national big data strategy to promote innovative applications of big data and vigorously advance data openness and sharing. Concurrently, with China's economic rise, the nation faces increasingly complex international situations and geopolitical relations, making information security ever more critical. Information security constitutes an essential component of the national security

system.

Academic journals, particularly those related to geographic and resource sciences, may involve data and information pertinent to politics, military affairs, and national defense, which are vital to national security. With the development of information technology and the explosive growth of networking and digitization, information can be easily copied, duplicated, and transmitted, greatly enhancing dissemination efficiency. However, this process entails numerous security risks and poses severe challenges related to information leakage, piracy, infringement, and accountability. Therefore, it is necessary to systematically examine the information security issues inherent in the publication and sharing of associated data in academic journals, providing a reference for formulating regulations and policies on information security management for such data.

On November 28, 2002, the Xiangshan Science Conference on “Scientific Data Sharing in China,” attended by over 130 scientists from various disciplines and relevant leaders from national ministries and commissions, reached a consensus: scientific data can only realize its maximum value as a social public resource through sharing. The conference explored four main pathways to promote scientific data sharing: from a strategic national development perspective, using public welfare and basic scientific data as key leverage, integrating with the construction of the national “e-government” system, and actively exploring paid services for commercial scientific data. In 2003, the National Science and Technology Resource Management Center was established, initiating the construction of the National Science and Technology Resource Sharing Network and launching China’s scientific data sharing project.

China’s basic strategy for data sharing involves a top-down approach, with state investment and public welfare sharing across society. Based on this strategy, over two decades, through “integration, sharing, improvement, and enhancement,” scattered scientific data has been largely consolidated into nationally prominent platforms. Large-scale scientific program data has been submitted to national data centers, establishing a national “hub” for scientific data management—a national platform enabling one-click queries.

By 2019, building upon the original nine national scientific data centers and one sharing network established in 2003, the system expanded to 20 national data centers plus the national sharing network. To date, nearly 6,000 scientific databases of varying scales covering all fields of science and technology have been constructed. Although the number of data platforms and databases has reached considerable scale, China’s data resources still face numerous issues, including insufficient systematic organization, scientific rigor, and standardization, as well as poor data quality and redundant construction. These problems primarily stem from the lack of unified norms and standards, imperfect data management and submission systems, and incomplete data policies.

To further coordinate the planning of science and technology research and development institutions and establish a comprehensive R&D system, the *Law on*

Scientific and Technological Progress was revised in 2007. It explicitly states that scientific research and development institutions funded by fiscal resources should establish mechanisms conducive to scientific and technological resource sharing to promote effective utilization. To further strengthen and standardize scientific data management, ensure data security, improve open sharing levels, and better support national scientific and technological innovation, economic and social development, and national security, the *Measures for Scientific Data Management* were introduced in 2018. These measures provide detailed regulations on data collection, submission and preservation, sharing and utilization, confidentiality and security, thereby promoting data sharing.

2.2 Comparison of Governance Strategies for Academic Papers and Scientific Data in China

Scientific data and academic papers constitute two important components associated with scientific development. Comparing the similarities and differences in their development strategies can deepen our understanding of scientific data sharing pathways (Table 1). The primary challenge in the academic paper domain is the large quantity of publications but relatively few high-quality papers and high-impact journals. The strategic approach to address this issue is bottom-up, focusing on improving journal quality and publication standards starting from the journals themselves. The structure follows: paper → journal → disciplinary cluster → national platform, with journals as the key leverage point. The main pathway is “borrowing a ship to sail to sea” through the CNKI platform, enterprise-led and relatively decentralized management. This results in most rights (except authorship) “flowing out with the borrowed ship,” necessitating strengthened protection through the Copyright Law and Publishing Management Regulations.

In contrast, scientific data faces significantly different challenges. The main contradiction lies between growing research demands and relatively scarce shared scientific data, with data remaining on computers of individuals, institutions, and research groups. The strategic approach is opposite to that of academic papers, adopting a top-down direction starting from national coordination. The corresponding structure is: dataset → data center → disciplinary sharing network → national platform, with national platform construction as the key. This is primarily achieved through the “National Science and Technology Resource Sharing Network,” characterized by public welfare and managed mainly by the National Science and Technology Resource Platform Center. Consequently, core rights in copyright can be retained domestically, although many property rights issues remain to be clarified. Management policies partially draw on existing copyright law while formulating specific scientific data management measures based on the unique characteristics of scientific data.

Table 1 Comparison of Governance Strategies for Academic Papers and Scientific Data in China

Academic Papers Domain	Scientific Data Domain
Primary Challenge: High publication volume but few high-quality papers and high-impact journals	Primary Challenge: Data hidden on computers of individuals, institutions, and research groups
Solution Approach: Bottom-up, starting from journals	Solution Approach: Top-down, starting from national coordination
Structure: Paper → Journal → Disciplinary Cluster → National Platform	Structure: Dataset → Data Center → Disciplinary Sharing Network → National Platform
Key Leverage: Journals	Key Leverage: National Platform Construction
Main Pathway: “Borrowing a ship to sail to sea,” CNKI platform	Main Pathway: National Science and Technology Resource Sharing Network
Management: Enterprise-led, relatively decentralized	Management: National Science and Technology Resource Platform Center, public welfare
Copyright: Most rights (except authorship) “flow out with the ship”	Copyright: Core rights retained domestically (many property rights issues to be clarified)
Protection: Copyright Law, Publishing Management Regulations	Protection: Copyright Law, Scientific Data Management Measures

2.3 Management Policies for Publishing Scientific Data Associated with Academic Papers

The management of scientific data publishing primarily references the Copyright Law and the Measures for Scientific Data Management. The premise for scientific data to be protected by copyright law is to treat scientific data as works. Both data works and the corresponding rights of their producers should be protected by copyright law from unlawful infringement. However, scientific data works differ significantly from other works, requiring adjustments when referencing copyright law, though interpretations in this regard have not yet been developed. The management policies for publishing scientific data associated with academic papers are illustrated in Figure 1 [Figure 1: see original paper].

The Measures for Scientific Data Management comprise six parts: general provisions (basis for formulation), responsibilities, collection/submission and preservation, sharing and utilization, confidentiality and security, and supplementary provisions. These specify the purpose and referenced regulations, define the scope of scientific data, and limit the applicability of the measures. The principles of hierarchical management, security control, and full utilization should be followed in scientific data management, with clear responsibility assignment, strengthened capacity building, and promoted open sharing. The responsibilities from central to local governments and specific research institutes, univer-

sities, and enterprises are clearly defined, coordinating scientific data sharing construction from top to bottom.

Data acquisition is the prerequisite foundation for sharing, including three stages: collection, submission, and preservation. Data collection must ensure accuracy and usability, with a scientific data submission system established. Legal entities should establish robust data preservation systems, with the State Council's science and technology administrative department strengthening overall layout and optimizing integration to form national scientific data centers.

2.4 Strengthening Geographic and Resource Data Sharing to Promote Integrated Data Publishing

With the state's promotion of scientific data sharing, geographic and resource scientific data sharing has significantly improved. Focusing on earth system science and global change research innovation, national major demands, and regional sustainable development, the National Earth System Science Data Center was established. Relying on the Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, and through over 20 years of collaborative construction, it pioneered data submission for national science and technology program projects, forming the largest comprehensive database group for earth system science in China.

Progress has also been made in data publishing. In June 2014, the *Journal of Geographical Sciences* published a special issue on data papers, pioneering data paper publishing in China. This catalyzed the launch of the *Journal of Global Change Data* (bilingual) in 2017 and promoted the publication of associated data from the first batch of 36 alliance journals. In June 2014, the Global Change Scientific Research Data Publishing System (bilingual) was officially launched online (co-sponsored by the Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, and the Geographical Society of China). In 2020, the *Journal of Global Change Data Repository* (bilingual), a high-starting-point journal under the Excellence Action Plan, was launched, completing the data publishing chain. Currently, the *Journal of Global Change Data* and the Global Change Data Repository collaborate with 74 domestic and international journals, publishing 1,080 datasets. Among these, 711 datasets (66%) are associated with academic journals, and 428 datasets (40%) are associated with journals other than the *Journal of Global Change Data*. The system has established one editorial office, two journals, one publishing system website, and integrated Chinese-English bilingual datasets and data papers. On October 25-26, 2020, the Strategic Seminar on the Integration Development of Scientific Data Publishing and Scientific Journals in Global Change Related Fields was held in Beijing. The conference reached consensus on integrating data publishing with first-class university discipline construction, standardizing data citation by scientific journals, declaring original data associations, and evaluating data center influence, and approved the "Hundred Journals Forum Plan for Integrated Development of Data Publishing and Academic Journals."

3. Scientific Data Security Management

With rapid economic and social development, protecting information security has become a major national strategic demand. The widespread application of information technology and the rapid development of cyberspace technology have greatly promoted economic and social prosperity while introducing new security risks and challenges.

3.1 Information Security Situation and Content

Information security primarily refers to protecting the safe operation of network information systems—free from danger, threats, and accidents. New challenges for information security management in the networked and digital era include: (1) National security issues caused by information security risks, including political security, cultural security, and technological security [1]. According to statistics, over 42 million malicious program samples were captured throughout 2020, with an average daily propagation frequency of more than 4.82 million times. Based on propagation sources, most originated from overseas, primarily from the United States and India [2]. (2) Cybersecurity issues triggered by information transmission, security vulnerabilities, and surging data volumes [3], such as information leakage, piracy, and infringement caused by copying, duplication, and transmission, as well as webpage tampering and data leakage from cyberattacks. In 2020, the National Information Security Vulnerability Sharing Platform recorded 20,704 security vulnerabilities, a year-on-year increase of 27.9%, with an average annual growth rate of 17.6% since 2016. Among these, 7,420 were high-risk vulnerabilities, accounting for 35.8% [2].

Information security can be ensured from both technical and supervisory perspectives by improving network system prevention and control functions, strengthening data screening and authentication, enhancing users' subjective prevention awareness, and perfecting information sharing and legal safeguards for security supervision, thereby enabling networks to operate with confidentiality, integrity, authenticity, reliability, availability, and controllability. However, rapid technological development and relatively lagging legal construction still pose certain risks to network information security. The construction of cybersecurity technology and legal systems will be a long-term, continuously improving process requiring effective supervision, strengthened infrastructure, improved talent development, and the formulation of emergency response plans and measures to build a robust network information security defense line.

3.2 Information Security Management Policies for Data Publishing and Sharing

The convergence of information technology and economic society has triggered rapid data growth, making data a national fundamental strategic resource. Big data is increasingly exerting significant influence on global production, distribution, exchange, and consumption activities, as well as on economic operation

mechanisms, social lifestyles, and national governance capabilities.

In 2015, the State Council issued the *Outline for Promoting Big Data Development*, proposing a comprehensive action plan for advancing big data development and application in China [4]: big data as a new driver for economic transformation and development, a new opportunity for reshaping national competitive advantages, and a new approach for enhancing government governance capabilities. Establishing a management mechanism that “speaks with data, decides with data, manages with data, and innovates with data” supports and ensures that scientific data becomes an important academic resource for China’s scientific and technological development. The *National Security Law of the People’s Republic of China* was officially promulgated, incorporating data security into the national security framework.

In 2016, the State Council released the *13th Five-Year Plan for National Economic and Social Development*, proposing the implementation of a national big data strategy to promote innovative big data applications and vigorously advance data openness and sharing [5]. Open development, shared development, and their security management all rely on the supporting role of scientific data and its promotion of scientific and technological innovation.

In 2018, the State Council issued the *Measures for Scientific Data Management*, with Article 22 explicitly stating [6]: “Competent authorities and legal entities should actively promote the publication and dissemination of scientific data, and support researchers in organizing and publishing scientific data with clear property rights, complete accuracy, and high sharing value.” However, as entity data types become increasingly complex and data formats more diverse, issues such as intellectual property protection for scientific data, data preservation and security, and data acquisition and cataloging have attracted widespread attention. The divergence in information security management approaches and loose data management methods have become increasingly apparent with growing data sharing and openness.

In 2021, China released the *14th Five-Year Plan for National Economic and Social Development and Long-Range Objectives Through 2035* [7], proposing to accelerate digital development and build a digital China, particularly by establishing and improving the national public data resource system, promoting cross-departmental, cross-level, and cross-regional data convergence and deep utilization, enhancing the functions of the national data sharing and exchange platform, and deepening the sharing and utilization of basic information resources such as spatial geography. Building a digital China requires establishing a more equitable and reasonable network infrastructure and resource governance mechanism on the basis of creating an open, healthy, and secure digital ecosystem, safeguarding cyberspace sovereignty, and building a community with a shared future in cyberspace [8]. On June 10, 2021, the *Data Security Law of the People’s Republic of China* was officially adopted, establishing basic systems for data security management, clarifying data security protection obligations and responsibilities, and emphasizing the principle of balancing security and

development with supportive measures.

3.3 Scope of Data Sharing Security Management

Data sharing security involves both the security of the data itself and the security of information during transmission. The transmission process involves modern information networks, digital infrastructure, and digital platforms. Geographic and resource research data security primarily concerns maps, statistical data, and sensitive words or terms.

Data sharing security management is a massive undertaking involving all aspects of information networks, infrastructure, and digital platforms. Information network technology serves as the guarantee for security management, infrastructure is the key to security management, and digital platforms are the medium and support for security management. The ultimate goal of data security management is to build data sharing security management infrastructure, conduct data management risk assessments based on cybersecurity system construction, and provide data services under secure conditions. The data sharing security management framework is illustrated in Figure 2 [Figure 2: see original paper].

Modern Information Networks: - Fixed networks - Mobile networks - Internet - Satellite internet - Internet of Vehicles - Internet of Things

Digital Infrastructure: - Digitalized highways, railways, ports, and airports - Digitalized water, electricity, and gas infrastructure - Digitalized financial facilities

Digital Platforms: - Data centers - Data exchange platforms - E-commerce platforms - Cloud computing platforms - Internet platforms

Cybersecurity System: - Early warning network - Protection network - Support network

Data Risk Assessment: - Basic data risks - Data security capabilities - Full lifecycle data risks

Data Services: - User authentication - User information protection - Platform information management

3.4 Countermeasures for Data Sharing Information Security Management

Data sharing based on security management requires work in the following areas:

(1) Legislation and Implementation on Data Security

On June 1, 2017, the *Cybersecurity Law of the People's Republic of China* [9] took effect; on September 1, 2021, the *Data Security Law of the People's Republic of China* [10] took effect; and on November 1, 2021, the *Personal Information Protection Law of the People's Republic of China* [11] took effect. This legislation manages and regulates information security from multiple dimensions—

cybersecurity, data security, data protection security, and personal information protection—representing a new height in information security management and serving as a milestone for raising data security awareness and comprehensively improving data governance capabilities across society.

(2) Establishing Data Security Management Systems

Based on relevant data security legislation, each entity should establish data security management systems tailored to its specific needs during implementation, such as classification and hierarchical management, user registration and authorization, registration for use, protection capability assessment, security and confidentiality management, and transaction security management. As data security management evolves with network and information technology, new issues continue to emerge. Therefore, security management systems must be updated in a timely manner to keep pace with the times, achieving proactive rather than reactive security management.

(3) Improving the Data Sharing Standard System

The data sharing standard system includes basic standards, platform technology standards, data security standards, service security standards, and multiple other categories. Currently, construction of this system is still in its infancy. On one hand, the big data era demands rapid development of the data sharing standard system; on the other hand, its construction requires interdisciplinary and cross-departmental collaboration. Since data sharing started relatively late in China, in addition to requiring disciplinary crossover and departmental cooperation, relatively lagging independent innovation technologies and insufficient talent development also contribute to the incomplete construction of the data sharing standard system.

(4) Researching and Applying Data Security Technologies

Monitorable, controllable, and traceable data security technologies depend on the development of internet technology. China's internet technology started relatively late. The "Four Principles of Internet Governance" proposed by President Xi Jinping in 2016 serve as fundamental guidelines for researching and applying data security technologies. Data security technology is the technical support for information security management, requiring continuous innovation and application of new technologies and methods. Innovative and mature internet technologies should be promptly transferred and applied to the field of data security to achieve a win-win situation for both data security management and internet governance.

4. Recommendations for Strengthening Data Publishing and Sharing

It is foreseeable that scientific data publishing and sharing will be on the rise for the next two decades. Using data publishing to drive academic innovation is

an excellent approach for academic progress and an important support for improving scientific integrity and promoting scientific discovery. Data submission and data publishing represent two different paths for data sharing: data submission refers to submitting data from national fiscal-supported research projects (including original and basic data), paper-associated data, and data from other sources to designated data centers in accordance with the *Measures for Scientific Data Management* [5] and the *Measures for the Management of National Science and Technology Resource Sharing Service Platforms* [12] to strengthen data management; data publishing refers to releasing entity data through media such as books, journals, CDs, and networks according to the *Publishing Management Regulations* [13] and the *Measures for Scientific Data Management* [5]. Data submission and data publishing are not mutually substitutable. It is recommended that the Chinese Academy of Sciences, while focusing on the submission of paper-associated data, also prioritize data publishing to promote standardized data management and data reuse, leveraging the value-added role of data. Specific recommendations are as follows:

(1) Seize Opportunities in Domain Knowledge and Data Fusion Service Platforms (Hubs)

Taking the China Geographic and Resource Journals Network as an example, this platform has 58 geographic and resource journals as members and has been built into a data processing platform for “one-time editing, diversified publishing,” with integrated journal-data consolidation and knowledge service functions. Through collaboration with data centers and data publishing platforms, it has played a leading and exemplary role in geoscience data submission and data publishing, providing a reference for data sharing of journal papers in other disciplinary fields.

(2) Conduct Preliminary Research and Pilot Programs for Scientific Data Contribution Evaluation

The current scientific research contribution evaluation system still lacks evaluation components for scientific data contributions. Incorporating scientific data achievements into the research contribution evaluation system can not only stimulate researchers’ enthusiasm for sharing scientific data but also improve the efficiency of scientific data reuse and leverage its due resource value. Since the current research evaluation system does not consider contributions from scientific data achievements, data authors’ efforts are not recognized, which to some extent affects and delays the process of scientific data sharing.

(3) Increase Training and Support for Data Publishing Talent

Since data publishing has a shorter history than journal publishing, talent cultivation for data publishing has not yet received sufficient attention. Compared to journal editors, data editors must be familiar with journal publishing processes while also mastering professional knowledge in data review and editing, data formats and types, and mathematical security and confidentiality. This raises professional requirements and increases training difficulty. Currently, no

policies for training data publishing editors have been introduced, and there is a shortage of scientific data publishing talent. Strengthening relevant talent development is necessary to meet the needs of scientific data sharing in the big data era.

(4) Strengthen Information Security Management for Data Publishing and Sharing

The smooth advancement of data publishing and sharing depends on information security management in the data sharing environment, involving both subjective and objective aspects. First is security in the ideological domain, which constitutes the first line of defense for information security management. Second is infrastructure security, which forms the foundation and key to information security management. Finally, there is the formulation and implementation of information security management norms at all levels. Only through standardized management at the institutional level, emphasis on infrastructure construction, and enhanced security awareness can effective information security management be achieved.

(5) Enhance Publicity for Data Publishing and Increase Its Recognition

Data publishing is an important pathway to enhance the reproductive value of scientific data resources. However, due to the lack of evaluation systems, insufficient achievement evaluation policies in research institutions, and limited researcher awareness of data publishing, current recognition of data publishing remains low. Therefore, publicity for data publishing should be strengthened to activate scientific data held by researchers, encouraging their active participation in data publishing and enabling them to benefit from data publishing and sharing.

Increased funding should be allocated to establish a special project for scientific data sharing engineering, providing sufficient, stable, and timely support for the construction and operation of public welfare and basic scientific data sharing projects. The national scientific data sharing management regulations should be introduced to accelerate the legislative process, legally guaranteeing scientists' and the public's legitimate rights to use scientific databases. A combination of paid and free sharing mechanisms should be adopted for scientific data from different sources and with different characteristics, with different sharing levels for different databases. "Integrating numerous databases to achieve a sharing platform is a massive undertaking requiring considerable time." To enable scientific data sharing to be put into use and 发挥其服务功能 as soon as possible, a dynamic construction approach of "building while promoting application while improving" could be adopted.

5. Conclusion

Information security management for the publication and sharing of associated data in academic journals constitutes a foundation of academic publishing security. Information security management for data publishing is a prerequisite for ensuring the secure sharing of scientific data. In the era of networking and informatization, amidst the torrent of big data, both infrastructure construction and advanced technological means are required, along with enhanced security awareness among staff. Only by building an “iron wall” of information security can effective management of data publishing and sharing be achieved from multiple dimensions, thereby creating a secure and orderly information security environment that promotes the development of academic journal-associated data publishing and sharing.

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Note: Figure translations are in progress. See original paper for figures.

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