Systematic Compilation Technology and Application of Historical Marine Scientific Survey Data in the South China Sea and Its Affiliated Islands and Reefs (2)

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Abstract

During the implementation of the systematic compilation project for historical data from marine scientific expeditions in the South China Sea and its affiliated islands and reefs, data management constitutes a critical task. Adopting the perspective of data managers, this paper takes data as the research object and data governance as the research core to investigate scientific data management practices, constructing a simplified data governance model encompassing six major systems: security system, organizational system, standard system, resource system, sharing system, and integration system, thereby providing guidelines for data governance of both project-specific data and South China Sea marine data. The article focuses on presenting concise discussions on the data security system, data standard system, and data resource system.

Full Text

Preamble

HISTORICAL DATA REORGANIZATION TECHNOLOGY AND APPLICATION FOR SCIENTIFIC INVESTIGATION OVER THE SOUTH CHINA SEA AND ITS AFFILIATED ISLANDS AND REEFS

Abstract: In the process of implementing the project "Systematic Reorganization of Historical Data from Marine Scientific Investigations in the South China Sea and Its Affiliated Islands and Reefs," data management constitutes a critical task. From the perspective of data managers, this paper takes data as its research object and data governance as its core focus to explore scientific data

management practices. It constructs a streamlined data governance model comprising six major systems: security, organization, standards, resources, sharing, and integration. This model provides guidance for data governance efforts concerning both project-specific data and broader South China Sea marine data. The article focuses on brief discussions of the data security system, data standards system, and data resource system.

Key Words: South China Sea; Historical data; System reorganization; Data governance

Scientific data represents a crucial foundational strategic resource for national scientific and technological innovation and economic development, being the fastest-spreading, widest-reaching, and most potentially exploitable scientific resource in the information age (The Central People's Government of the People's Republic of China et al., 2018). The project "Systematic Reorganization of Historical Data from Marine Scientific Investigations in the South China Sea and Its Affiliated Islands and Reefs" systematically reorganizes valuable first-hand scientific data obtained from China's marine scientific expeditions in the South China Sea and its affiliated islands and reefs since the 1950s, encompassing marine hydrology, meteorology, chemistry, biology, ecology, fisheries, geology, geophysics, and island-reef geological drilling. However, due to complex project structures, diverse data collection methods, evolving technologies and equipment, inconsistent data standards across institutions, and varying statistical methodologies among project teams—not to mention the previous lack of unified data management and governance systems—the data suffers from numerous issues regarding completeness, accuracy, and consistency. Historical documents contain errors, anomalies, and missing values, while identical data sources are recorded differently across project teams, or seemingly similar data carry different actual meanings.

How can scientific data be managed scientifically (The Central People's Government of the People's Republic of China et al., 2018)? This proposition must be addressed during project implementation and represents a critical challenge for the South China Sea Marine Data Center (Digital South China Sea et al., 2019). Strengthening and standardizing scientific data management serves three primary purposes: ensuring scientific data security, improving open sharing levels, and supporting national scientific innovation, economic development, and national security (The Central People's Government of the People's Republic of China et al., 2018). In the big data environment, addressing the problems in project reorganized data and South China Sea marine data requires following the principles of hierarchical management, security and controllability, and full utilization. Building a South China Sea marine data governance system and proposing a set of governance methods for scientific management across all stages of the data lifecycle—standardizing collection, processing, sharing, and management activities—represents an effective approach to achieving scientific data management.

1 Data Governance System

During the project implementation and article preparation phases, extensive literature research and online investigations were conducted to systematically review, study, analyze, and understand domestic and international data governance literature and resources. Generally speaking, data governance refers to all business, technical, and management activities undertaken to improve data quality, encompassing organizational structures, policies, data standards, process specifications, technical tools, and supervision mechanisms.

The Data Governance Institute (DGI) provides a concise definition: data governance is the exercise of decision-making and authority related to data matters (DGI Data Governance Framework et al., 2021). The DGI Data Governance Framework is a logical structure that summarizes ten key elements of data governance from three dimensions—organization, rules, and processes—and presents their logical relationships in a clear and intuitive manner. The framework integrates governance processes into the model, uses arrows to indicate data governance sequences, clarifies organizational and communication aspects of the 5W framework (WHY, WHAT, HOW, WHO, WHEN), and forms a complete, self-contained system from methodology to implementation.

The Data Management Association (DAMA) identifies eleven aspects in its "Data Management Body of Knowledge (DAMA-DMBOK)" framework: data governance, data architecture, data modeling and design, data storage and operations, data security, data integration and interoperability, document and content management, reference and master data, data warehousing and business intelligence, metadata, and data quality (DAMA Data Management Body of Knowledge (First Edition) et al., 2021). DAMA's approach emphasizes establishing a decision-making system to provide guidance and oversight for the ten functional aspects of data management.

Domestic and international data governance models each have distinct focuses and characteristics, with varying expressions of connotation, elements, models, and frameworks (Dong Kaijun et al., 2017; Sun Jiarui et al., 2018; Liu Guifeng et al., 2018; Liu Guifeng et al., 2017; Zhang Ning et al., 2017). Some emphasize theoretical exploration, others practical application, and still others focus on participants. However, issues such as data standardization, data quality, data rights confirmation, data circulation, data security, privacy protection, and data sharing have attracted high-level attention across all sectors. Moreover, data governance objectives are relatively unified: ensuring data management activities remain standardized, orderly, and controllable; guaranteeing data is managed correctly and effectively; and ultimately maximizing data value.

Notably, in March 2020, four major international data organizations—CODATA (Committee on Data of the International Science Council), the Research Data Alliance (RDA), the International Science Council World Data System (ISC-WDS), and GO FAIR (Global Open FAIR)—launched the Data Together initiative (International Science Council World Data System et al., 2020), jointly

committed to optimizing the global research data ecosystem and providing seamless access to high-quality, interoperable research outputs and services. The Data Together initiative encourages enhanced cooperation in four areas: governance and participation in interoperability, policy and law, infrastructure, and semantics.

Data governance for scientific data is an extremely important component of scientific data management and represents a long-term, complex systematic project. From the perspective of data managers, this article explores deep structural changes in data governance concepts, architecture, operational mechanisms, and behavioral patterns to effectively advance intelligent governance capabilities.

Focusing on two core governance aspects—data security and data quality—and combining them with two value-added aspects—data open sharing and innovation support—the article establishes a streamlined South China Sea marine data governance model comprising six systems: security, organization, standards, resources, sharing, and integration. This forms an implementable data governance framework and action plan, creating a data circulation model and governance ecosystem with positive interaction, co-construction, sharing, and collaborative governance among multiple stakeholders. This approach enhances the scientific, refined, and intelligent level of data management and provides normative references for data governance in the South China Sea scientific expedition historical data reorganization project, as shown in Figure 1 [Figure 1: see original paper].

The primary purpose of the South China Sea marine data governance system is to ensure data security, improve data quality, and strengthen data sharing, with the ultimate goal of establishing a scientific data management model that enables deep data value mining and empowers scientific research.

The first component of the streamlined South China Sea marine data governance model involves establishing scientific data management systems and standards. This forms the important foundation for effective data management. First, construct an organizational system by establishing unified, standardized, and universal data management systems that clarify data circulation rules, implement a co-construction, sharing, and collaborative governance mechanism, and optimize full lifecycle data resource management, thereby systematically and comprehensively embedding data collection, aggregation, integration, governance, and circulation into research activities. Second, build a standards system by improving fundamental data standards and key technical procedures to enhance data quality through systematic, standardized, and normalized processes and measures. Third, establish a resource system for the South China Sea scientific expedition historical data reorganization by compiling data resource catalogs to improve data quality and standardization.

The second component focuses on strengthening orderly scientific data opening and sharing. Scientific data can only maximize its value and release its enormous hidden potential when it is connected, circulated, and utilized. Establishing

data asset status encourages orderly data circulation and efficient utilization. First, create a sharing system by establishing a unified and orderly data sharing service mechanism: rely on the South China Sea and Adjacent Sea Area Branch of the National Earth System Science Data Center to promote orderly data circulation and accelerate data sharing and exchange; simultaneously strengthen independent development of Digital South China Sea and optimize metadata and core data management and governance in the integrated database for South China Sea scientific expedition historical data reorganization to promote deep data mining and effective utilization. Second, establish an integration system to promote deep integration between data and users, expand data services and application scenarios, and enhance the level of data resource value empowerment for scientific research.

The third component emphasizes strengthening scientific data security protection. Security is the prerequisite for development, and scientific data management and sharing must strengthen data security guarantees. Balancing virtual and physical realities, security and development, and protection and openness creates a security protection system that runs through the entire data lifecycle. The data center implements the Data Security Law, improves data classification and grading security protection, strengthens physical security protection for critical information infrastructure of the South China Sea scientific expedition historical data reorganization integrated database system, enhances network security situational awareness and continuous protection capabilities, improves data traceability and system security early warning capabilities, and strengthens protection capabilities for secure application of critical data resources.

2 Data Security System

As a crucial production factor, data security is the bottom line that must be ensured. The management and sharing of South China Sea scientific expedition historical data reorganization data must also comply with laws and regulations to guarantee security. The Data Security Law of the People's Republic of China officially took effect on September 1, 2021, clearly defining data security as the state of effective protection and lawful utilization of data, along with the capacity to maintain continuous security, achieved through necessary measures (National People's Congress et al., 2020).

The South China Sea marine data governance system has established a full lifecycle security protection system for South China Sea scientific expedition historical data reorganization data management. Combined with actual data integration and sharing service processes, it forms a long-term data security management mechanism that strengthens protection measures through information security safeguards in physical security, network security, system security, and application security. This ensures the South China Sea scientific expedition historical data reorganization integrated database system and data are "visible, knowable, manageable, and controllable," with differentiated protection for potentially sensitive information and data.

Physical security primarily ensures computer room environmental safety and system hardware equipment security. The South China Sea Marine Data Center has established emergency response systems, access registration systems, and other security management protocols, while creating information equipment inventories to strengthen hardware device security management. Hardware equipment for the integrated database system—including data servers, network servers, and storage servers—meets relevant product safety standards, with necessary redundancy and backups for major hardware devices and communication lines.

Network security is ensured through continuous monitoring of equipment operation in the South China Sea scientific expedition historical data reorganization integrated database system. The system continuously monitors performance of major network equipment including data servers, network servers, and storage servers to ensure continuous availability. It also monitors network connectivity status, errors and drops, disk utilization, CPU and memory utilization, database counts, and other critical network performance indicators to enable inspection and early warning of network health. Additionally, firewalls, intrusion detection, and other security protection measures safeguard the platform, with regular security audits of network equipment operation, data sharing network traffic, and user behavior in data circulation.

System security is achieved through data backup, access control, and authorization management. The platform has established data backup mechanisms to implement full, incremental, regular, and dynamic backups of critical data as needed to ensure data security. Access control in data exchange primarily includes restrictions on access from various connected IPs. The authorization management module implements graded and classified access control to data resources for various users. The platform also strictly restricts the use of default operating system accounts and anonymous accounts, regularly changes account passwords with complexity requirements, and strictly sets operating system access control policies to prohibit all unnecessary access permissions.

Application security achieves isolation between applications and data, with applications accessing data through data services. The platform's application access front-end should be deployed separately from back-end application services. The platform particularly strengthens access control by implementing unified identity authentication, authorization, and verification for user data access processes. It exercises the finest-grained control and dynamic adjustment of user permissions to access application systems, application services, application functions, and data services as needed, achieving in-depth access control that includes application access control, service access control, and data access control. The platform also emphasizes user security management, with access control functions, security access policies, and strict management of remote access permissions.

3 Data Standards System

Research on scientific data standards systems helps standardize standardization issues throughout the scientific data management lifecycle and promotes resolution of cross-disciplinary and cross-domain scientific data standard inconsistencies (Wang Juanle et al., 2020; Wang Juanle et al., 2021). Against the backdrop of implementing the Scientific Data Management Measures and promoting national scientific data center construction, Wang Juanle et al. proposed a reference model for scientific data standards systems, as shown in Figure 2 [Figure 2: see original paper].

Basic scientific and technological work refers to systematic investigation, survey, collection, identification, evaluation, and comprehensive analysis of fundamental scientific questions and natural phenomena, data, materials, and related information to promote the flow and use of these scientific materials (Ministry of Science and Technology of the People's Republic of China et al., 2009). Particularly for projects in the "data reorganization" category, where scientific data itself constitutes the research subject, the project implementation process essentially represents the entire scientific data management lifecycle, requiring corresponding standards and specifications for guidance.

According to information released by the National Earth System Science Data Center's National Science and Technology Basic Resources Survey Special Project Data Submission Management Center, prior to the "South China Sea and Its Affiliated Islands and Reefs Marine Scientific Investigation Historical Data Systematic Reorganization" project (Project No.: 2017FY201400), 11 reorganization projects were deployed under the National Science and Technology Basic Resources Survey Special Project between 2007-2015 (National Earth System Science Data Center et al., 2020). The project information list is shown in Table 1 . Based on project introduction information, an incomplete statistical analysis of relevant standards and specifications development shows that 2 of the 11 reorganization projects formulated their own standards and specifications.

Table 1 Data Reorganization Projects Information

Project Number	Project Name
2015FY210400	Compilation and Data Reorganization of Modern Vertical Deformation Atlas in Mainland China
2014FY120600	Investigation and Reorganization of Basic Data for Water Environment Criteria in China
2014FY120500	Reorganization of Chinese Forest Classics and Records

Project Number	Project Name
2014FY120300	Reorganization of Historical Solar Physics Observation Data in China
2013FY110900	Integration and Standardized Reorganization of Basic Scientific Work Data and Materials
2011FY120300	Reorganization of Paleoclimate Proxy Resources in China for the Past 2000 Years
2009FY120100	Reorganization of Bioinformatics Basic Information
2008FY220200	Reorganization of Ionospheric Historical Data and Compilation of Electron Concentration Profiles and Regional Characteristics Atlases
2008FY120100	Reorganization of Rice Variety Historical Data
2007FY220400	Reorganization of Climate and Environmental Evolution Information Reconstructed from Tree Rings in China's Arid Regions
2007FY220200	Deep Processing and Reorganization of Long-term Farmland Experimental Data

Among these, the "Investigation and Reorganization of Basic Data for Water Environment Criteria in China" project (Project No.: 2014FY120600) formulated four standards and specifications: "Water Quality Criteria Data Reorganization Technical Specification Part 1: Pollutant Content" (GB/T 34666.1-2017), "Water Quality Criteria Data Reorganization Technical Specification Part 2: Aquatic Organism Toxicity" (GB/T 34666.2-2017), "Water Quality Criteria Data Reorganization Technical Specification Part 3: Basic Physical and Chemical Parameters of Water Bodies," and "Water Quality Criteria Data Reorganization Technical Specification Part 4: Aquatic Organism Species" (Wang Yi, 2021; National Earth System Science Data Center et al., 2020).

The "Integration and Standardized Reorganization of Basic Scientific Work Data and Materials" project (Project No.: 2013FY110900) established standards and specifications including two management specifications—Measures for the Management of Basic Scientific Work Data and Materials Submission and Detailed Implementation Rules for Basic Scientific Work Data and Materials Sharing Services—and nine technical specifications: Basic Scientific Work

Data and Materials Integration and Reorganization Procedures (Technical Methods), Basic Scientific Work Data and Materials Classification and Coding, Basic Scientific Work Data and Materials Standardized Reorganization Quality Control Specifications, Basic Scientific Work Data and Materials Database Design Specifications, Basic Scientific Work Data and Materials Database Construction Specifications, Basic Scientific Work Data and Materials Core Metadata and Extension Standards, Basic Scientific Work Data and Materials Cataloging Specifications, Basic Scientific Work Data and Materials Exchange Technical Specifications, and Basic Scientific Work Data and Materials Sharing Service Platform Interface Specifications (National Earth System Science Data Center et al., 2020).

The South China Sea Marine Data Center comprehensively analyzed the data characteristics and reorganization technical requirements of the "South China Sea and Its Affiliated Islands and Reefs Marine Scientific Investigation Historical Data Systematic Reorganization" project (Project No.: 2017FY201400). Building upon the "South China Sea Marine Science Data Collection and Organization Guide" (Xu Xiaolu et al., 2015) and "South China Sea Marine Section Scientific Investigation Data Reorganization Specifications (Draft)" (Xu Chao et al., 2016), and in accordance with the standard requirements of the Ministry of Science and Technology's Basic Research Division's "Compilation of Scientific Data Submission Documents for Basic Scientific Work Special Projects" (November 1, 2016), the center developed the "South China Sea and Its Affiliated Islands and Reefs Marine Scientific Investigation Historical Data Systematic Reorganization Technical Specifications" based on the national scientific data center's scientific data standards system reference model's eight subsystems: definition and guideline standards, scientific data description standards, scientific data collection and processing standards, scientific data submission standards, scientific data preservation and maintenance standards, scientific data sharing service standards, scientific data evaluation standards, and scientific data security standards.

These specifications first define data according to the disciplinary characteristics and content of the original South China Sea scientific expedition historical data reorganization materials, clarifying unified reorganization methods and requirements. They include technical implementation details for data description standards, digital processing standards, standardized processing standards, and data submission standards, guiding the reorganization process of digitization, standardized processing, quality control, and unified data formatting.

The specifications consist of six parts to meet the needs of various project topics and disciplines: - Part 1: Marine Hydrology and Meteorology - Part 2: Marine Chemistry - Part 3: Marine Biology and Ecology - Part 4: Marine Fishery Resources Survey - Part 5: Island-Reef Geological Environment - Part 6: Island-Reef Geological Samples

The specifications further clarify standards for reorganized datasets based on the South China Sea scientific expedition historical data reorganization integrated

database construction and data management sharing requirements, including technical implementation details for data preservation, data sharing services, and data security. They establish standards and technical implementation details for data entities, metadata, data documentation, data classification, data thumbnails, and data samples, ensuring the integrity and consistency of reorganized data following digitization and standardized processing procedures, and guaranteeing standardization and normalization of full lifecycle data management throughout the South China Sea scientific expedition historical data reorganization project implementation.

4 Data Resource System

Planning and establishing a data resource system is extremely complex work, with data classification as its core task—an indispensable foundational activity for data organization, management, and sharing. Data classification for reorganized data differs from disciplinary classification; it must combine the actual situation of South China Sea scientific expedition historical data reorganization, adjusting and supplementing based on disciplinary classification.

The purpose of data classification for South China Sea scientific expedition historical data reorganization is to improve data use efficiency. To facilitate data management, query, retrieval, and sharing, the classification should not be overly granular, as excessively detailed categories may result in more data types than data instances, while retaining expandability.

The data resource classification for South China Sea scientific expedition historical data reorganization follows these principles: (1) Scientific principle—classification should scientifically describe or reflect the data resource system structure; (2) Systematic principle—classification should have appropriate generality and inclusiveness to accommodate all existing data; (3) Integrity principle—classification should maintain relative completeness in disciplinary and thematic relationships, ensuring every dataset has a definite position; (4) Hierarchical principle—classification should proceed layer by layer with balanced development at each level; (5) Revealing principle—classification should reflect data content and attribute characteristics, demonstrate relationships, and facilitate retrieval and analysis; (6) Practicality principle—classification should benefit data organization and management while respecting user habits, with category names following disciplinary conventions (Liao Shunbao et al., 2005).

Based on comprehensive analysis of South China Sea scientific expedition historical data reorganization data and existing shared South China Sea marine data, and primarily referencing the National Standard of the People's Republic of China for Discipline Classification and Codes (GB/T 13745-2009), a new South China Sea marine data resource system has been planned. The newly formed marine data resource system covers 10 secondary disciplines, integrates 18 thematic databases, and consolidates 80 core data types, as shown in Figure

3 [Figure 3: see original paper].

Figure 3 South China Sea Marine Science Data Resource System
Fig.2 South China Sea marine and ocean science data resource system

Following the establishment of this comprehensive data resource system, the South China Sea scientific expedition historical data reorganization integrated database has simultaneously established a data classification and grading protection system.

According to the "Regulations on State Secrets and Their Classification Levels in Marine Work" (Document No. Guo Hai Mi Zi [1996] 450), shared data in the South China Sea scientific expedition historical data reorganization integrated database does not include classified data. Based on the principle of availability, shared data is categorized as metadata, general data, important data, and core data. According to the project implementation process, data is classified as raw data, quality-controlled data, standardized data, data products, and metadata, with different protection measures applied to different levels.

The South China Sea scientific expedition historical data reorganization integrated database establishes data access permissions to ensure data security. Correspondingly, based on the availability principle and data classification levels, users are categorized as guest users, registered users, real-name authenticated users, and project-certified users.

Data access permission controls for the South China Sea scientific expedition historical data reorganization integrated database are shown in Table 2 :

Table 2 Data Access Authority Control Information

User Category	Permissions
Guest User	No registration required; can search and browse metadata for all datasets
Registered User	Must register and log in; can search and browse metadata for all datasets; can directly download standardized data or data products online
Real-name Authenticated User	Must register, log in, and pass real-name authentication; can search and browse metadata for all datasets; can add quality-controlled data to shopping cart and obtain data sharing online after approval

User Category	Permissions
Project-certified User	Must register, log in, and pass project certification; can search and browse metadata for all datasets; can add raw data to shopping cart, upload signed and stamped "South China Sea Marine Data Sharing Application Form," and obtain data sharing online after approval

As a crucial strategic resource and new production factor supporting China's maritime power strategy and sustainable socio-economic development in the South China Sea, the scientific investigation historical data of the South China Sea and its affiliated islands and reefs is non-renewable and must be systematically reorganized through rescue efforts, with efficient and orderly management and sharing of reorganized materials realized as soon as possible. The data management of the South China Sea scientific expedition historical data reorganization project achieves data governance, improves data quality, and forms a new data work ecosystem under the premise of ensuring data security. The systematic reorganization and scientific governance of historical data also lays a solid data foundation for the subsequent design, development, and construction of Digital South China Sea.

References

The Central People's Government of the People's Republic of China. Ensuring Security, Highlighting Sharing, and Supporting Innovation[EB/OL]. (2018-04-08)[2021-10-28]. http://www.gov.cn/zhengce/2018-04/08/content_{5280429}.htm. (in Chinese).

South China Sea Marine Data Center. Digital South China Sea[EB/OL]. (2019-03-25)[2021-10-28]. http://data.scsio.ac.cn/#parallax-block4 (in Chinese).

The Central People's Government of the People's Republic of China. Notice of the General Office of the State Council on Issuing the Measures for the Management of Scientific Data[EB/OL]. (2018-04-02)[2021-10-28]. http://www.gov.cn/zhengce/content/2018-04/02/content_{5279272}.htm (in Chinese).

DGI Data Governance Framework. [EB/OL]. [2021-10-28]. https://datagovernance.com/the-dgi-data-governance-framework/

DAMA Data Management Body of Knowledge (First Edition). [EB/OL]. [2021-10-29]. http://www.dama.org.cn/drupal620/zh-hans/node/13 (in Chinese).

Dong Kaijun, Yang Maoxi. Motivations and Trends of Big Data Governance from the Perspective of Science, Technology, and Society[J]. Science and Technology Management Research, 2017, 37(22): 26-31. (in Chinese with English abstract).

Sun Jiarui. Research Progress on Domestic Data Governance: System, Guarantee, and Practice[J]. Research on Library Science, 2018(16): 2-8. (in Chinese).

Liu Guifeng, Qian Jinlin, Lu Zhangping. A Comparative Study on Foreign Data Governance Models[J]. Library Tribune, 2018, 38(11): 18-26. (in Chinese with English abstract).

Liu Guifeng, Qian Jinlin, Lu Zhangping. Research Progress of Data Governance at Home and Abroad: Connotation, Elements, Models and Framework[J]. Library and Information Service, 2017, 61(21): 137-144. (in Chinese with English abstract).

Zhang Ning, Yuan Qinjian. A Review of Data Governance Research[J]. Journal of Intelligence, 2017, 36(5): 129-134, 157. (in Chinese with English abstract).

International Science Council World Data System. Datatogether final version march 2020 Final [EB/OL]. (2020-03-30)[2021-10-29]. https://www.worlddatasystem.org/news/files/DataToget

National People's Congress. Data Security Law of the People's Republic of China. [EB/OL]. (2021-06-10)[2021-11-02]. http://www.npc.gov.cn/npc/c30834/202106/7c9af12f51334a73b56
(in Chinese).

Wang Juanle, Shi Lei, Xu Bo, Wang Yujie, Gao Mengxu, Wang Chao. Study on China's Scientific Data Standards System[J]. China Science & Technology Resources Review, 2020, 52(05): 45-51+77. (in Chinese with English abstract).

Wang Juanle, Wang Yujie, Zhang Min, Jiang Han, Hong Mengmeng, Li Shuhan. Review of Hotspots in Earth Data Science and Sharing in 2020[J]. Science & Technology Review, 2021, 39(01): 105-114. (in Chinese with English abstract).

Ministry of Science and Technology of the People's Republic of China. Special Project for Basic Scientific and Technological Work. [EB/OL]. (2009-09-11)[2021-10-29]. http://www.most.gov.cn/ztzl/kjzg60/kjzg60hhcj/kjzg60jcyj/200909/t20090911_{72827}.htm
(in Chinese).

National Earth System Science Data Center. List of Projects under the Special Project for Basic Resources Survey. [EB/OL]. [2020-10-29]. http://www.geodata.cn/project/projects.html?progname=%E7%A7%91%E6%8A%80%E5%9F%BA%E7%A1
(in Chinese).

Wang Yi, Wang Juanle, Wang Xiaojie, et al. Analysis and Implications of the Implementation Layout of China's Special Project for Basic Resources Survey[J]. China Science & Technology Resources Review, 2021, 53(03): 33-43. (in Chinese).

National Earth System Science Data Center. Investigation and Reorganization of Basic Data for Water Environment Criteria in China. [EB/OL]. [2020-10-29].

http://www.geodata.cn/project/projectdetails.html?projectguid=38971528978768 (in Chinese).

National Earth System Science Data Center. Integration and Standardized Reorganization of Basic Scientific Work Data and Materials. [EB/OL]. [2020-10-29]. http://www.geodata.cn/project/projectdetails.html?projectguid=203898025766836 (in Chinese).

Xu Xiaolu, Li Sha, Xu Chao. Discussion on Standardization of South China Sea Marine Science Data Collection and Organization[J]. Journal of Tropical Oceanography, 2015(06), 42-48. (in Chinese with English abstract).

Xu Chao, Li Sha, Chen Rongyu, He Yunkai, Chen Shaoyong. Management and Sharing of South China Sea Marine Section Scientific Investigation Data[J]. Marine Information, 2016(01): 19-28. (in Chinese).

Liao Shunbao, Jiang Lin. Study on the Classification System of Earth System Science Data[J]. Progress in Geography, 2005(06): 93-98. (in Chinese).

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