

Analysis of the Current Situation and Research on Countermeasures of National Fundamental Surveying and Mapping Achievements Services

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Abstract

Based on the current situation of the application and service of national fundamental surveying and mapping achievements from 2020 to 2024, this paper adopts a combined method of quantitative and qualitative analysis to identify the existing problems and challenges, including constraints imposed by confidentiality management policies, the need to improve the timeliness and category diversity of data, and the insufficient service awareness and informatization service level. Corresponding countermeasures and suggestions for promoting the efficient provision and extensive utilization of fundamental surveying and mapping achievements are put forward, mainly including improving the policy and institutional system for the confidentiality management of surveying and mapping achievements, perfecting the achievement update mechanism, enriching the variety of achievements, advancing the processing and compilation of public-version surveying and mapping achievements, and constructing a public geographic information data innovation and application laboratory.

1. Introduction

Fundamental geographic information is an important part of the national spatial data infrastructure, an authoritative and unified positioning foundation and spatial carrier for national informatization construction, and an indispensable fundamental and strategic information resource for national economic construction, social development and national defence construction (Wang et al., 2015). With the advancement of the country's deepening reform comprehensively and the rapid development of new technologies, the positioning of surveying, mapping and geographic information work has undergone a major transformation. Under the background of the new era, the positioning of surveying, mapping and geographic information work adheres to "supporting economic and social development, serving the needs of various fields, supporting natural resources management, and serving ecological civilization construction", and surveying, mapping and geographic information has also become a new factor of production (Ministry of Natural Resources of the People's Republic of China, 2023).

National fundamental surveying and mapping achievements refer to the data, maps, images and related technical materials generated through systematic and foundational geographic information collection activities conducted in accordance with nationally unified planning and standards. Specifically, they include surveying and mapping datum data (geodetic survey achievements), fundamental aerial photography data, Digital Orthophoto Map (DOM) data, topographic feature data (also known as Digital Line Graphic (DLG) data), Digital Elevation Model (DEM) data, and topographic map mapping data (DTM) (Di et al., 2016). The Regulations of the People's Republic of China on the Administration of Surveying and Mapping Achievements promulgated by the State Council (State Bureau of Surveying and Mapping, 2006) aim to strengthen the

management of surveying and mapping achievements, safeguard national security, promote the utilization of surveying and mapping achievements, and meet the needs of economic construction, national defence construction and social development. The regulations clearly stipulate that: "If a legal person or other organization needs to use fundamental surveying and mapping achievements that are state secrets, it shall put forward a clear purpose and scope of use, and submit an application to the surveying and mapping administrative department at the place where the surveying and mapping achievements are located for approval". That is, the relevant surveying and mapping achievements may only be distributed and used upon approval through administrative licensing.

To give full play to the value of fundamental surveying and mapping achievements as a new factor of production, and fully support the high-quality development of the economy and society, this paper sorts out the service status of national fundamental surveying and mapping achievements from 2020 to 2024, analyzing the existing problems and challenges under the new situation, and finally provides targeted countermeasures and suggestions.

2. Current Situation of National Fundamental Surveying and Mapping Achievements Services

National Geomatics Center of China (NGCC), as the main department for storing and providing national fundamental surveying and mapping achievements, is responsible for providing fundamental surveying and mapping achievements such as geodetic survey achievements, DOM, DLG, DEM, DTM. Classified by confidentiality level, the achievements include classified and unclassified fundamental surveying and mapping products. By delivery method, they are provided through both online and offline modes. Among them, the offline distribution

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method is adopted for classified fundamental surveying and mapping achievements in accordance with the Measures for the Administration of the Provision and Use of Classified Fundamental Surveying and Mapping Achievements, and the combination of online and offline methods is used for providing and sharing non-classified fundamental surveying and mapping achievements.

To clearly reflect the provision and application of national fundamental surveying and mapping achievements, this paper conducts statistical analysis by delivery method (online, offline) and confidentiality level, and the specific situation is as follows.

2.1 Offline Provision Situation

2.1.1 Classified Fundamental Surveying and Mapping Achievements: From 2020 to 2024, a total of 1,347 batches of classified surveying and mapping achievements (all belong to administrative licensing items) were provided to the society, with a total data volume of 2078.26 TB. The service targets cover 25 industries including transportation, geology and mineral resources, geographic information, aerospace, water conservancy and hydropower, petroleum and petrochemical, urban and rural construction and planning, land management, forestry, science, education, culture and health, electric power, environmental protection, oceanography, seismology, software and information technology services, coal, agriculture, communications, and publishing, involving 340 units; the service contents mainly include 4D products (DOM, DLG, DEM, DTM), geodetic achievements, topographic maps, etc. The data volume of achievements provided in the past five years are shown in Figure 1.

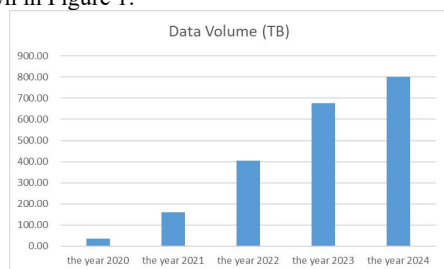


Figure 1. Statistical Situation of Classified Fundamental Surveying and Mapping Achievements Provided by Data Volume (2020-2024).

It can be seen from Figure 1 that the data volume of classified fundamental surveying and mapping achievements provided was about 30 TB in 2020, about 160 TB in 2021, about 400 TB in 2022, about 680 TB in 2023, and about 800 TB in 2024. From the perspective of the change trend of data volume, it shows an increase trend overall, with significant growth from 2021 to 2022 and from 2022 to 2023.

The classified fundamental surveying and mapping achievements provided from 2020 to 2024 specifically include DOM, DLG, DEM, paper topographic maps and geodetic achievements, and the statistics by type are shown in Figure 2 and Figure 3. Among them, 576,232 sheets/scenes of DOM were provided, with a data volume of 2072.09 TB; 197,255 sheets of DLG were provided, with a data volume of 0.9 TB; 293,008 sheets of DEM were provided, with a data volume of 4.89 TB; 11,687 sheets of paper topographic maps were provided; 18,951 points of geodetic achievements were provided, with a data volume of 0.38 TB. It can be seen from Figure 2 and Figure 3 that DOM has the largest provision

volume, followed by DEM, DLG, geodetic achievements and topographic maps.

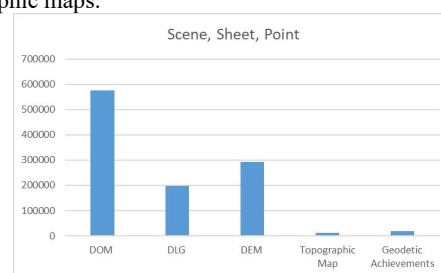


Figure 2. Total Sheet Count of DOM, DLG, DEM, Topographic Maps and Geodetic Achievements Provided in the Past 5 Years.

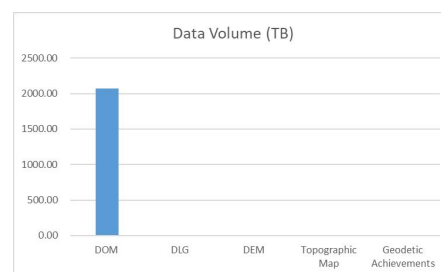


Figure 3. Total Data Volume of DOM, DLG, DEM, Topographic Maps and Geodetic Achievements Provided in the Past 5 Years.

To clarify the industry distribution characteristics of fundamental surveying and mapping achievements services, statistical analysis was conducted by industry departments. The results show that industries such as natural resources, transportation, and aerospace are still the main demanders of data. The natural resources industry mainly uses the data for geological and mineral exploration and the implementation of surveying, mapping and geographic information projects. The transportation industry mainly uses it for railway and highway planning. The aerospace industry mainly applies it to airport site selection, auxiliary flight procedure design and airport planning. The specific industry distribution of fundamental surveying and mapping achievements services is shown in Figure 4.

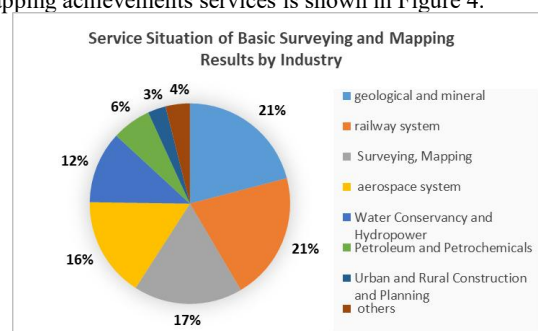


Figure 4. Situation of Fundamental Surveying and Mapping Achievements Services by Industry.

2.1.2 Non-Classified Surveying and Mapping Achievements: From 2020 to 2024, a total of 82 batches of non-classified surveying and mapping achievements were provided offline to the society, with a total data volume of 16.68 TB. The service targets cover 18 industries including geographic information, aerospace, geology and mineral resources, science, education, culture and health, railway, water conservancy and hydropower, urban and rural construction and

planning, and petroleum and petrochemical, involving 57 units; the service contents mainly include 1:1,000,000 and 1:250,000 public version fundamental geographic information data (DLG, DEM). The number of maps and data volume of achievements provided are shown in Figure 5 and Figure 6 respectively.

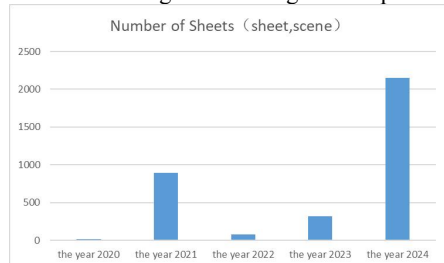


Figure 5. Statistical Situation of Non-Classified Surveying and Mapping Achievements Provided by Number of Sheets (2020-2024).

As shown in Figure 6, 13 non-classified surveying and mapping products were provided in 2020, nearly 1,000 in 2021, approximately 100 in 2022, around 700 in 2023, and over 2,000 in 2024. Therefore, the number of map sheets provided in 2024 was the highest.

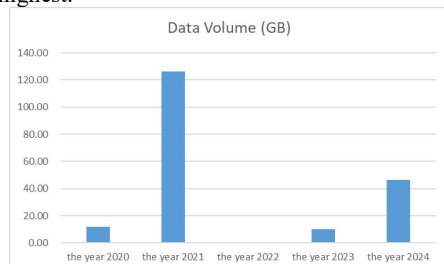


Figure 6. Statistical Situation of Non-Classified Fundamental Surveying and Mapping Achievements Provided by Data Volume (2020-2024).

It can be seen from Figure 6 that the data volume of non-classified surveying and mapping achievements provided was 15 GB in 2020, more than 120 GB in 2021, which had the largest data volume, relatively less in 2022, 2023 was slightly lower than that in 2020, and 40 GB in 2024.

2.1.3 Other Surveying and Mapping Achievement Materials: From 2020 to 2024, a total of 955 batches of other surveying and mapping achievement materials were provided to the society, with a total data volume of 2831.83 TB, mainly including intermediate project achievements and undetermined confidential achievements. The service targets cover 13 industries including geographic information, state organs, geology and mineral resources, urban and rural construction and planning, land, and science, education, culture and health, involving 141 units. The provision situation of other surveying and mapping achievement materials is shown in Figure 7.

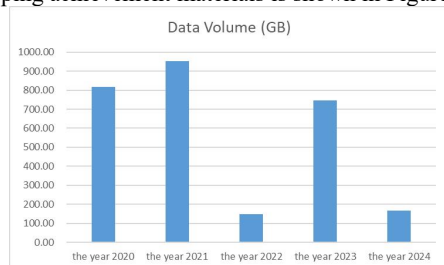


Figure 7. Statistical Situation of Other Surveying and Mapping Achievement Materials Provided by Data Volume (2020-2024).

It can be seen from Figure 7 that, in terms of data volume, 800 TB of other surveying and mapping achievements were provided in 2020, more than 950 TB in 2021, about 130 TB in 2022, about 740 TB in 2023, and 180 TB in 2024, among which 2021 had the largest data volume.

2.2 Online Provision Situation

From 2020 to 2024, the surveying and mapping achievement materials provided online mainly include non-classified fundamental surveying and mapping achievements such as 30m global land cover data, 1:250,000 and 1:1,000,000 fundamental geographic information data (mainly DLG), as detailed in Table 1, Table 2, and Table 3. The specific situation of each year is as follows: 31,684 batches and 4.23 TB in 2020; 44,345 batches and 4.23 TB in 2021; 64,816 batches and 5.16 TB in 2022; 58,833 batches and 3.68 TB in 2023; 63,354 batches and 4.54 TB in 2024. The overall trend shows year-by-year growth, and 2022 had the largest number of download batches and data volume.

The service targets cover universities, research institutes, enterprises and public institutions, and individuals in industries such as natural resources, ecological environment, biology, electric power, architectural design, and municipal administration. From the statistics of the distribution of service targets, universities have the largest number of download batches, mainly for teaching and scientific research; followed by enterprises and public institutions, mainly serving the implementation of project engineering.

Year	Data Type	Download Batch	Download Batch (GB)
2020	Global Land Cover Data	4980	1029.77
2021	Global Land Cover Data	5211	728.84
2022	Global Land Cover Data	5344	681.46
2023	Global Land Cover Data	6236	638.63
2024	Global Land Cover Data	11016	1154.65
Total		32787	4233.35

Table 1. Statistical Table of Non-Classified Surveying and Mapping Achievement Materials (Global Land Cover Data) Provided Online from 2020 to 2024.

Year	Data Type	Download Batch	Download Batch (GB)
2020	1:250,000 Public Fundamental Geographic Information Data	13614	2877.57
2021	1:250,000 Public Fundamental Geographic Information Data	19233	3058.46
2022	1:250,000 Public Fundamental Geographic Information Data	23972	2410.07

2023	Information Data 1:250,000 Public Fundamental Geographic Information Data	20856	1533.05
2024	Information Data 1:250,000 Public Fundamental Geographic Information Data	21116	1936.18
Total		98791	11815.33

Table 2. Statistical Table of Non-Classified Surveying and Mapping Achievement Materials (1:250,000 Public Fundamental Geographic Information Data) Provided Online from 2020 to 2024.

Year	Data Type	Download Batch	Download Batch (GB)
2020	1:1,000,000 Public Fundamental Geographic Information Data	13090	425.83
2021	1:1,000,000 Public Fundamental Geographic Information Data	19901	547.6
2022	1:1,000,000 Public Fundamental Geographic Information Data	35500	2194.27
2023	1:1,000,000 Public Fundamental Geographic Information Data	31741	1600.42
2024	1:1,000,000 Public Fundamental Geographic Information Data	31222	1564.31
Total		131454	6332.43

Table 3. Statistical Table of Non-Classified Surveying and Mapping Achievement Materials (1:1,000,000 Public Fundamental Geographic Information Data) Provided Online from 2020 to 2024.

3. Overall Situation Analysis

3.1 Increasing Volume of Classified Fundamental Surveying and Mapping Data Provided Annually

In recent years, with the advancement of Chinese-style modernization, the demand for the use of classified fundamental surveying and mapping achievement data has continued to rise, and the amount of data provided has increased year-by-year. From the perspective of achievement types, DOM achievements have the largest data volume provided, accounting for more than 99% of the total data volume; the demand for traditional paper surveying and mapping achievements has decreased year-by-year due to factors such as confidentiality restrictions and insufficient currentness.

3.2 Dual Growth in Online and Offline Services for Non-Classified Surveying and Mapping Achievements

Taking online services as an example, the data download volume has increased significantly. In 2024, the number of data download batches increased more than 25% compared with 2023, and the data volume increased more than 42%, which reflects the strong demand of users for non-classified surveying and mapping achievements. Recently, the state has issued relevant policies to encourage the development of the public version of surveying and mapping achievements and promote the sharing of non-classified achievements, which not only increases the supply of the public version of surveying and mapping achievements, but also provides data support for online services, further promoting the increase in the distribution service quality of non-classified surveying and mapping achievements.

3.3 Other Surveying and Mapping Achievement Materials Mainly Serve the Internal System of the Ministry of Natural Resources

The usage of such achievements is directly related to the amount of major project tasks within the natural resources system. They mainly provide surveying and mapping project achievements such as survey and monitoring achievements, intermediate achievements of 3D real-scene modelling, and global geographic information resource achievements for units within the system, supporting the development of businesses such as the construction of 3D Real-Scene China, urban territorial space monitoring, special rectification of illegal construction on cultivated land in rural areas, and remote sensing monitoring of natural resources protection and utilization.

4. Problems and Challenges

4.1 The Current National Policies on the Confidentiality Management of Surveying and Mapping Achievements Restrict the Coverage of Achievement Distribution

In accordance with the Provisions on the Scope of National Secrets in the Administration of Surveying, Mapping, and Geographic Information Work, most fundamental surveying and mapping achievements are classified as secret contents. For example, national geodetic survey achievements and 1:50,000 national basic scale topographic maps and their full-element digital achievements are mainly classified as confidential. The Measures for the Administration of the Provision and Use of Classified Fundamental Surveying and Mapping Achievements clearly require that applicants for the use of classified fundamental surveying and mapping achievements must meet a series of conditions, including that the applicant must be a legal person or other organization, have a clear and legal purpose of use, and meet the standards for confidentiality storage and use conditions. In addition, there are strict restrictions on the use and storage of classified surveying and mapping achievements. The using unit is not allowed to copy, transfer or lend them without permission or provide them to a third unit in any form without the written permission of the competent department. To some extent, the above policy requirements restrict the circulation and sharing of surveying and mapping achievements, making it difficult for them to play a role in a wider range of fields and groups. For example, some units cannot obtain classified surveying and mapping achievements because their confidentiality environment does not meet the application

requirements, which further affects the development of their business.

4.2 The Currentness and Variety of Fundamental Surveying and Mapping Achievement Data Need to be Improved

Affected by factors such as limited national financial investment, national multi-scale topographic feature data, aerial photography products, and geodetic survey achievements cannot be updated in a timely manner. For example, the currentness of 1:1,000,000 fundamental geographic information data still remains in 2019. In addition, the existing national fundamental surveying and mapping achievements are still dominated by traditional topographic maps and orthophotos, lacking specialized achievement services for professional fields; at the same time, the integration and productization of multi-source data are insufficient, making it difficult to accurately meet the personalized needs of different industries.

4.3 The Awareness of Achievement Services and the Level of Information-based Services Need to be Further Improved

At present, the information-based systems relied on by the distribution services of national fundamental surveying and mapping achievements include the National Geographic Information Resource Catalog Service System, the Intelligent Approval System of the Ministry of Natural Resources, and the Surveying and Mapping Achievement Distribution Management System. The National Geographic Information Resource Catalog Service System provides the Catalog and metadata query functions of existing surveying and mapping achievements. The Intelligent Approval System of the Ministry of Natural Resources is responsible for the acceptance and approval of classified surveying and mapping achievements. The Surveying and Mapping Achievement Distribution Management System undertakes the management work of data provision. At the same time, the online government service section of the Ministry of Natural Resources and the website of National Geomatics Center of China have also released information such as relevant government service guidelines. Relying on the above information-based systems, the whole process of query, application, acceptance, approval and distribution of classified fundamental surveying and mapping achievements has basically been realized online, and the submission of paper materials and the receive of final achievements have also realized the "one-stop" service in the government service hall, with a user satisfaction rate of more than 90%.

From the perspective of service initiative, the current achievement services are still mainly passive in responding to user needs, and the awareness of active service is insufficient. For example, there are a few scenarios for actively promoting national fundamental surveying and mapping achievements, the efforts to actively connect with the special needs of users are insufficient, and there is a lack of intelligent service means such as lacking AI intelligent replies application. From the perspective of system coordination, although the various information-based systems have realized interface docking, they have not met the efficiency and convenience requirements of "one-stop online handling". Users need to switch operations between different systems, and there is still a gap for improvement in the level of information-based and intelligent services.

The confidentiality management policy system of surveying and mapping achievements should be Improved, and the precision of classified management should be promoted. Further, we should refine the detailed rules for the confidentiality management of classified achievements, and improve the accuracy and scientificity of the classified determination work of classified achievements. We should adjust the focus of the confidentiality management of classified achievements, shifting from taking "spatial position accuracy" as the core to taking "geographic feature attributes" as the core [5, 6]. We should refine the management requirements and operation specifications for the problems existing in the key points such as the application, storage, use and destruction of classified data, to ensure the whole process control of confidentiality management.

The achievement update mechanism should be improved and the currentness of fundamental surveying and mapping achievements should be enhanced. We should construct a fundamental surveying and mapping achievement update mechanism combining "regular update + dynamic update", and implement quarterly or monthly dynamic updates for key areas and key fields. We will strengthen the cooperative work with relevant departments, establish an inter-departmental data sharing mechanism, and timely obtain the geographic information change data generated in the process of work from various departments as an important supplement to the update of fundamental surveying and mapping achievements. New technologies such as cloud computing, artificial intelligence and big data should be actively introduced to improve the efficiency and accuracy of data processing and analysis, and to realize the rapid update and publish of fundamental surveying and mapping achievements.

We will enrich the variety of achievements and improve the pertinence of achievement services. Through promoting the transformation of the fundamental spatiotemporal information database represented by 4D products to fundamental geographic entity database and 3D real-scene to optimize the types of achievements. We should leverage technologies such as 3D modelling and virtual reality to transform 2D surveying and mapping data into visualized products like 3D real-scene models and VR maps, thereby enhancing the intuitiveness and usability of the deliverables. Multi-source data fusion and application should be strengthened, and foundational surveying and mapping data should be deeply integrated with heterogeneous multi-source data such as satellite remote sensing, LiDAR, and UAV aerial surveys, through which new types of geospatial products—such as 3D underground utility models and hyperspectral imagery—should be developed. Meanwhile, we will promote the integration of fundamental topographic data with IoT (Internet of Things) sensing data and humanistic economic data to generate comprehensive surveying and mapping achievements. Thematic geospatial products should be developed to meet the diverse needs of different field, such as carrying out underwater topographic surveying of key rivers, lakes and reservoirs to provide data support for water conservancy project construction and water resource management. Producing thematic maps and data products for ecological protection, agricultural planning and underground space development to meet the special needs of relevant fields.

We should promote the processing and compilation of the public version of surveying and mapping achievements, and expand the supply of non-classified achievements. We should combine the differentiated needs of national defence construction and economic construction for geographic

5. Countermeasures and Suggestions

information data and construct a dual data product system consisting of a "classified version" and a "public version". We should process and compile multi-scale, multi-type public versions of surveying and mapping achievements based on technological development trends and the non-classified data needs of various industries, significantly expanding the coverage and variety of public-version vector, imagery, digital line graph, and 3D model data.

We should strictly comply with relevant regulations to promptly release catalogs of non-classified fundamental geographic information achievements to the public, further expand the scope of open sharing, and ensure that more users' legitimate usage needs are met.

We should build a geographic information public data innovation application laboratory, and expand the application scenarios of classified achievements. In response to the challenges of high security requirements and limited societal applicability of classified surveying and mapping achievements, geographic information public data innovation application laboratories should be established to meet the demands of public governance, industrial development, and scientific research. By building a safe and reliable physical environment for classified data processing and a full-process control technical process, and adopting the mode of "original data not leaving the domain, data available but not visible, and achievements review before being taken out", the application scenarios of data are expanded under the premise of ensuring data security, and the potential value of classified geographic information public data is fully explored.

6. Conclusion

To fully implement the national strategic deployment regarding the construction of Digital China and the development of the digital economy, and accurately grasp the work orientation of surveying, mapping and geographic information in the new era and new journey of "supporting economic and social development, serving the needs of various industries, supporting natural resources management, and serving ecological civilization construction", the work of national fundamental surveying and mapping achievements services needs to adhere to uphold fundamental principles and create new fields, coordinate development and security, and take services as the guarantee for development, take services as the driving force for innovation, take services as the promotion for production, and take services as the assistance for reform (Wang et al., 2015). Through measures such as improving the security and confidentiality system, enhancing the currentness of achievements, enriching the variety of achievements, promoting the processing and compilation of the public version of surveying and mapping achievements to strengthen the supply of non-classified achievements, and building a geographic information public data innovation application laboratory, to continuously improve the service level of national fundamental surveying and mapping achievements, to further play the role of surveying, mapping and geographic information data as a basic and strategic resource and factor guarantee, to provide comprehensive empowerment for high-quality development, and offer support for the construction of Chinese-style modernization.

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