

Research on Technical Methods for Quality Assurance of Natural Resources Survey and Monitoring Results

Wenchao Gao¹, Chenni Lu¹, Chang Liu¹, Bingquan Yao¹, Hai Li¹, Shuai Dong^{1*}

¹National Quality Inspection and Testing Center for Surveying and Mapping Products, Beijing, China - 397595381@qq.com

Keywords: Natural resource survey and monitoring, quality assurance technology, parcel results, evaluation method, quality model

Abstract:

This paper is based on the core task of comprehensively ensuring the quality of natural resources survey and monitoring results. Combining the team's research achievements over the years in unifying the quality management methods, processes, and requirements for survey and monitoring, as well as standardizing quality control methods, inspection technologies, and evaluation indicators, it strengthens quality management by continuously enhancing full-chain process quality inspections, strictly implementing result quality acceptance procedures, and continuously improving the technical capabilities for result quality control to ensure the quality of results. At the same time, focusing on the application in the quality control project of the dynamic full-coverage remote sensing monitoring project for land use, it summarizes and analyzes the designed full-chain process quality inspection contents, the formulated result quality inspection contents and evaluation indicators, as well as the development and application of the result quality inspection software. The results show that it can comprehensively ensure the authenticity, accuracy, and reliability of the results.

1. INTRODUCTION

The Ministry of Natural Resources issued the Overall Plan for Constructing the Natural Resources Survey and Monitoring System in 2020, explicitly proposing to focus on establishing a survey and monitoring technical system with remote sensing as the main means. It conducts surveys on the types, quantities, qualities, spatial distributions, and other conditions of natural resources in China, including cultivated land, forests, grasslands, wetlands, and land use. It also stipulates that based on the completed surveys, annual monitoring and updating of natural resources achievements should be carried out in key areas to promptly grasp changes in the types, areas, scopes, etc., of each piece of natural resources nationwide, and clarify the inventory and changes of various natural resources in China. Additionally, it clearly requires that during the implementation of natural resources survey and monitoring work, the construction of a quality management system for natural resources survey and monitoring should be carried out simultaneously to comprehensively ensure the authenticity, accuracy, and reliability of survey and monitoring results.

At present, natural resources survey and monitoring work mainly uses aerospace optical satellites to obtain earth observation image data. After correction, digital orthophotos are produced as the basic base map data for survey and monitoring. By comparing the basic base map data with the patch classifications in the historical database, data where the images no longer support the patch classifications in the historical database are identified. Such data are extracted according to the survey and monitoring patch classification system. When necessary, field verification and evidence collection are carried out according to the requirements of different types of survey and monitoring projects, ultimately forming survey and monitoring patch achievements. The corrected orthophotos and extracted monitoring patch achievements are finally stored in a

database for statistical analysis and daily business management applications, making these two types of achievements the most important results of survey and monitoring.

In recent years, the team has consistently focused on constructing the quality management system for natural resources survey and monitoring, carrying out technical research on unifying quality management methods, processes, and requirements for survey and monitoring, as well as standardizing quality control methods, inspection technologies, and evaluation indicators. In terms of institutional and standard construction, the Guidelines for Quality Management of Natural Resources Survey and Monitoring (Trial), compiled by the team, has been issued by the Ministry of Natural Resources for national implementation. The drafting of the industry standard Quality Requirements for Natural Resources Survey and Monitoring is ongoing, continuously improving the capacity and technical level of survey and monitoring quality management to provide high-quality quality inspection technical support for scientific analysis and objective evaluation of the efficiency of natural resources and ecological environment protection, restoration, governance, and utilization.

2. MAIN RESEARCH CONTENTS

In the field of quality assurance for natural resources survey and monitoring, domestic researchers have mainly conducted studies on quality management from the stages of data collection, data processing, data storage and management, as well as data release and sharing. Some researchers have also explored the quality management of Real Scene 3D China construction achievements from the four key elements of quality planning, quality control, quality assurance, and quality improvement. Abroad, Canada's satellite forest resource survey focuses on ensuring spatiotemporal consistency of data in quality control, while the U.S. water resource monitoring

* Corresponding author

emphasizes data spatiotemporal comparability and guarantees spatial matching of monitoring data across different scales.

This paper in the research on technical methods for quality assurance of natural resources survey and monitoring, takes the integrity of achievements and the accuracy of thematic quality as the starting point. Focusing on the relevant research and applications in remote sensing monitoring quality control in recent years, it summarizes the research and application status in aspects such as full-chain process quality inspection, design of key inspection contents for main achievements, establishment of quality evaluation indicators, and development of quality inspection software. It also classifies, summarizes, and analyzes typical quality issues found. The results show that the research achievements can effectively ensure the realization of quality objectives, comprehensively guarantee the authenticity, accuracy, and reliability of achievements, meet the application needs of natural resources management, the modernization of the national governance system and capacity, and high-quality development, and can provide reference for quality management of other types of natural resources survey and monitoring projects.

3. RESEARCH ON FULL-CHAIN PROCESS QUALITY INSPECTION

Process quality control is the core concept of quality management. Strengthening process quality control has always been the guiding principle adhered to in national major surveying, mapping and geographic information engineering projects, and the work of natural resources survey and monitoring is no exception. Carrying out full-chain natural resource process quality inspection focuses on inspecting the implementation of survey and monitoring quality management work. The inspection contents are mainly carried out from two aspects: process quality control status and process achievement quality. The purpose is to track the overall quality of survey and monitoring by the operating unit, correct technical deviations in the operation process, and eliminate existing major quality hidden dangers.

3.1 Inspection Contents and Methods for Process Quality Control

For the design of inspection contents for natural resources survey and monitoring quality control, it is applicable to full-chain inspections of various survey and monitoring tasks, including basic natural resources survey and monitoring and special survey and monitoring. The inspection contents mainly include two aspects: design process quality inspection and operation process quality inspection, which are generally carried out through methods such as reviewing records, interviewing and communicating, and on-site inspection.

The inspection contents of design process quality mainly include four aspects: In terms of design management: Whether the design unit has formulated and effectively implemented a quality management system for survey and monitoring. In terms of design specifications: Whether the principle of "design first, then produce" is strictly followed, the preparation, review, and approval procedures of technical design documents are carefully fulfilled, and when the task changes, whether the design plan is modified and supplemented, and the necessary verification, review, and approval procedures are performed. In terms of design methods: Whether laws, regulations, and standards are strictly followed to ensure that the classification indicators for survey and monitoring are clear, the technical methods are

scientific, and the quality requirements are explicit. In terms of design verification: Whether quality inspection of first-piece achievements is carried out to verify the technical design and avoid systematic quality problems caused by design defects.

The inspection contents of operation process quality mainly include six aspects: In terms of operation management: Whether the operation unit has established a quality management system within its business scope and ensured its effective operation, and whether a hierarchical quality responsibility system has been established and the responsibilities of all-level persons in charge have been effectively implemented. In terms of operation personnel: Whether a special quality management department is established and equipped with full-time quality management personnel and quality inspectors, whether technical and quality training has been carried out for the project, and whether personnel are posted after passing the assessment when necessary. In terms of operation equipment: Whether the used instruments and equipment have been verified by legal metrology verification (calibration) institutions and are within the valid period, and whether the used software has passed testing and verification. In terms of operation data and materials: Whether reference materials are authentic, authoritative, and complete, whether they are applied in strict accordance with the use principles, and whether the data are true and valid without fraud. In terms of operation methods: Whether the operation is carried out in accordance with the process flow and technical index requirements specified in the design plan to ensure no deviations and that the achievements meet the design requirements. In terms of quality inspection: Whether the inspection proportion, inspection contents, modification and re-inspection of quality problems meet the requirements, whether the achievement quality evaluation method is correct, and whether the inspection records and reports are complete and standardized.

3.2 Inspection Contents and Methods for Process Achievement Quality

For the quality inspection of process achievements in natural resources survey and monitoring, the inspection contents generally include two parts: key process inspection and stage achievement inspection of achievement production. The key process inspection for production is specifically determined according to the requirements of different types of survey and monitoring projects, showing certain differences. However, major national-level survey and monitoring projects covering the whole country usually adopt satellite remote sensing, generally including orthophoto map production and survey monitoring patch achievement production. The stage achievement inspection is determined according to the characteristics of the achievements. Image-based achievements usually include logical consistency, time accuracy, position accuracy, and image quality, etc. Patch-based achievements generally include logical consistency, time accuracy, position accuracy, integrity, and the thematic accuracy of various survey and monitoring achievements, etc. The sampling inspection method is generally used, and the inspection contents and methods refer to the requirements of achievement inspection.

The key process inspection contents for orthophoto production generally include such links as data collection, block adjustment, stereo model restoration, orthorectification, image fusion, color processing, mosaic and clipping, and edge matching inspection. The key process inspection contents for monitoring patch production generally include whether the extraction principles, extraction technical processes, extraction methods, processing

methods, and the correctness and compliance of information expression meet the design requirements, as well as whether the patch extraction contents and indicators, patch classification, patch boundary accuracy, patch numbering, and logical relationship processing meet the technical requirements, etc.

3.3 Process Quality Inspection Workflow

The process quality inspection workflow consists of three stages: inspection preparation, inspection implementation, and result feedback, as shown in Figure 1.

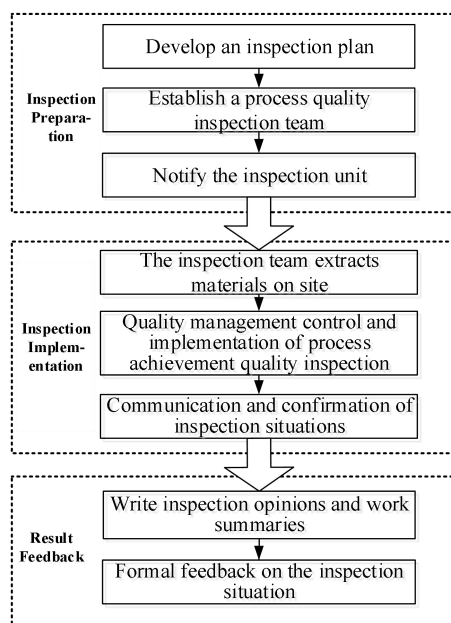


Figure 1. Process Quality inspection procedure

Based on the actual situation of project organization and implementation, develop a process quality inspection plan. According to the project design and specific requirements of process quality inspection, establish an inspection team, organize relevant personnel for training, unify the technical approach, and reach a common understanding of quality. One week before implementing the process quality inspection, notify the relevant units undertaking the production tasks in writing. The inspected units shall prepare relevant materials in accordance with the inspection requirements.

After the inspection team arrives at the site, collect materials related to the quality management situation and sample stage achievements. When sampling stage achievements, select those with a high degree of completion. If the production and submission for inspection of the first-piece achievement have been completed, the inspection object for stage achievements at this time shall focus on the submitted first-piece achievement. Inspect the quality of key production processes and the quality of achievements. During the inspection implementation, conduct on-site inspections of the process quality control situation and the process achievement quality situation as required, and fill in the corresponding inspection record forms. Finally, based on the inspection situation, the inspection team shall feedback the main quality issues, communicate for confirmation, and return relevant materials.

After the on-site inspection, the inspection team shall, based on the inspection situation, prepare process quality inspection opinions, review the sampling opinions of various data

achievements, put forward rectification suggestions, and formally feedback to the inspected units.

4. RESEARCH ON TECHNOLOGY FOR QUALITY INSPECTION OF ACHIEVEMENTS

This paper focuses on the achievements of natural resource investigation and monitoring, including orthophoto maps, polygon data extracted from investigations, database results, statistical analyses, cartographic reports, and other deliverables. It specifically integrates the conventional monitoring of land use dynamic full-coverage remote sensing to study the inspection contents, methodologies, and evaluation metrics for digital orthophoto maps and polygon results derived from investigation and monitoring.

4.1 Digital Orthophoto Map Achievements

4.1.1 Principles for Establishing Quality Models: To ensure comprehensive coverage of the technical quality requirements specified in the technical scheme while highlighting the application needs of vector polygon extraction, this study designed a quality model for orthophoto map achievements, including quality inspection items, inspection contents and methods, with reference to Quality Inspection and Acceptance of Digital Mapping Achievements (GB/T 18316-2008). The quality model comprises six quality elements: spatial reference system, positional accuracy, logical consistency, imaging characteristics, image quality, and accessory quality, with the following refinements and supplements to the inspection items in the national standard.

In view of the strict requirements for the monitoring phase of each county-level monitoring unit nationwide, the different requirements for the spatial resolution of image sources in the three types of monitoring areas across the country, and also considering the impact of image side-view angles on orthorectification in complex terrain areas, special inspection items for imaging characteristics such as image source phase, spatial resolution, and side-view angle are set up.

To ensure the surface quality of orthophoto maps, three supplementary inspection items—specifically texture features, image noise, and information loss—were instituted. This was executed based on pre-established inspection items for sampling interval, data range, and color mode, in strict accordance with the technical scheme's control requirements for color coordination processing, distortion/stretching, image noise, and cloud/snow/fog shadow occlusion. These measures are designed to guarantee that key monitoring zones—encompassing urban-rural junctions, peri-urban settlements, roadway corridors, mountainous industrial-mining areas, and contiguous cultivated land tracts, which are subjected to intensive human activities and influences—are devoid of surface-quality anomalies that may impede change polygon delineation or land-cover interpretation. Additionally, the area of substandard imagery is mandated to conform to the technical specifications delineated in the scheme.

To meet the requirements for remote sensing monitoring database establishment and post-application needs, in compliance with the technical scheme's provisions (such as no cloud, snow, or fog coverage), and adhering to the principle of selecting the optimal from superior results, inspection items are specifically set up to focus on examining the supplementation of cloud/snow/fog coverage gaps in the deliverables, as well as addressing professional imaging issues including geometric

misalignment, structural discontinuity, streaking artifacts, line feature dropout, and banding noise.

4.1.2 The key inspection focuses on: Six quality elements including spatial reference system, positional accuracy, logical consistency, imaging characteristics, image quality, and accessory quality. The inspection focuses on imaging characteristics and image quality, and the detailed inspection items refined according to the project characteristics are shown in Table 1.

Quality Element	Inspection Item	Inspection Content
Imaging Characteristics	Image Temporal Phase	Whether the currency of the image meets the requirements
	Resolution	Whether the spatial resolution of the image meets the requirements
	Side View Angle	Whether the side view angle of the image meets the requirements
Image Quality	Sampling Interval	Whether the sampling interval of the image meets the requirements
	Data Range	1) Whether the effective data range of the image meets the requirements 2) Whether the image cropping extension method meets the requirements
	Color Mode	Whether the image color mode and pixel bit depth meet the requirements
	Texture Features	Whether the image color processing and texture features meet the requirements, including: 1) Whether color images simulate natural true color, and whether there is color abnormality in fusion processing 2) Whether the colors of images in the same area with similar phases are uniform, and whether the color transition in mosaicking is natural 3) Whether the tone is uniform, distortion-free, and with moderate contrast 4) Whether the spectral information is rich, details are clear and layers are distinct, and whether there is ghosting or blurring 5) Whether there is distortion of important features or large-area streaking 6) Whether there is misalignment, fracture, or streaking caused by the image source

Quality Element	Inspection Item	Inspection Content
	Image Noise	The degree of influence of image noise, stains, etc. meets the requirements, including: 1) Whether there is line dropout or banding caused by the image source 2) Whether there is edge pixel value abnormality or internal noise caused by image processing 3) Whether there is abnormal pixel value in the area without valid values
	Information Loss	Whether the degree of image pixel information deficiency and loss meets the requirements, including: 1) Whether special mosaicking and processing have been carried out 2) Whether there are image cracks or loopholes 3) Whether cloud, snow, or fog shadows cover the features 4) Whether cloud, snow, and fog shadows are delineated and replaced as required 5) Whether there is overexposure or spectral overflow

Table 1. Key Inspection Items for DOM

4.1.3 Inspection Methods: For inspection items related to the spatial reference system, logical consistency, sampling interval, data range, and color mode in image quality, as well as data item definitions in accessory quality, and partial statistical calculations and value range judgments during inspection—all of which have deterministic logical constraint rules—software automatic inspection is adopted. Results are automatically analyzed and determined by computer software.

For inspection contents such as image temporal phase, resolution, and side view angle in imaging characteristics; image noise and information loss in image quality; and partial inspection contents of data in accessory quality—all of which have clear inspection rules or auxiliary data—software-assisted inspection is used. This method outputs partial intermediate inspection results to assist manual screening and troubleshooting, and analyze and determine the final results.

For positional accuracy, texture features in image quality, and other contents of image noise and information loss, inspection is generally completed manually through human-computer interaction inspection in professional software environments such as ArcGIS. Specifically, positional accuracy inspection refers to using data such as the orthophoto base map of the Third National Land Survey, high-precision aerial orthophotos, high-precision topographic map data results, and survey control points to check the planar positional accuracy of the achievements.

4.1.4 Achievement Evaluation : For digital orthophoto achievements, the current practice of organizing achievements by county-level administrative regions—breaking the traditional sheet-based organization—has led to an excessively large value of N (effective area of unit achievement) in the quality evaluation process. This makes the error limit r_0 specified in the current GB/T 18316-2008 Quality Inspection and Acceptance of Digital Surveying and Mapping Achievements inapplicable. Therefore, a technical index adjustment scheme for achievement evaluation has been developed. Overall, the evaluation adopts the minimum value method specified in 18316. However, for image quality, the evaluation comprehensively considers both the error area and the severity of issues. For example, severe tone distortion, blurred texture that fails to clearly represent land use type features and boundaries, and large-area distortion/streaking of local features directly adopt the error and omission deduction method, with scores deducted according to the impact on achievement usability.

4.2 Results of Investigation and Monitoring Patches

4.2.1 Principles for Establishing Quality Model: According to the work requirements of land change survey, technical indicators and quality requirements specified in the technical scheme, and based on the principles of curbing "non-agriculturalization" of cultivated land and preventing "non-grainization", the inspection contents, inspection items, and inspection specifics are determined from three aspects: consistency, completeness, and accuracy. The inspection focuses on the completeness and thematic accuracy of newly added construction and cultivated land change patches.

4.2.2 Key Inspection Contents: The contents of integrity and accuracy inspection for vector map spot results are shown in Table 2.

Quality Element	Inspection Item	Inspection Content
Integrity	Omission and Redundancy of Map Spots	1) Omission or redundant extraction of map spots in the suspected new construction layer, count the numbers respectively. 2) Omission or redundant extraction of map spots in the cultivated land change layer, count the numbers respectively. 3) Omission or redundant extraction of map spots in the construction land and facility agricultural land change layer, count the numbers respectively. 4) Omission or redundant extraction of map spots in the non-cultivated agricultural land change layer, count the numbers respectively. 5) Omission or redundant extraction of map spots in the unused land change layer, count the numbers respectively. 6) Omission or redundant

Quality Element	Inspection Item	Inspection Content
Accuracy	Type Judgment	extraction of map spots in the new reclamation layer, count the numbers respectively. 7) Omission or redundant extraction of map spots in the 6 types of monitoring with an area of more than 10 mu, count the numbers respectively. 1) Incorrect type judgment of map spots in the suspected new construction layer, count the number of misjudgments. 2) Incorrect type judgment of map spots in the cultivated land change layer, count the number of misjudgments. 3) Incorrect type judgment of map spots in the construction land and facility agricultural land change layer, count the number of misjudgments. 4) Incorrect type judgment of map spots in the non-cultivated agricultural land change layer, count the number of misjudgments. 5) Incorrect type judgment of map spots in the unused land change layer, count the number of misjudgments. 6) Incorrect type judgment of map spots in the new reclamation layer, count the number of misjudgments.
	Position and Other Attributes	1) Whether the position accuracy of the 6 types of monitoring map spots delineation exceeds the limit (delineation of non-universal map spot boundaries exceeding the limit is classified into this category), count the number of exceedances. 2) Errors in labeling other attributes (except for types) of the 6 types of monitoring map spots, count the number of errors and omissions. 3) Other errors in the 6 types of monitoring map spots (including non-universal improper handling of connectivity and up-down relationships, improper comprehensive or detailed extraction, topological relationship errors, etc.), count the number of errors and omissions.

Table 2. Key Inspection Items for Map Spot Results

4.2.3 Inspection Methods:Consistency inspection of vector map spot layers shall be conducted by software automatic inspection, and integrity and accuracy inspection shall be carried out by software-assisted and human-computer interaction methods. For the inspection results given by the software or contents requiring further verification, manual one-by-one investigation is required.

4.2.4 Result Evaluation:The integrity and accuracy of map spot extraction shall meet the following index requirements:The missing extraction rate of 2 types of monitoring map spots (such as suspected new construction and cultivated land outflow changes) shall not exceed 1%;The missing extraction rate of 4 types of monitoring map spots (such as construction land and facility agricultural land changes, non-cultivated agricultural land changes, unused land changes, and new reclamation) shall not exceed 5%;The missing extraction rate of large map spots with an area of more than 10 mu among the above 6 types of monitoring map spots shall not exceed 1%;The redundant extraction rate of the above 6 types of monitoring map spots shall not exceed 10%, the correct type judgment rate shall be no less than 95%, and the accuracy rate of delineation and other attribute labeling shall be no less than 98%. The correct type judgment rate of the map spots in the daily change verification result layer shall be no less than 95%.

For result inspections in different monitoring areas with orthophoto maps of different accuracies:When inspecting based on low-resolution imagery, the missing extraction of important change map spots shall be strictly checked;When inspecting based on high-resolution imagery, on the basis of the former, the redundant and erroneous extraction of map spots, as well as the accuracy of delineation position and type, shall be strictly checked.

4.3 Development of Software Tools

A quality inspection software system was designed and developed according to the characteristics of inspection contents and evaluation. With 72 functional items developed, it realizes:Automated inspection of normativeness and consistency for digital orthophoto maps and vector map spot results, as well as auxiliary inspection of integrity;Positioning and labeling of quality issue information;Fine-grained statistics and evaluation of quality information, etc.This improves the accuracy and efficiency of inspections.



Figure 2.DOM Result Software Inspection Tool



Figure 3.Map Spot Result Software Inspection Tool

5. APPLICATION AND TYPICAL PROBLEM ANALYSIS

5.1 Application And Statistics Situation

For the results of the digital orthophoto map, more than 200 survey areas nationwide were selected as test data to carry out application verification on the designed inspection contents, evaluation indicators and methods, using the researched full-chain process quality control, orthophoto map result quality inspection technologies and evaluation methods. From the perspective of the overall evaluation results, the rate of excellent and good products reaches 86.2%, and the quality of the results can meet the design requirements of the project. The statistical results of the number of excellent products, good products and qualified products are shown in Figure 4. The research results can ensure the achievement of the project's quality objectives and have been applied in the quality control work of remote sensing monitoring.

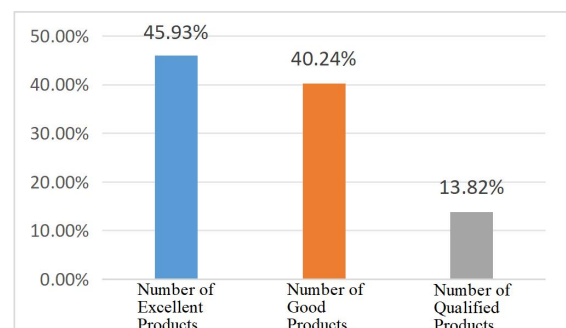


Figure 4.Statistics on DOM Sample Quality

Based on the results of the survey and monitoring map spots, the research team adopted the developed full-chain process quality control methods, as well as the quality inspection technologies and evaluation methods for map spot results. Taking into account the differences between the north and the south, the Northeast Region was selected as Experimental Zone 1, the Northern Region as Experimental Zone 2, the Mid-Northern Region as Experimental Zone 3, the Southeast Region as Experimental Zone 4, and the Southern Region as Experimental Zone 5. Sample area data were selected within these experimental zones for application verification, and various results such as the completeness rate of map spot extraction, the accuracy rate of land type judgment, the mapping accuracy, and other attribute annotations were summarized

respectively. These can effectively ensure the achievement of quality objectives. The statistical data on the completeness rate of extraction, the accuracy rate of land type judgment, the mapping accuracy, and other attribute annotations are shown in Figures 5 to 7.

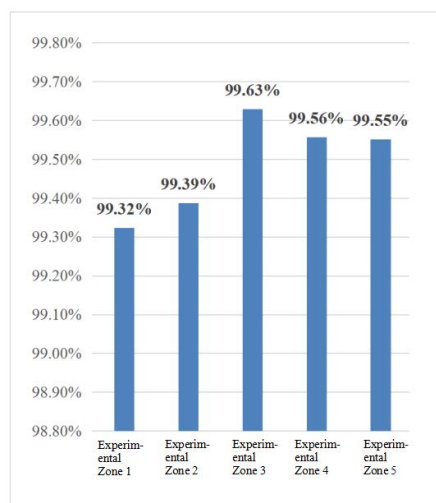


Figure 5. The extraction completeness rate of change spots

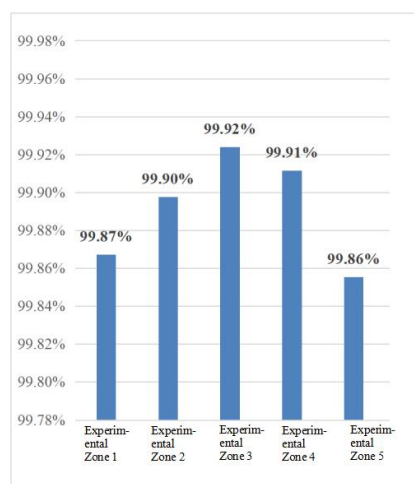


Figure 6. The correct rate of land use type judgment for change spots

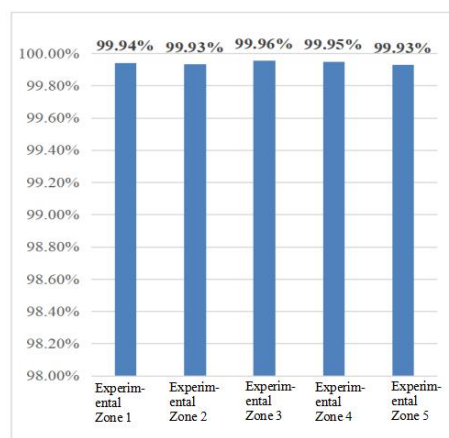


Figure 7. The accuracy rate of delineation and other attribute labeling

5.2 Typical quality problems and analysis

The orthophoto map achievements have some typical quality problems in terms of image quality, including: Abnormal pixel values inside or at the edges of some images, manifested as black edges, white edges, colored edges, etc. Local distortion and streaking in some images. Local tone distortion, color abnormality, and unnatural tone transition between image blocks in some images. Local cloud, snow, fog, and shadow occlusion of ground objects, strip noise, ghosting blur, spectral overflow and other typical quality problems.

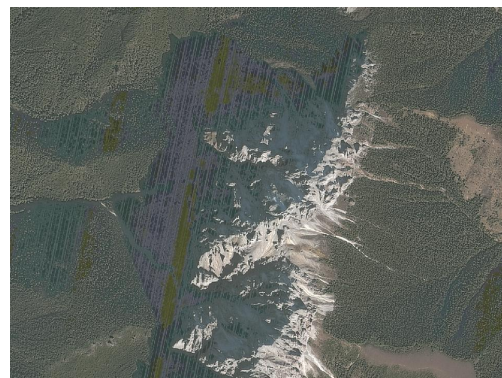


Figure 8. Local obvious banding defects

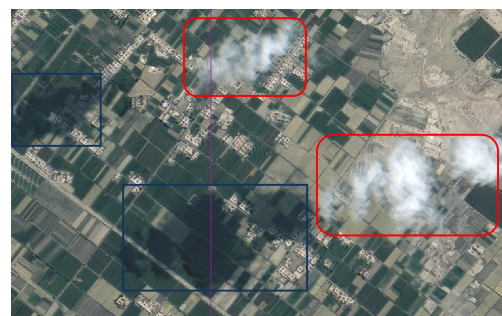


Figure 9. Cloud and cloud shadow occlusion of ground objects

The typical quality problems of monitoring spot achievements mainly include: In the non-construction land scope of the database, there are cases of missing extraction of spots such as buildings/structures, built roads, large ditches, park green spaces, and mining areas; In the cultivated land scope of the database, there are cases of missing extraction of spots such as water surfaces, forest land, and orchard land, etc.



Figure 10. Missing extraction of new buildings in the bulldozing area



Figure 11. Missing extraction of orchard and forest land in cultivated land

Upon analysis, the main causes of the above quality problems are as follows: Inadequate understanding of technical indicators and classification standards: Operators have insufficient comprehension of remote sensing monitoring technical indicators, unclear grasp of key points, and inaccurate mastery of the classification standards for the Third National Land Survey (Three Adjustments), leading to missing or incorrect extraction of key spots. Lack of work conscientiousness: Individual operators are not meticulous enough, resulting in missing extraction of obvious large-area change spots. Inexperience in technical processes: Individual operators are unfamiliar with the technical processes for change spot extraction, causing various inconsistencies and logical errors in spot extraction. Insufficient technical coordination in production: Production units lack sufficient technical coordination in some production processes, leading to inconsistent standards and scales for change spot extraction. Weakness in process quality control: The effectiveness of process quality control by production units needs to be strengthened, and self-inspection of some achievements is insufficient.

6. CONCLUSION

The team has carried out research on technical methods for quality management of natural resources survey and monitoring achievements from the aspects of continuously strengthening the quality inspection of the whole chain process, strictly implementing the achievement quality acceptance procedures, and continuously enhancing the technical capabilities of achievement quality control. Through specific applications in projects, it can effectively ensure the realization of quality objectives, comprehensively ensure the authenticity, accuracy and reliability of achievement quality, and meet the application needs of natural resource management, the modernization construction of the national governance system and governance capacity, and high-quality development. The research achievements can provide reference for the quality management work of other types of natural resource survey and monitoring projects. In the new era of intelligent surveying and mapping development, the team will focus on the development of remote sensing image large models and intelligent technologies, explore the research and application in the inspection fields such as the integrity of natural resource survey and monitoring achievements and the accuracy of special topics, and continuously improve the technical support capabilities of quality inspection.

REFERENCES

- Chen, Y.M., 2018. Reasonable Positioning of Quality Inspection Methods for Surveying and Mapping Products [J]. *Modern Property Management*, (05): 8.
- GB/T 18316. Specifications for inspection and acceptance of quality of digital surveying and mapping achievements [S]. Beijing: General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China, The Standardization Administration of China, 2008.
- Li, W.S., 2017. The geographic conditions monitoring promoting the transformation and upgrading of surveying, Mapping and Geoinformation Industry [J]. *Geomatics World*, 24(02):1-6.
- Liu, J.Y., Peng S., Chen J., et al, 2015. Knowledge based quality checking method and engineering practice of GlobeLand30 cropland data [J]. *Bulletin of Surveying and Mapping*, (04):42-48.
- Ministry of Natural Resources of the People's Republic of China, 2020. Overall Plan for the Construction of Natural Resource Survey and Monitoring System. [EB/OL]. (2020-01-17) [2020-02]. http://gi.mnr.gov.cn/202001/t20200117_2498071.html.
- Zhang L., Cheng, P.F., Han, W.L., 2015. Investigations of quality evaluation standard for national surveying and mapping key project products [J]. *Bulletin of Surveying and Mapping*, (02), 55-57, 63.
- Zhou X., Ruan, Y.Z., Gui, D.Z., et al, 2013. Study on the system and mechanisms of national geographic condition monitoring [J]. *Remote Sensing Information*, 28(02), 121-124.