QUALITY INSPECTION OF REMOTE SENSING FARMLAND RESOURCE MONITORING DATA ACHIEVEMENTS

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ABSTRACT:

The article proposes a quality inspection process for the monitoring data of remote sensing arable farmland resources, including an overall review, detailed inspection, and sample external review. The necessary parameters for analysis are determined, and the detection methods for different inspection items are differentiated. Some inspection items that can be automatically checked by the program are distinguished, and a rule library is established to achieve batch automatic inspection of some inspection items. Then, the implementation methods for the remaining quality inspection items are studied, the common problems are identified, and the human-machine interaction inspection of the quality inspection items is improved. Finally, the monitoring data results of arable farmland resources in 161 counties were tested, and the results showed that the proposed technical route is feasible, and the quality evaluation result is objective

1. INTRODUCTION

Arable farmland resources are important infrastructure and natural elements for agricultural production, which are of great significance to ensure national food security and promote agricultural modernization. To understand and grasp the distribution and utilization of national cultivated land resources, China has launched remote sensing monitoring of cultivated land resources since 2000, which can clarify the suspected changes of cultivated land "non-farming" and "non-grain growing", and timely obtain the current situation and changes of cultivated land resources, providing scientific basis for national agricultural planning and land use adjustment.

The quality of monitoring data for remote sensing cultivated land resources has a significant impact on agricultural development and national land management. With the development of the national remote sensing cultivated land resources monitoring project, it is important to ensure authoritative, objective, and accurate information on cultivated land resources, to conduct in-depth research on quality detection methods for monitoring data, and to explore scientific and efficient quality control and inspection models for the successful completion of the project. Compared to basic surveying and mapping data, there are differences in content and quality requirements for monitoring data of remote sensing cultivated land resources. Firstly, the content of remote sensing cultivated land resources monitoring data breaks through the traditional constraints of the seven elements of topographic maps and enriches and expands based on needs, integrating other information such as land surveys and geographic monitoring. Secondly, in terms of quality requirements, the basic surveying and mapping results are mainly standardized through the production process, forming standardized results that strictly follow national standards in terms of accuracy, content, and data format. As a new form of basic geographic information product, remote sensing cultivated land resources monitoring data has obvious differences in its production process and result organization compared to traditional basic geographic information products. Existing national standards cannot complete quality testing applicable to this result.

By analyzing the differences between remote sensing land resources monitoring data and basic surveying and mapping data, this article proposes a set of processes and methods applicable to quality inspection of remote sensing land resources monitoring data results based on actual verification work.

2. QUALITY INSPECTION CONTENTS AND METHODS

Based on the analysis of the characteristics of remote sensing land resources monitoring results, the overall inspection method is proposed to carry out the inspection work, referring to GB/T 18316-2008 "Specifications for inspection and acceptance of quality of digital surveying and mapping achievements"; In accordance with the " Plan for Quality Inspection and Acceptance of National Geographic Monitoring Achievements " by the Investigation and Monitoring Department of the Ministry of Natural Resources, the quality inspection of remote sensing land resources monitoring data results mainly includes four detection parameters and 19 inspection items, including completeness and validity of data storage, mathematical basis of results, general inspection content, recall rate, and accuracy. The specific inspection content and inspection methods are shown in Table 1.

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Detection parameters	Detection object	Detection items	Test method
Data integrity and storage validity	Submitted results	Readability of files	Internal inspection method
		Completeness of submitted results	
		Consistency of remittance requirements	
	Related information	Readability of files	Reference data comparison method
		Completeness of submitted results	
		Consistency of remittance requirements	
Mathematical foundations	Coordinate system	Consistency with the design document	Internal inspection method
	Elevation foundation		
	Projection parameters		
General inspection content	Organization of directories	Consistency with the design document	Internal inspection method
	file naming		
	Dataset definition		
	Data layer definition		
	Attribute item definition		
	file format		
	Data coordinates		
	Topological relationships		
Recall and accuracy	Recall rate	Evaluate the integrity of cultivated land monitoring data	Reference data comparison method/ Field measurement method
	Accuracy	Evaluate the accuracy of cultivated land monitoring data	

Table 1. Contents and Test Methods of Quality Inspection for Remote Sensing Farmland Monitoring Data Results

2.1 Reference data comparison method

The referential data comparison method is used to determine whether the tested data is incorrect or incomplete, or to calculate the difference between the tested data and the reference data by comparing various reference data, such as reference image data, field survey verification data, land survey, and geographical survey in the production process. There are three methods for comparison: Firstly, Image data overlap inspection: manually compare the digital orthophoto image with the cultivated land resource monitoring map to check whether the plane position deviation of elements such as cultivated land resource monitoring patches meets the technical design requirements; Secondly, Verification of field survey results: interactively check the consistency between the attributes of remote sensing cultivated land resource monitoring patches and the attributes of patches on the field survey verification map using a computer; Thirdly, Comparison with professional data: automatic comparison of attribute values of thematic data through program modules. This automated checking method based on computer program modules is highly efficient and accurate. It is recommended to use related programs for quality control and inspection

2.2 Internal inspection method

The internal inspection method examines the inherent characteristics of the data being tested. This method examines vector data, image data, etc. through indoor inspection, such as mathematical foundation, catalog organization, file naming, data set definition, file format, topology relationship, etc.

2.3 Field measurement method

The field measurement method compares the results data with the field measurement results through on-site measurement or inspection to determine whether the tested data is incorrect or incomplete, or to obtain the difference between the tested data and the field measurement data. This method is suitable for checking vector data, image data, etc. through on-site inspection, such as checking whether there is redundancy or omission in remote sensing farmland resource monitoring data through on-site inspection, and whether the geometric elements are expressed abnormally.

3. TECHNICAL

In order to better carry out the inspection of remote sensing cultivated land resource monitoring data, the methods of overall overview (computer automatic inspection), detailed inspection (human-machine interaction inspection), and out of sample overview are adopted for inspection. Firstly, the computer automatic inspection items are used to conduct an overall overview of batch results based on administrative divisions. After all the overall overview are qualified, the sample size is determined by hierarchical grading based on administrative divisions from the batch results, Extract samples (taking into account both terrain and regional categories) for detailed investigation, and finally conduct an overview of the data outside the sample based on issues such as county boundaries, universality, and tendency. The technical route for detecting the quality of remote sensing cultivated land resource monitoring data is shown in Figure 1.

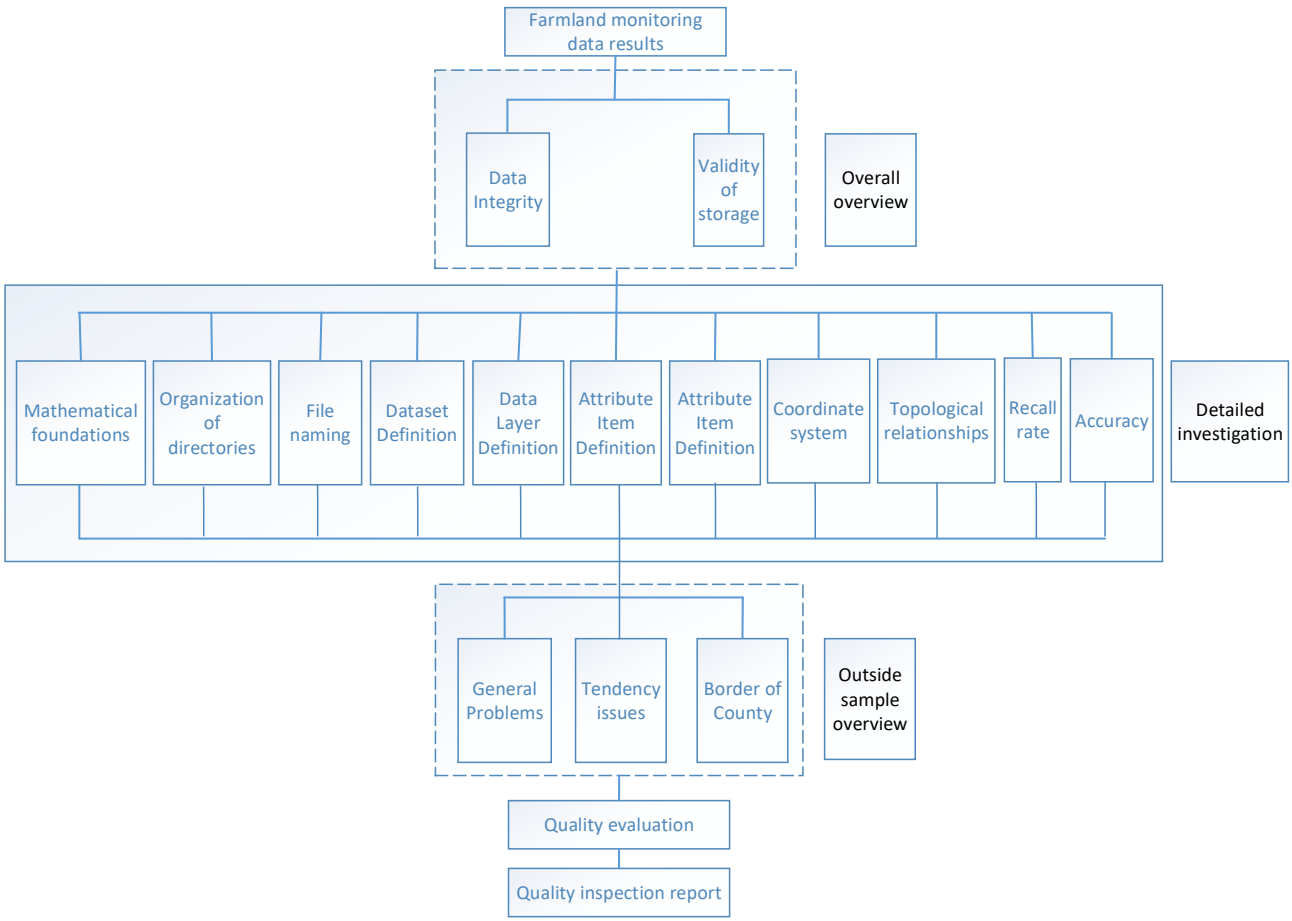

Figure 1. The Technical Route of Quality Inspection of the Remote Sensing Farmland Monitoring Data

3.1 Overall overview

The integrity and storage effectiveness of data are the primary contents of the quality inspection of cultivated land resource monitoring data, which directly affect the subsequent data analysis, processing, and application. During testing, the integrity and accuracy of data should be ensured to prevent misjudgment due to missing or erroneous data

3.2 Detailed investigation

Detailed investigation is carried out after the overall overview is qualified. This mainly uses quality inspection software to conduct overall inspections based on customized plans for batch results based on administrative divisions, as shown in Figure 1. Automatic inspection based on customized plans achieves batch and efficient data quality inspection requirements, and can set up data quality inspection plans for large numbers and multiple check items. By specifying a batch of to-be-checked data directories, math-based inspections can be automatically completed, including general content such as directory organization, file naming, dataset definition, data layer definition, attribute item definition, file format, data coordinates, and topological relationships.

On the basis of automatic inspection, human intervention is required to test the data completeness and accuracy of farmland resources monitoring data results. Data completeness and accuracy are important indicators of the quality testing of farmland resources monitoring data. They are directly related to the reliability of data applications. Completeness refers to the ability to correctly detect all data, while accuracy refers to the correctness of the detection results.

3.2.1 Recall rate: The recall rate mainly focuses on whether there are omissions or redundant updates in the monitoring patches, and generally uses reference image comparison or indoor and outdoor comparison of survey results as reference

materials for inspection. For example, Figure 2 and Figure 3 show the omission of newly constructed buildings within the farmland area. These problems not only reflect incomplete monitoring updates caused by unclear images or confused use of images, but also demonstrate issues with careful monitoring updates.

(a)Image of the previous phase (b)Image of the latter phase

Figure 2. Missing collection of newly buildings within the scope of farmland

(a)Image of the previous phase (b)Image of the latter phase

Figure 3. Missing collection of newly constructed roads within the scope of farmland

3.2.2 Accuracy rate: The accuracy mainly focuses on whether the updated types of cultivated land resource monitoring patches are correct, usually using reference image comparison method or indoor checking outdoor survey results and other reference materials. The main problems are manifested in the following two aspects: Firstly, in the comparison process between pre-phase and post-phase images, it is found that paddy fields and other cultivated lands are mistakenly updated as artificial water surfaces; Secondly, the patch types of changes within the cultivated land range are not represented correctly, such as the misrepresentation of greenhouses as buildings in Figure 4, or the misrepresentation of hardened surfaces as non-railway surfaces in Figure 5. These problems reflect that the operators have a deviation in understanding the technical regulations, and some of the expressions of land-use show the phenomenon of "different body with same spectrum" or “same body with different spectrum”.

(a)Image of the previous phase (b)Image of the latter phase

Figure 4. The greenhouse is incorrectly represented as a building

(a)Image of the previous phase (b)Image of the latter phase

Figure 5. The hardened surface is represented as a trackless road surface

3.3 Outside sample overview

It is obviously not enough to conduct a detailed inspection of the results of farmland resource monitoring data by only sampling a certain amount of samples from county-level survey areas to evaluate the quality. Considering the applicability of farmland resource monitoring data results, it is necessary to conduct a 100% inspection of important inspection items in the results in order to comprehensively judge the quality of the results. The out of sample survey of the monitoring data results of cultivated land resources is to check the results in the area outside the sample for the administrative region unit, which mainly adopts two methods, namely, 100% detailed survey of the universality and tendentiousness of the results, and inspection of the cultivated land change map with an area of more than 20000 square meters. The main problems discovered during the external survey of cultivated land resource monitoring data results are manifested in the following three aspects: the first issue is about recall rate: omission of collection for newly constructed high-grade roads; The second issue is about accuracy: cultivated land (paddy field) is mistakenly collected as water surface, etc; The third issue is about the border connection between counties: the location of cultivated land resource monitoring maps between counties is not connected or the attributes are not connected.

4. CASE ANALYSIS

4.1 Overview

The national arable land resource monitoring, using high-resolution satellite imagery of better than 1 metre in the second quarter of the year, compared with the previous year's imagery data, will monitor changes in the "non-farming" and "non-grain growing" of arable land within the scope of about 2,880 county-level survey areas across the country, in order to obtain timely information on the status and changes in arable land resources. The current status and changes of arable land resources are obtained in a timely manner.

The results of the arable land resources monitoring involve 12 production and operation departments, 10 batches of results, and about 2,880 county-level survey areas, which is a large amount of data and complicated to check. In order to strive to complete the assessment of the quality of the results within a limited period of time and to reduce the intensity and repetitiveness of the sampling and evaluation work, the detailed inspection of the samples from the 161 county-level survey areas, which cover a total area of about 540,000 square

kilometers, was carried out using a general inspection technique based on quality control software.

4.2 Realization of quality control technology

Cultivated land resources monitoring data results quality inspection software takes into account human-computer interaction inspection on the basis of realizing automatic batch inspection; secondly, spatialized inspection records are generated by adopting locating points combined with screenshots of inspection problems, and at the same time, the inspection records are classified and sorted out according to the sequence of inspection parameters, and the results are unified into the database, so as to realize spatialization of inspection problem records based on the database technology; and thirdly, it solves the problem of automated quality evaluation of inspection results. Realize the quality evaluation of unit results under the support of quality database. Finally, solve the problems of high efficiency, flexibility, applicability and large-scale production of the software, realize the automated quality inspection of batch data through the design of automatic batch inspection method of large data volume based on the quality inspection scheme, and greatly improve the efficiency of the quality inspection of large-scale arable land resource monitoring data results.

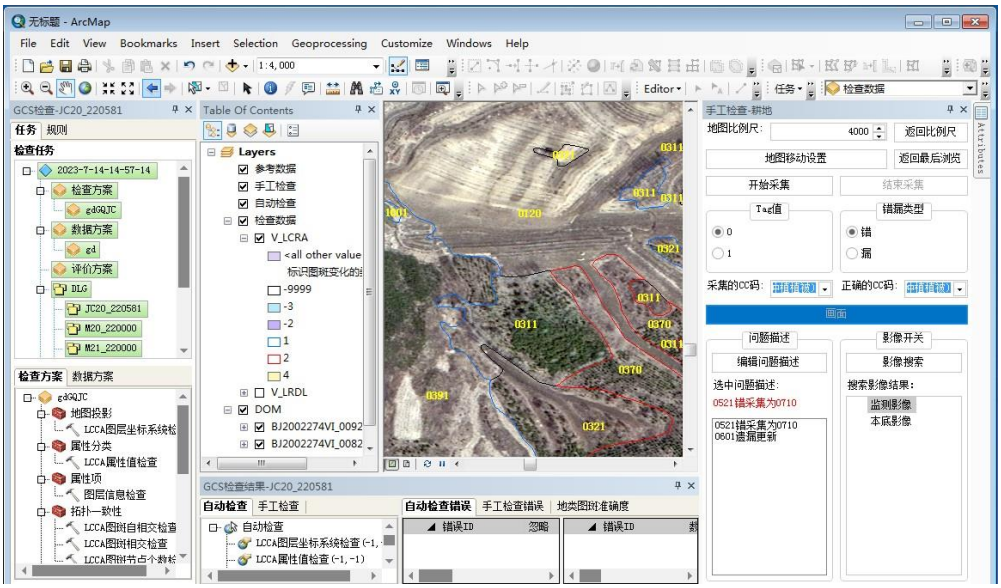

Figure 5. Software for quality checking the results of monitoring data on cropland resources

4.3 Inspection results

By adopting the method of overall general check, detailed check and out-of-sample general check based on the quality inspection technology proposed in this paper, a combination of batch automatic check and human-computer interaction check is realized, and the check and evaluation of the samples of 161 county-level survey areas are efficiently accomplished, and the general problems of the sample results are clarified. The statistical graphs of the two indicators, namely, checking rate of completeness and accuracy, of the 161 samples are shown in Fig. 6.

Finally, the results of the monitoring data of arable land resources in about 540,000 square kilometers in 161 counties are tested, and the results show that the technical line proposed in the paper is feasible and the quality evaluation results are objective.

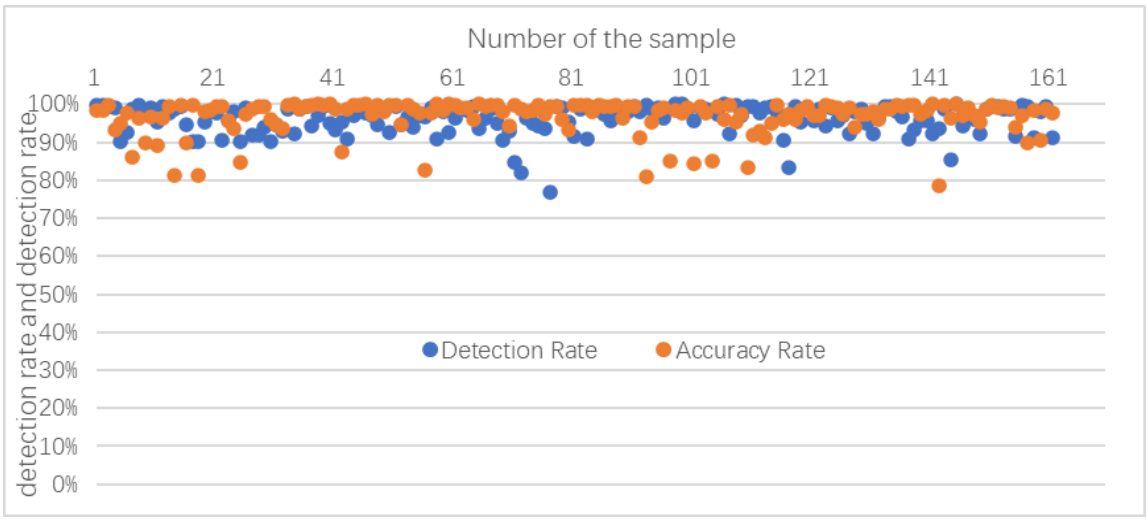

Figure 6. Statistical charts for completeness and accuracy

5. CONCLUSION

Based on the analysis of the difference between the results of cultivated land resource monitoring data and the results of basic surveying and mapping data, this article extracts automatic inspection items from the results of cultivated land resource monitoring data, realizes automatic inspection of some inspection items, and improves the efficiency of quality inspection of large-scale data results. For the recall and accuracy inspection of inspection items, reference data comparison, field measurement, and computer interaction inspection methods are used, This ensures the consistency and objectivity of the quality evaluation of cultivated land resource monitoring data results, and ensures the high-quality and efficient completion of the quality testing tasks of the national cultivated land resource survey and monitoring project.

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