ON THE QUALITY CONTROL OF MONITORING RESULTS OF URBAN SPECIAL GEOGRAPHY AND NATIONAL CONDITIONS

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ABSTRACT:

The results of urban thematic geographic condition monitoring are based on the results of geographic condition monitoring, further refinement of classified geographic information vector data, and then summarize the total amount of each urban thematic type, the amount of change and other information through the method of statistical analysis. It provides first-hand information for governmental management departments to make decisions and manage cities. Therefore, the quality of urban thematic GIS monitoring results directly affects the results of statistical analysis. This thesis discusses a variety of quality control methods, and how these methods are successfully and efficiently applied in urban thematic geographic national condition monitoring results, so as to guarantee the quality of the results. It also provides ideas and references for producers of geographic information products and quality inspectors in the production and quality control of geographic information result vectors.

1. RESEARCH BACKGROUND

Geographic national condition monitoring is a major survey of national conditions and strengths, an important basis for formulating and implementing national development strategies and plans, optimizing the pattern of spatial development of the national territory, and an important support for promoting natural ecosystems and environmental protection, rationally allocating various types of resources and realizing green development. Its results have been applied in various fields such as "multi-planning", supervision of urban planning implementation, governance of illegal land use and illegal buildings, environmental protection and governance, etc., and have played an indispensable role in the construction of the ecological civilization system. 2013-2015, China completed the first national geographic national census, and the results have been published by the Ministry of Natural Resources, the National Bureau of Statistics, the State Council and the State Administration of Statistics, as well as by the State Council. Ministry of Natural Resources (MNR), National Bureau of Statistics (NBS), and the Office of the State Council Leading Group for the First National Geographic National Condition Census have jointly released them to the public. From 2016 onwards, the acquisition of geographic national information has entered the stage of regularized monitoring, as a basis, in accordance with the principles of comprehensive coverage, standardization and consistency, and highlighting the key points, with June 30, 2020 as the point of time, and in accordance with the program's requirements for the content of the monitoring and the indicators stipulated in the "Contents and Indicators of Geographic National Condition Monitoring" (GH/T 9029-2019,2020) to carry out the monitoring of the geographic national condition in 2020.1 China has been carrying out geographic national condition monitoring for five consecutive years. Normalized monitoring of geographic national conditions has been carried out for five consecutive years. It is an urgent demand of government departments and the public to carry out geographic condition monitoring to grasp the dynamics of geographic condition in a timely, accurate and comprehensive manner, and to reveal in depth the internal relationship between economic and social development and resources, ecology and the environment, as well as the laws of evolution and development trends. With the expansion of application fields and the upgrading of application levels, especially the operational work of the "two unifications", higher requirements have been put forward for geographic national information products with continuous time, national coverage of spatial scope, complete and standardized content, and stable and reliable quality, therefore, it has become more necessary to continuously carry out geographic national condition monitoring and provide constant and solid information support. Therefore, it is even more necessary to continuously carry out geographic national condition monitoring and provide a steady stream of solid information support. (Ministry of Natural Resources.,2020)

The results of geographic national condition monitoring are categorized into two forms of results, namely, surface cover and geographic national condition elements, with cities and counties as units. Among them, the monitoring of changes in land surface cover involves eight first-level categories, including 47 second-level categories and 88 third-level categories, such as planted vegetation, forest and grass cover, housing buildings (districts), railroads and roads, structures, heaps and diggings, bare ground, and waters, which are all represented by surface patches, with an area of no less than 200 square meters on the

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map. The monitoring of geographic elements involves five categories: railroads and roads, structures, tailing ponds on the surface of heaps and excavations, waters, and geographic units, including point, line and surface elements. Data production is based on the first national geographic national census and other annual monitoring results, based on the remote sensing image data of the previous year's annual monitoring period, identifying areas of change, adopting techniques and methods such as remote sensing image interpretation, change information extraction, data editing and organization, and field survey, making full use of the collected sample data for interpretation to assist in the internal interpretation, collecting change information, and combining thematic data of multiple industries and the results of field survey to carry out the background data analysis and analysis. Combined with multi-industry thematic data and field survey results, the background data were updated. For features that are difficult to identify accurately, external investigation is required.

The results of the thematic monitoring of the urban geographic situation are based on the national geographic situation monitoring, with defined rules and coding methods, and further expanding the relevant content and scope according to local needs and the characteristics of the monitoring area.

2. QUALITY CONTROL OBJECTS

2.1 Presentation of results of urban thematic geospatial monitoring

The results of the National Geographic State Monitoring provide information on the surface coverage of each city. The natural resources planning department of each province and city has refined the classification criteria to meet the planning needs of the administrative authorities of the province and city on the basis of the standardized national geographic condition monitoring data, and the refined surface coverage classification data are the urban geographic condition thematic monitoring results.

The results of urban thematic geographic national condition monitoring have been applied in a number of fields, including the management of State-owned natural resources, the governance of illegal land use and illegal buildings, and environmental protection and governance, and have played an indispensable role in the construction of an ecological civilization. It inherits the existing results of geographic national condition monitoring work, comprehensively adopts remote sensing, artificial intelligence and big data technologies, coordinates the use of remote sensing images from spaceflight, aviation and unmanned aerial vehicles, carries out satellite image pre-processing, fusion, ortho-correction, color-tuning splicing and mosaicing of panchromatic and multi-spectral bands of satellite images, and carries out the in-house collection, editing and finishing, and the out-of-house investigation and verification of the urban element monitoring data through image comparison. Through comprehensive statistics and thematic analysis and evaluation of spatial data, thematic statistical reports, statements and graphic results are formed.

For example, in one city, the monitoring content was refined and local characteristics were added to include five types of thematic monitoring of urban conditions: housing construction, transportation facilities, water facilities, urban and rural land use and ecological environment. Table 1 is the type of data of urban geographic national condition thematic monitoring results. It includes single buildings, public service building points, planned roads, bridges, transportation stations, rail transit stations, rail transit entrances and exits, garbage dumps, urban water-prone points and earthquake emergency evacuation sites, 3 categories and 10 layers of data. It includes a collection of point-line plane-like vector data.

Number	Special Data	Geometry Type	
1.	Single building	Single building	Areal shape
2.		Public service building points	points
3.	Transportation facilities	Planning Road	Linear shape
4.		bridge	Linear shape
5.		Transport Depot	Areal shape
6.		Rail transit stations	points
7.		Rail transit entrances and exits	points
8.	ecological environment	Garbage dump station	Areal shape
9.		Urban waterlogging prone points	points
10.		Earthquake emergency shelter	points

Table 1. Special monitoring results of urban geography and national conditions.

2.2 Production technology process

The results of urban thematic geo-national condition monitoring adopt a combination of internal and external methods, utilizing remote sensing imagery, image processing, identification and collection of change information, external investigation and verification, data editing and finishing, etc., to carry out monitoring of forest and grassland resources and urban elements, and man-made buildings and structures, and to form a database. Statistics and analysis are carried out on the basis of the database to support the management work. The technical process is shown in Figure 1.

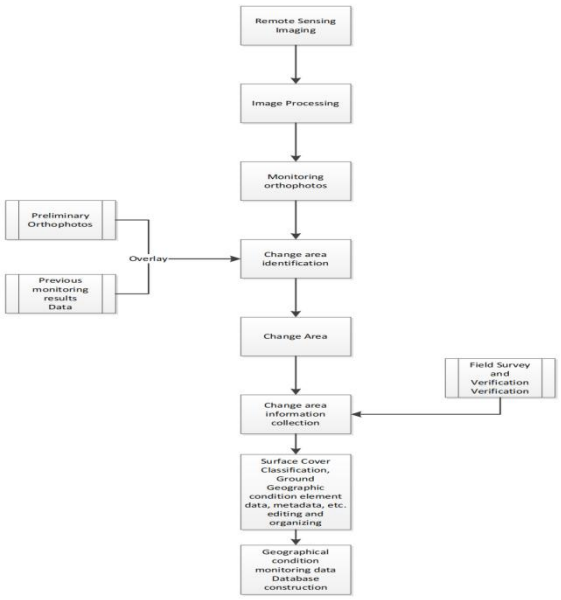

Figure 1. Technical process for the production of urban thematic GIS monitoring results.

2.2.1 Image processing

Selecting higher resolution images from remote sensing images as the main image data source and supplementary image data source is conducive to improving the accuracy of identifying features.

2.2.2 Change area information collection

The pre-inspection results data and pre-orthophoto images were superimposed to manually identify areas of change.

2.2.3 Field survey and verification

Organize the data after the field mapping through the tablet device. Formation of results such as field track routes, field photographs, field mobilization plots and metadata.

2.2.4 Data editing and organization

Internal editing and organizing of the data after the external survey and verification. Pay attention to the consistency of the data.

2.3 Quality requirements for urban thematic GIS monitoring results

Combine the quality elements and the structure of the outcome data to analyze and generalize the quality requirements.

2.3.1 Mathematical basis of results checked

(1) The coordinate system adopts the 2000 national geodetic coordinate system.

(2) Elevation Datum 1985 National Elevation Datum, elevation system is normal elevation; elevation value unit is meter retaining 2 valid decimal places 0.01 meter).

(3) The projection parameters are Gauss-Krüger projection by 6 ° bands.

2.3.2 Data Acquisition Accuracy

Data collection accuracy, i.e. the extent to which the boundaries and locations of features collected correspond to the boundaries and locations of features on the imagery. The collection accuracy of clearly demarcated surface cover classification boundaries and the boundaries of geographic national conditions elements as well as positioning points on the image should be controlled within 5 pixels. In special cases, such as blockage by high-rise buildings and shadows, the acquisition accuracy should be controlled within 10 pixels in principle.

2.3.3 Accuracy of surface cover patch classification

Within transitional zones without clear demarcation lines or where classification indicators are not easily and accurately measured making accurate categorization difficult, plots in the surface cover classification data should at least ensure that they meet the categorization requirements of the higher level type.

2.3.4 Attribute accuracy of geographic country elements

The values of attribute items of geographic national elements such as length, width, elevation, area, etc. are in metric units, and the correct conversion of the units of measurement should be ensured when assigning values using industry-specific information. Valid decimal places to be retained for quantitative attribute values acquired.

2.3.5 Data consistency requirements

If the background data do not correspond to actual feature conditions, they should be corrected as errors.

2.3.6 Data availability

The overall currency of the monitoring results data shall be as of June 30 of the current year.

2.3.7 Logical consistency requirements

Whether the naming of data files, the definition of each data layer and its attribute items, and the format of data files meet the requirements of technical regulations. There are no compound polygons, no parametric curves, no geometric ring sticking (including point sticking and line sticking), and no elements with more than 100,000 nodes. The total number of geometric topological problems accounts for less than 10% of the total number of geometric elements, and the main geometric topological problems include: non-overlapping of common edges of geometric elements, duplication of geometric elements, non-closure of polygonal elements, self-intersections of geometric elements (local widths between any edges of the surface elements are all greater than 0.2 meters), folding of geometric surface elements (folding angle is less than 5 °), and the area of less than 100 square meters of the unrealistically tiny surface, etc.

By monitoring and grasping the quantity, area, scope, distribution and change of these urban elements, it provides data support for natural resources management and ecological civilization construction, such as land change survey, arable land protection, supervision of land spatial planning implementation, use control, rights and interests management, ecological protection and restoration, inspector and law enforcement, and forest, grass and wet protection. Therefore, how to control the quality of urban thematic GIS monitoring results is the focus of data production managers and quality inspectors.

2.4 Inspection content and methodology

The time accuracy, attribute accuracy and location accuracy of urban thematic GIS monitoring results are mainly checked manually and by human-computer interaction.

The spatial reference system and logical consistency are mainly checked automatically by software, such as checking the elements of geodetic datum, elevation datum, map projection, etc., and checking the concepts between data logical consistency elements such as consistency, format consistency, and topological consistency.

The quality of the representation is then mainly checked using human-computer interaction.

2.4.1 Manual inspection

It focuses on the completeness of the extraction of change information, the correctness of attribute discrimination, and whether the accuracy at the time of collection is over the limit.

At the stage of internal change information extraction and internal editing and finishing, the positional accuracy is mainly to check whether the overlap of maps and orthophotos is over the limit, and whether the geometric position of maps and elements is over the limit; the attribute accuracy is mainly to check whether the classification of maps is correct, the completeness of the change identification, the correctness of the classification of elements, the errors and omissions of attribute values, and the attributes are not overlapped; and the temporal accuracy is mainly to check whether the data sources of original information, monitoring data and results meet the requirements of time point. The time accuracy is mainly to check whether the original information data source and monitoring data results meet the time point requirements. Checking the elements of monitoring changes by manual checking and judging the correctness of the extraction of internal change patches are the main methods of quality control, and are the key links to guarantee the quality of data.

2.4.2 Automatic software checks

According to the inspection program, using the quality control software, the computer can automatically batch check the results related to spatial reference system and logical consistency. Data pre-processing, results remittance, inventory inspection and other internal production stage results are mainly checked automatically by the software for quality control. Vector data can be subjected to attribute consistency, enumeration value domain of change data, layer completeness, correctness of attribution of all elements, geometrical abnormality of all elements of change data, inability of self-intersection and self-overlap of road element data, connectivity of rural roads, and the quality control of the map.

Layer integrity and other checks are performed and manual methods are used to troubleshoot each of the problems identified by the software.

2.4.3 Human-computer interaction checks

The quality problems detected by the software cannot be corrected automatically, and manual methods must be used to check the results of the software checks line by line and to correct any problems that exist.

3. INSPECTION CONTENT AND MENTHODOLOGY

In the quality control of urban-type geographic condition monitoring results, centralized quality control measures such as the ISO9000 quality control system, the two-level inspection and one-level acceptance system, the process inspection and the review of results are comprehensively applied. Among them, ISO9000 is to control the quality of the entire production process, process inspection is for each stage of results, the two-level inspection and one-level acceptance system is for the self-inspection of the results by the production unit and the acceptance of the results by the third-party quality inspection unit, and the review of the results is the way in which the project organizer supervises and randomly checks the results after the acceptance.

3.1 ISO9000 quality system

ISO9000 quality system is by the state or government-recognized organizations based on the ISO9000 series of quality system standards for third-party certification activities, with absolute power and prestige to ensure openness, justice, fairness and full trust between each other. In the production of ISO9000 quality control system in the core "people, machines, materials, methods, environment and measurement" to the quality control of the project. People that is, managers pay attention to the project; the project leader based on the production program to prepare the project design book, guide the production staff; production staff to participate in the training, the design of the book to learn to understand and master; quality control personnel to the production staff training, summarize the common problems of the previous year, to avoid similar problems occur. Machines: the use of instruments, to obtain a certificate of instrument calibration; equipped with high-performance graphics workstations to meet the operational needs of the image and software. Data: original base maps. Methods: production implementation program - technical design document - operating instructions. Check and verify the feasibility of the design book, operation instruction book and quality control program through the joint completion of the first piece of results. And form the analysis of common problems and explain to the production staff. Environment: The environment of the machine room where the production is done. Confidentiality measures. Production software and QC software should be tested before they are put into production and QC.(GB/T 19000-2016,2016)

3.2 Two-level inspection

The inspection of urban thematic monitoring results carries out a "two-level inspection and one-level acceptance" system, with the unit undertaking the monitoring task being responsible for the "two-level inspection" of the quality of the monitoring results and entrusting the acceptance to a qualified quality-control organization. Inspections at all levels should be carried out independently and should not be omitted or replaced. The first level of inspection shall carry out 100% internal inspection of the monitoring results, and the proportion of external inspection shall not be less than 30% of the external inspection during the external production. Only after the monitoring results have passed the first-level inspection can the second-level inspection be carried out; the second-level inspection carries out 100% internal inspection of the monitoring results and information, and the proportion of external inspection shall not be less than 10% of the external work at the time of production, and in principle, the results of the external inspection shall not be duplicated with those of the first-level inspection; after the completion of the second-level inspection, the quality level of the unit results shall be evaluated and an inspection report shall be prepared, and the inspection records and the inspection report shall be submitted together with the results for Acceptance. The monitoring results shall be accepted only after the second-level inspection is qualified. Acceptance shall carry out quality rating and require the production unit to revise the problems, verify that the revision has been completed and prepare the inspection report. (GB/T 18316-2008,2008)

3.3 Process quality inspection

The process quality inspection mainly checks the key nodes in the production, the completeness of the preparation of the production materials; the images should meet the requirements of the resolution and the time phase of the year; the instruments in the production process have been checked and calibrated to meet the needs of the production; and the production software and the quality inspection software have been tested and put into use. Whether the results that have been checked at two levels are submitted in accordance with the requirements for acceptance of the results, and so on. (National Quality Inspection and Testing Center For Surveying and Mapping Products.,2021)

3.4 Re-inspection

The review of the results is to ensure the quality of the revised results through the acceptance of the urban geographic condition monitoring results and then take appropriate samples, focusing on the problems found at the time of acceptance and carrying out inspections.

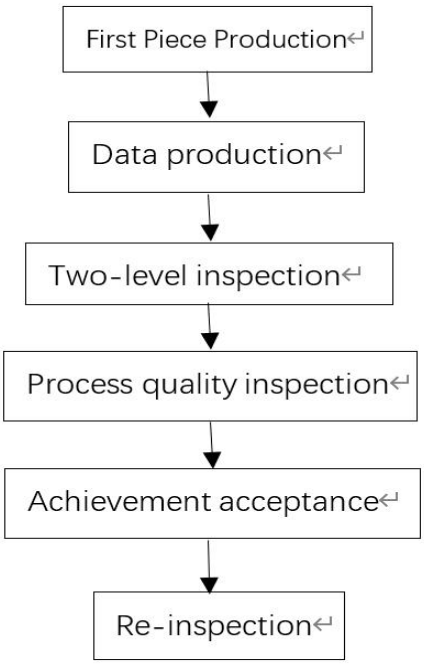

Figure 2. Quality control process.

4. QUALITY ISSUES AND QUALITY CONTROL EFFECTIVENESS

4.1 Main quality issues

The main issues identified from the tracking of results from the 2017-2020 tracking are as follows.

4.1.1 Logical consistency

Monolithic building surfaces overlap.

4.1.2 Attribute errors

The single building has incorrect attributes in fields such as number of floors, door address, floor area, etc., which are inconsistent with the field data.

Bridges have errors in field attributes such as type, load capacity, bridge name, and height limit.

Errors exist in field attributes such as length of planned road and implementation of planned road.

Figure 3. Gas equipment incorrectly labeled as a single building.

Figure 4.The attribute for the number of layers of the monolithic results is 5, while the actual number is 4.

4.1.3 Redundant or missing elements

Monolithic building leakage collection.

The monolithic building has been demolished without deletion.

Figure 5. Missing refuse collection stations at both point and surface levels.

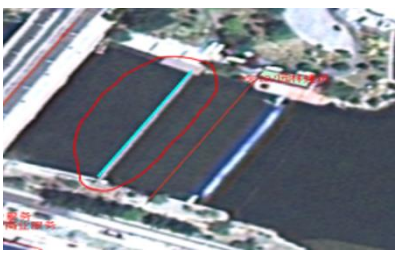

Figure 6. External verification of no bridges, internal redundant footbridge data.

4.1.4 Positional accuracy

(1) Individual monolithic building range images are not supported; individual high-rise monolithic buildings are not corrected for projection differences.

(2) The geographic location of individual city information elements is inconsistent with the POI data. For example, the subway station entrances and exits are inconsistent with the POI data location.

4.1.5 Characterization quality errors

(1) A few new single buildings have inconsistent floors of houses that are not collected separately.

(2) Individual unreasonably small plots exist at the single building level.

(3) Inconsistent criteria for the collection of single buildings in the same area, some collected as single buildings and some as non-single buildings

(4) Railroad and highway bridges do not coincide with the centerline of the railroad or highway in the image.

Figure 7. Single building not drawn according to the image plan.

4.2 Quality Control Effectiveness Quality Control Effectiveness

The above quality problems have been well controlled through quality control measures, and the quality of results has been well controlled, and similar problems have been reduced year by year. The next step will be to try to introduce the third-party supervision mechanism into quality control and seek different quality control methods. However, we also know that the ultimate goal of quality control is to pursue the results to meet customer needs. Therefore, it is a process of constantly pursuing better quality of results, which needs to be constantly updated and improved according to customer needs.

5. CONCLUSION

The quality control of this project has introduced the integration of two-level inspection and one-level acceptance of mapping quality inspection system and ISO9000 quality management system. Through the quality control of ISO9000 quality management system of human-machine-material, method and environment measurement and the control of two-level inspection and one-level acceptance of surveying and mapping, the project has achieved remarkable results in the quality control of urban thematic monitoring results. For four consecutive years, the quality control of a city's thematic monitoring results has well met the needs of using departments and users. It has also provided a reference for peers.

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