

# RESEARCH ON QUALITY STATUS QUO AND QUALITY EVALUATION THEORY OF NATURAL RESOURCES REMOTE SENSING DATA AND COMMON PRODUCTS

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**KEY WORDS:** Natural Resources Remote Sensing Data, Common Products, Quality Research, Quality Evaluation, General Quality Evaluation Model.

### ABSTRACT:

The research on the quality evaluation of satellite remote sensing data and common products of natural resources is to analyze the role of satellite remote sensing data and common products in the management of natural resource elements such as land, forest, grassland, wetland and water, study their quality models and quality evaluation methods, build a quality evaluation index system, and study the technical processes and methods of quality inspection, So as to provide basic support for the research on the framework of quality evaluation standard system and provide technical support for promoting the application of natural resources satellite remote sensing data and common products. Firstly, this paper combs and summarizes the list of 9 categories and 32 types of natural resources satellite remote sensing data and common products. Focusing on the current situation and characteristics of the quality research of typical natural resources satellite remote sensing data and common products, this paper summarizes the quality inspection contents and evaluation methods, existing and proposed standards at home and abroad, the quality characteristics of natural resources satellite remote sensing data and common products are analysed. On this basis, a complete quality evaluation system framework of natural resources satellite remote sensing data and common products is established, and quality elements and quality sub elements are proposed to describe the quality model of natural resources satellite remote sensing data and common products, so as to form a method suitable for evaluating the quality of natural resources satellite remote sensing data and common products.

## 1. INTRODUCTION

After years of research and development on the basis of remote sensing application and technology, China's different application industries have established many remote sensing business application systems according to the business needs of their respective fields. However, the quality of satellite remote sensing data and products used by different departments is uneven, which limits the level, application field and scope of remote sensing. The important reason is the lack of standardized natural resources satellite remote sensing data and products.

Therefore, break through the important bottleneck of the lack of standardization and standardization of natural resources satellite remote sensing data and product application, build a complete and systematic evaluation model around the typical natural resources satellite remote sensing data and product quality evaluation, form an objective evaluation index system, formulate standard process and standardize technical standards, so as to improve the product quality of natural resources satellite remote sensing data, Promote the application capacity of natural resources satellite remote sensing data products, realize the transformation of business and provide technical support.

The research on the quality evaluation of satellite remote sensing data and common products of natural resources is to analyse the characteristic role of satellite remote sensing data and common products in the management of natural resource elements such as land, forest, grassland, wetland and water,

construct the quality evaluation index system of satellite remote sensing data and common products, and study the quality evaluation methods, So as to provide basic support for the research on the quality evaluation standard system framework of natural resources satellite remote sensing data and common products.

## 2. RESEARCH STATUS

### 2.1 Concept

Focusing on the application of natural resources satellite remote sensing data and common products in the management of natural resources such as land, forest, grassland, wetland, water and surveying and mapping, sort out the types of natural resources satellite remote sensing data and common products by means of field investigation and data access, summarize and form a list of natural resources satellite remote sensing data and common products, including optical data Laser data, microwave data, geometric products, radiation basic products, land cover products, vegetation products, energy balance products and water products. There are 3 categories and 6 types of natural resources satellite remote sensing data; There are 6 categories and 26 types of common products of natural resources satellite remote sensing, as shown in table 1.

No.	Class	Subclass
1	Optical Data	Panchromatic Data

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No.	Class	Subclass
		Multispectral Data
		Hyperspectral Data
2	Laser Data	Laser Altimetry Data
3	Microwave Data	Active Microwave Data
		Passive Microwave Data
4	Geometric Products	DOM
		DSM
5	Radiation Basic Products	Surface Reflectance
		Radar Backscattering Coefficient
		Atmospheric Water Vapor Content
		Aerosol Optical Thickness
		Cloud Mask
		Water Leaving Emissivity
6	Land Cover Products	Land Cover
		Land Use
7	Vegetation Products	Vegetation Index
		Vegetation Coverage
		Leaf Area Index
		Chlorophyll Content of Vegetation
		Forest Aboveground Biomass
		Forest Tree Height
		Vegetation Phenology
8	Energy Balance Products	Surface Emissivity
		Surface Temperature
		Surface Net Radiation
9	Moisture Products	Evapotranspiration
		Concentration of Suspended Solids in Water
		Water Transparency
		Water Area
		Soil Moisture
		Drought Index

**Table 1.** List of natural resources satellite remote sensing data and common products.

## 2.2 Quality Inspection and Verification

**2.2.1 Natural Resources Remote Sensing Data:** The inspection contents, quality evaluation and inspection methods of satellite remote sensing data are complex. At present, there is no unified and formed standard for the quality inspection of satellite remote sensing data. The existing studies mainly evaluate the image spatial resolution, geometric distortion, radiation distortion, texture quality, remote sensing image compression quality, the fusion quality of various methods and the amount of unique spectral information of remote sensing image. Further research is needed on how to determine the content of quality evaluation, how to adopt appropriate quality inspection methods and quality evaluation indicators.

**2.2.2 Natural Resources Remote Sensing Common Products:** China's natural resources satellite remote sensing common products are in the stage of transformation from research to application, and the application standards and standardization need further research. In addition to the relatively mature quality inspection system of geometric products, the quality inspection of other common products mainly focuses on authenticity inspection, and the research object is mostly focused on the quality evaluation of single or a few typical products, such as land cover, vegetation index, etc.

## 2.3 Standard Status

**2.3.1 International Remote Sensing Data Standards:** International standards are mainly the standards formulated by ISO / TC 211, OGC and dgiwg. Among them, ISO / TC 211 standard is mainly a basic standard, which needs to be tailored in some specific application fields; OGC standard mainly focuses on spatial data conversion and interface service standards; Dgiwg mainly serves NATO's military geospatial data conversion and metadata standards. The standards of these standardization organizations are mainly geographic information standards, many of which design the technical content of remote sensing application, including the reference model of remote sensing image processing, remote sensing image metadata requirements, remote sensing image format and content requirements, etc. However, from the perspective of remote sensing data acquisition and application quality management, the coverage of the standard is not very complete.

**2.3.2 Domestic Remote Sensing Data Standards:** At present, China has reached hundreds of standards related to satellite remote sensing data above the industry level, mostly focusing on the basic concept of remote sensing, the principle of remote sensing imaging, the development of remote sensor, the reception and processing of remote sensing data, the calibration of remote sensor, the application and processing of remote sensing data industry, etc. There are two standards for the quality of satellite remote sensing data, and there are almost no standards for the quality control, management and evaluation of satellite remote sensing data. Therefore, it is of great significance to develop standards for the quality of satellite remote sensing data.

**2.3.3 International Remote Sensing Common Product Standards:** Since the 21st century, the demand for the standardization of remote sensing satellite data products and services from the perspective of application has increased rapidly, and has become one of the priorities of the international organization for geographic information standardization. As of 2016, ISO/TC211 has issued more than 60 international standards, technical specifications or technical reports (IS/TS/TR), of which 8 standards are directly related to remote sensing, mainly including reference model, transmission mode, data format, data products and services. In addition, OGC has issued nearly 80 standards, mainly including GML Geographic Image Coding specification in JPEG2000 and geopackages coding standard.

The development of remote sensing data standards led by the government has also advanced in product format, standard product classification, data archiving and metadata, with the United States as the forefront. The earth observation system (EOS) initiated by NASA has established systematic standards and specifications. The United States Geological Survey (USGS) has issued digital product standards and specifications such as digital topographic maps, and data standards and specifications such as digital orthophoto and digital elevation models.

**2.3.4 Domestic Remote Sensing Common Product Standards:** China has always lagged behind in the development and implementation of standards, which has become a weak link restricting the development of China's remote sensing application industry. At present, the national standards for satellite remote sensing applications are mainly developed from industry standards. In terms of standards related to the application of remote sensing satellites in the industry, they are mainly developed and established with the actual needs of the business operation of various industry departments, such as the surveying and mapping industry, mainly the technical regulations for the production of 4D products, the forestry industry standards, mainly the technical regulations for the investigation of forest and wetland resources, the geological and mineral industry, mainly the technical regulations for geological investigation and remote sensing monitoring of geological environment, and the water conservancy industry, mainly flood and drought disasters. The application of agricultural remote sensing has formed the technical specification of remote sensing monitoring of agricultural conditions. On the whole, the standardization of remote sensing application has a small number of standards and specifications, which are mainly remote sensing data products and remote sensing technical regulations.

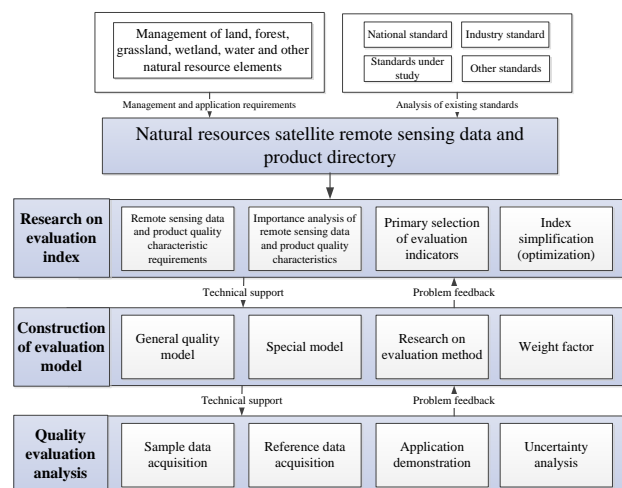
In order to improve the level and efficiency of remote sensing application technology and expand the field and scope of remote sensing application, since 2011, the high score observation Office of the State Administration of science, technology and industry for national defense (major special engineering center of the State Administration of science, technology and industry for national defense) has deployed 54 key technologies including products, involving 32+6 common products. A series of national standards have been developed in the "demonstration of satellite aircraft ground integrated quantitative remote sensing system and application (phase I)" project in the field of earth observation and navigation technology of the national high technology research and development plan, including the general method for authenticity inspection of land quantitative remote sensing products, the selection and layout specification of ground observation field for authenticity inspection of remote sensing products, and 24

single national standards for authenticity inspection of remote sensing products.

### 3. QUALITY MODEL AND EVALUATION METHOD COMBINING GENERAL AND SPECIAL PROJECTS

#### 3.1 Overall Framework

Fully learn from relevant standards and specifications, combined with internal specifications related to natural resources satellite remote sensing data and common product data processing and quality evaluation, collect and learn from relevant materials of natural resources satellite remote sensing data and common product quality evaluation methods, and take typical data as research examples to repeatedly verify and constantly revise the scientific of quality evaluation indicators and methods effectiveness, adaptability and operability, so as to prepare and form the quality evaluation system of natural resources satellite remote sensing data and common products. The overall framework is shown in figure 1.



**Figure 1.** Overall framework of quality evaluation system.

The research on quality evaluation of natural resources satellite remote sensing data and common products mainly includes:

**3.1.1 General Quality Model:** Based on the study of the structural characteristics of natural resources satellite remote sensing data and common product quality model, a general natural resources satellite remote sensing data and common product quality model system is proposed. It mainly includes: conceptual expression and model framework of quality model; The expression of quality elements, sub elements, indicators and quality rules in the quality model; Definition of relationship among object members in quality model; Quality evaluation model based on quality model.

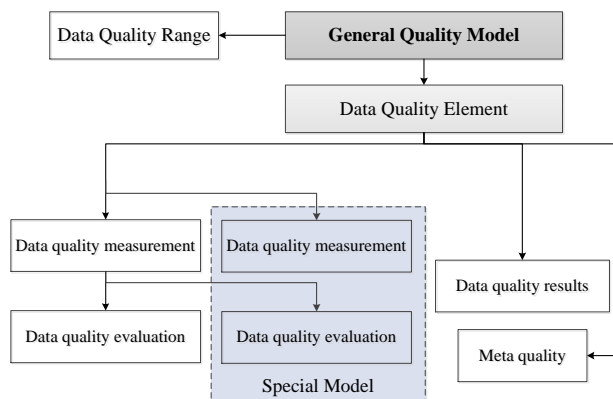
**3.1.2 Quality Evaluation Index:** Comprehensively analyse the quality evaluation methods of natural resources satellite remote sensing data and common products, and comprehensively consider different quality evaluation indicators to form a complete set of natural resources satellite remote sensing data and common product quality evaluation system.

**3.1.3 Quality Evaluation Method:** Sort out and analyse the contents related to the quality evaluation of natural resources satellite remote sensing data and common products, and form the methods suitable for evaluating the quality of natural resources satellite remote sensing data and common products, including the provisions on the calculation methods of each evaluation index.

**3.1.4 Relevant Standards:** The relationship with existing standards, including the names of relevant standards involved, the inapplicability analysis of existing standards, etc.

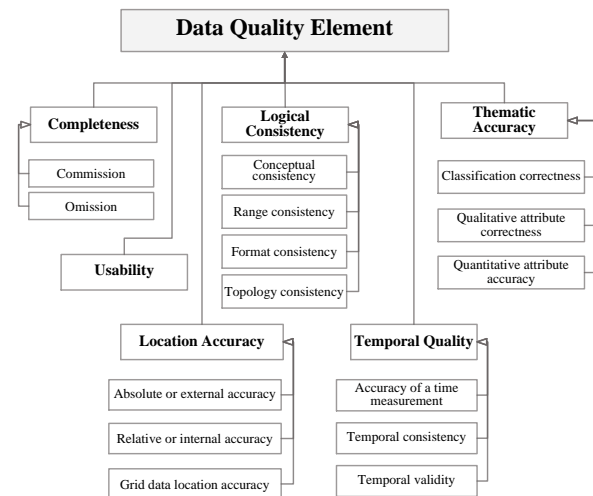
### 3.2 Quality Model

**3.2.1 Generalized Quality:** Describe the quality of natural resources satellite remote sensing data and common products from the perspective of users or data sharing. In addition to intrinsic quality, availability, the degree of meeting user requirements, whether the expression is clear and understandable, and dynamic quality have also become important aspects to measure the quality of natural resources satellite remote sensing data and common products (Du et al., 2000). Figure 2 shows quality description framework of natural resources satellite remote sensing data and common products.



**Figure 2.** Quality description framework of natural resources satellite remote sensing data and common products.

**3.2.2 General Quality Model:** Establishing a data quality framework reflecting the characteristics of the field is the first problem to be solved in data quality evaluation. The description of data quality is usually divided into different levels. So far, there is no unified term to express this level. Some are represented by fields and elements (Zhu et al., 2004). For example, MIT uses classes and fields, while ISO TC211 uses data quality elements and sub elements. Based on the quality characteristics of natural resources satellite remote sensing data and common products, and referring to the existing and proposed standards at home and abroad, this paper puts forward the following quality elements and quality sub elements to describe the quality model of natural resources satellite remote sensing data and common products, as shown in figure 3 (ISO 19157:2013).



**Figure 3.** Quality description framework of natural resources satellite remote sensing data and common products.

- (1) **Completeness:** It refers to the existence or absence of elements, element attributes and element relationships. It consists of two data quality elements: commission and omission.
- (2) **Logical Consistency:** It refers to the degree to which data structures (data structures can be conceptual, logical or physical), attributes and relationships comply with logical rules. It consists of four data quality elements: conceptual consistency, range consistency, format consistency and topology consistency.
- (3) **Location Accuracy:** It refers to the accuracy of the location of features in the spatial reference system. It consists of three data quality elements: absolute or external accuracy, relative or internal accuracy, and grid data location accuracy.
- (4) **Thematic Accuracy:** It refers to the accuracy of specified quantitative attributes, the correctness of non-quantitative attributes, and the correctness of element classification and its relationship. It consists of three data quality elements: classification correctness, qualitative attribute correctness and quantitative attribute accuracy.
- (5) **Temporal Quality:** It refers to the time attribute of an element and the quality of time relationship. It consists of three data quality elements: accuracy of a time measurement, temporal consistency and temporal validity.
- (6) **Usability:** It is based on user requirements, and all quality elements can be used to evaluate usability. When specific user requirements cannot be described by the above quality elements, usability elements can be used for evaluation. In this case, the availability element is used to describe the suitability of the data set for a specific application or for a set of requirements. For example, a data producer can use this element to show how the dataset is suitable for a variety of known purposes. This element can be used to declare the consistency of a dataset with a specific specification.

**3.2.3 Special Model:** Aiming at the temporal, spatial and thematic characteristics of natural resources satellite remote sensing data and common product quality, we should deeply explore the satellite remote sensing data and product quality elements that should be paid attention to in the process of quality inspection, and establish a practical application-oriented satellite remote sensing data and product quality evaluation scheme.

Based on the quality model of satellite remote sensing data and products, comprehensively consider the production mode,

achievement index and application mode of satellite remote sensing data and products in the field of natural resources, study the quality inspection sampling method, and reflect the integrity and correctness of classification quality from the geometric positioning accuracy and length deformation accuracy reflecting geometric quality, spectral correlation coefficient and information entropy reflecting image quality, Starting with the evaluation contents reflecting the qualitative correctness and accuracy of the quality of the topic, study the determination methods of qualitative indicators and the measurement and statistics methods of quantitative indicators for the quality evaluation of satellite remote sensing data and products, so as to form natural resources, including satellite remote sensing sensor correction data and derived common geometric products, radiation basic products, land use products, energy balance products, vegetation products Quality evaluation scheme of water resources products.

#### 4. QUALITY COMPOSITION OF COMMON PRODUCTS

##### 4.1 Common Products Quality Element Information

Collect the common products that have been commercially produced, sort out and summarize the relevant literature and data on the production process and quality evaluation methods of common products, and put forward a quality model of common products. As shown in table 2.

No.	Quality Elements	Quality Sub Elements
1	Completeness	Commission
		Omission
2	Logical Consistency	Conceptual Consistency
		Domain Consistency
		Format Consistency
3	Temporal Quality	Accuracy Of a Time Measurement
		Temporal Consistency
		Temporal Validity
4	Usability Element	
5	Metaquality	

Table 2. Quality model of common products.

##### 4.2 Application Example

**4.2.1 Completeness:** Check whether the common product has missing data in space-time, and analyze the integrity of the common product. For example, the edge connection problem.

**4.2.2 Logical Consistency:** Check whether the document storage organization, document format and document name of common products meet the requirements; Whether the documents of common products are missing, redundant and unreadable.

**4.2.3 Temporal Quality:** Time attribute accuracy and time relationship can be described by the following data quality parameters.

(1) Accuracy Of a Time Measurement: Check the time distribution and acceptable value of the product.

(2) Temporal Consistency: Based on the prior knowledge, the product time series under different surface types are extracted, and the time change analysis is carried out in combination with the surface conditions; Using the existing products as a reference, the time variation differences of different products are compared. The cross correlation  $\rho$  at delay  $d$  is defined as (Jorge, Beatriz, Fernando, 2018):

$$\rho = \frac{\sum_i [(x(i) - mx) \times (y(i-d) - my)]}{\sqrt{\sum_i (x(i) - mx)^2} \sqrt{\sum_i (y(i-d) - my)^2}}, \quad (1)$$

where  $\rho$  = cross correlation  
 $x(i), y(i)$  = series  
 $i = 0, 1, 2, \dots, N-1$   
 $mx, my$  = mean values of  $x$  and  $y$  series  
 $d$  = delay

(3) Temporal Validity: To quantify the 'smoothness' of products, the difference  $\delta$  between the  $x(t)$  product value at date  $t$  and the mean value between the two bracketing dates ( $1/2(x(t+\Delta t) + x(t-\Delta t))$ ) was computed (Marie et al., 2007):

$$\delta = \left( 1/2(x(t+\Delta t) + x(t-\Delta t)) \right) - x(t), \quad (2)$$

where  $\delta$  = difference  
 $x$  = product value  
 $t$  = date  
 $\Delta t$  = temporal sampling interval

**4.2.4 Usability Element:** Quality information oriented to the needs of the field of natural resources and not covered by other quality elements.

(1) Data Value Range: Check the correctness of the data value range.

(2) Spatial Consistency: Based on prior knowledge, check the spatial distribution of products, including global inspection and local inspection. Using the existing products as a reference, compare the differences of spatial distribution patterns of different products, including the spatial difference distribution diagram and statistical histogram of different products, spatial change trend distribution, etc.

(3) Precision Index: Accurate inspection and objective evaluation of common products can effectively improve the accuracy of products and promote and expand the deepening and application of common products in different research fields. The indicators used to measure accuracy include deviation, absolute error, average absolute percentage error, root mean square error, correlation coefficient, average relative error, etc.

**4.2.5 Metaquality:** Check whether the supporting documents of common products are complete and complete; Whether the common product matches its metadata and other files; Whether the contents of attached drawings, schedules and other documents are correct.

## 5. CONCLUSION

This paper summarizes and forms a list of natural resources satellite remote sensing data and common products, including 9 categories and 32 types, including optical data, lidar data, microwave data, geometric products, radiation basic products, land cover products, vegetation products, energy balance

products and water products. Focusing on the current situation and characteristics of the research on the quality of typical natural resource satellite remote sensing data and common products, and based on the research on the structural characteristics of natural resource satellite remote sensing data and common product quality model, the quality model of natural resource satellite remote sensing data and common products is established, which solves the quality factors of natural resource satellite remote sensing data and common products, such as type, scale. The quality requirements are different, and the reuse of quality model can be considered at the same time.

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