Quality Check Analysis of Basic Geographic Entity Data Results

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KEY WORDS: Basic geographic entity data, Real view 3D,Quality inspection,Content and methods,Key points

ABSTRACT:

Introduces the context in which the underlying geographic entity data was created. Analyze the definition of basic geographic entity data. The production process based on the results of basic geographic physical data, and analyze its characteristics. The contents and methods of quality inspection of basic geographic entity data are discussed by referring to the existing quality inspection standards and technical documents of surveying and mapping results. Combining with the real view 3D national basic geographic entity data quality inspection example, this paper points out the key points of the quality inspection based on basic geographic entity data.

1. INTRODUCTION

At present, China's rapid development of information technology, high-tech and surveying and mapping combination has become a new direction for the transformation and development of surveying and mapping geographic information business(Zhang, 2021).Geographic entity is the data base of new basic mapping (Zhang,2018), which is the natural features, artificial facilities and geographic units in the real world occupying a certain and continuous spatial location and having the same attributes or complete functions individually, and can realize the integration of spatial and thematic information(Cao,2021). Basic geographic entity is a geographic entity collected and expressed through basic mapping, which is the positioning framework and bearing foundation for other geographic entities and related information. Basic geographic information entity data is the digital description of basic geographic entities in the computer system, which is a part of the construction of real view 3D China, belongs to the standardized results of the new type of basic surveying and mapping, and mainly serves the transformation and production of the basic geographic entities at the city level(Zhu,2022). Changes in the production methods and forms of basic geographic entity data results have led to the updating of the content of the quality inspection of mapping geographic information and put forward new requirements for the quality inspection methods(Zhang,2018).The existing quality inspection and acceptance standards for mapping results are mainly for traditional mapping results, which are difficult to evaluate new basic mapping results objectively. This paper analyzes the characteristics and inspection contents of the results based on basic geographic entity data, refers to the existing quality inspection and acceptance standards and technical documents of mapping results, and discusses the quality inspection methods and inspection focuses of the results based on basic geographic entity data by taking the inspection of the live 3D national basic geographic entity data as an example, so as to provide references for the subsequent quality control and evaluation of the results of basic geographic entities.

2. TECHNICAL PROCESS AND CHARACTERISTICS

2.1 Technical processes

The collected basic topographic map data are pre-processed by format conversion, unification of mathematical bases, and extraction of data hierarchies, and the pre-processed data are transformed by geometric information compensation and semantic information conversion, and the spatial data of basic geographic entities are formed by reconstructing and integrating basic geographic entities, and the attributes of the basic geographic entities are supplemented with the attributes of the basic geographic entities by using auxiliary information such as the data of the real estate registration and the data of the third nationwide land survey. The attributes of the basic geographic entities are supplemented and assigned values using auxiliary information such as real estate registration data and the Third National Land Survey data. For the change of basic geographic entities, a skin data of inclined photography is utilized to superimpose the basic geographic entities for three-dimensional model acquisition, and the update of the change of basic geographic entities is completed. Finally, the hierarchical relationship is constructed for each basic geographic entity to establish the interrelated relationship between basic geographic entities. Considering that the terrain element data and the base geographic entity data will exist in parallel for a period of time and the terrain element data will be continuously updated for a period of time, the corresponding relationship between the terrain element data and the base geographic entity data is established through the attribute fields, such as the classification code or category of the base geographic entity, which is able to invert the generation of the traditional topographic maps, and to ensure the subsequent ability to utilize the updated terrain element data to quickly link the Update the basic geographic entity data. The technical process is shown in Figure 1.

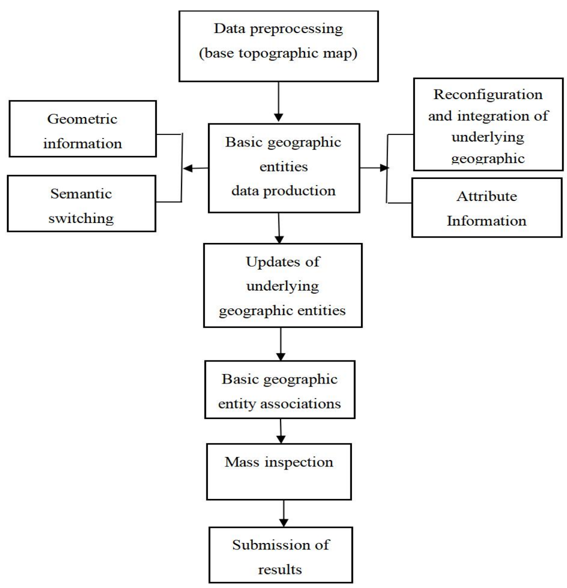

Figure 1. Technical Flowchart.

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2.2 Characteristics

Processing the stock of basic geographic information element data through geometric reconstruction, semantic mapping, etc., to realize the conversion and production of basic geographic entity data is an important way to efficiently obtain basic geographic entity data at the present stage. The traditional basic geographic information data is produced according to the scale, the content and elements are mainly expressed by topographic map cartography, with more natural attributes and fewer social and human attributes, the basic geographic entity can not only retain the elements and their attributes on the traditional topographic maps, but also increase the reference to auxiliary information to enter the relevant attributes, and the basic information unit of urban operation and management, through the fusion of the results of the multi-source data from multi-departmental and cross-industry. Make urban components, natural resources, socio-economic information into a comprehensive system, and in the way of basic geographic entities for organization and application, through the unique and unchanging code reflecting the entity's spatial objective existence of the identity, and then play the carrier function of geographic information, to better serve the application of various industries(Zhang,2020).

3. INSPECTION CONTENT AND METHODOLOGY

The basic geographic entity data results should ensure that the baseline, accuracy, and data organization meet the project requirements(Zhang,2022). Classification, logic, attributes, time and relationship should be accurate, and omission, duplication, redundancy and suppression are not allowed in principle. This paper refers to the current quality inspection and acceptance standards and technical documents of mapping results, and composes the quality elements of basic geographic entity data and elaborates the quality inspection contents, which are shown in Table 1. Combined with the characteristics of the basic geographic entity data and the production links, analyzes that the quality inspection points should include the following aspects: (1) The characteristics of basic geographic entity data are centered on the spatial identity code of the entity, which describes itself and the related information. The entity spatial identity code is the necessary constraint for the data. Attribute accuracy checking is the focus. (2) Reconstruction and conversion production (materialization conversion and semantic conversion) are especially critical in the production of basic geographic entity data, aiming at establishing the correspondence between topographic elements and geographic entities. The quality check of the relationship is the focus.

mass element (chemistry)	mass sub-element (math)	Inspection content
spatio-temporal reference frame	coordinate system	Conformity of coordinate systems
	elevation datum	Conformity of elevation benchmarks
	depth criteria	Conformity of depth benchmarks
	time base	Compliance with time benchmarks
time accuracy	data availability	Conformity with the current status of the source material
	Status of results	Conformity of results with current status
geometric accuracy	Planar Accuracy	Whether the plane accuracy meets the requirements
	Elevation accuracy	Whether the elevation accuracy meets the requirements
	Edge precision	Whether the precision of the edges meets the requirements
completeness	Redundancies, omissions	Entity redundancy, omissions
		Redundancy and omission of cartographic auxiliary elements produced by conversion
quality of characterization (math.)	2D graph metadata representation	Correctness of geometric types of 2D tuples
		Geometric representation refinement of 2D elements
		Two-dimensional elemental geometric anomalies
	3D metadata representation	Correctness and granularity of 3D metadata structure expression
		Correctness and fineness of texture representation of 3D metadata
Attribute Accuracy	Spatial identity code correctness	Uniqueness, correctness of spatial identity codes
	Categorization correctness	Correctness of classification codes
	Attribute correctness	Correctness of the values of other basic attributes of the entity
		Correctness of Entity Extension Attributes
		Correctness of attribute joins
		Correctness of attribute values of cartographic auxiliary elements produced by conversion
Relationship quality	spatial relation	Correctness of physical spatial relationships
	family relationship	Correctness of entity class relationships
	time correlation	Correctness of entity time correlation relationships
	geometric relation	Correctness of solid geometric compositional relationships
logical consistency	Positional consistency	Consistency in the location relationships of different types of tuples for the same entity
		Attribute value consistency across entities involving the same attribute
	Attribute Consistency	Consistency of attribute values of different types of tuples for the same entity
		Attribute value consistency across entities involving the same attribute
	Element and attribute consistency	Consistency between graph elements and attribute values for the same entity
Data organization and structure	data organization	Compliance of data organization with requirements
		Is the data file true, redundant, data unreadable
	data structure	Data structure compliance
		Conformity of basic attribute item definitions (e.g., name, type, length, range of values, etc.)

		Conformity of entity extended att ribute item definitions
		Conformity of Entity Semantic R elationship Table Entry Definitio ns
Annex q uality	metadata representation	Correctness and completeness of metadata files, attribute entries
		Correctness of metadata content
	Subsidiary information	Completeness, completeness and correctness of subsidiary informa tion

Table 1. Quality Inspection Table.

3.1 Spatio-temporal Benchmarks

Check whether the coordinate system and elevation datum of th e data results meet the technical design requirements.
A combination of automatic programmed checks and manual ch ecks are used to carry out the inspections.

3.2 Time Accuracy

Checking whether the raw materials and data results such as bas ic geographic information element data used for conversion pro duction meet the requirements.
Manual checking is used to analyze whether the results are in co mpliance with the requirements by verifying the current status o f the data sources of the basic geographic information elements used for the conversion of production.

3.3 Geometric Accuracy

Geometric accuracy mainly includes plane accuracy, elevation a ccuracy and edge accuracy. Check whether the plane position er ror and elevation error of the data results meet the accuracy requ irements; whether the edges of different production units and dif ferent production units meet the technical design requirements; whether the graphic corners are accurate and whether the edges are shifted, and so on.
The methods of external inspection (field measurement) and int ernal inspection (data comparison and staking method) are used.
Internal checking: Adopting the results with good presentability, accuracy indexes meeting the requirements and qualified accept ance, the coordinates of obvious feature points in the results are collected and compared with the coordinates of feature points of the same name on the data results to assess the planimetric and elevation accuracy of the data results. The verification and analy sis method is used to check the correctness of the edges between different regional networks, production units, administrative di visions and production units.
Field check: Use RTK or total station and other relevant mappin g instruments to measure the planimetric and elevation accuracy of the data results in the field. Select about 20-50 feature points with the same name in the unit results to calculate the medium error, and check whether their planimetric and elevation accurac ies are not lower than the data accuracies before remodeling, an d whether they meet the requirements of the corresponding resul ts' accuracies.

3.4 Completeness

Check for redundancies and omissions in data results; omitted a nd redundant layers in data layers; redundancies and omissions i n attribute items; incomplete expressions such as unconstructed surfaces and lines; and redundancies and omissions in combined entities.
Adopting the methods of comparison of production and referenc e data, verification and analysis, and field measurement, checki ng whether there are redundancies and omissions in the cartogra phic auxiliary elements and entities by comparing them with the data of basic geographic information elements, and checking w hether there are redundancies and omissions in the combined en tities by verification and analysis.

3.5 Characterization Quality

Check the correctness of the geometric expression of the data re sults: whether the location of the point data meets the technical design requirements; whether the water system, transportation a nd other elements expressed in lines are continuous; whether the political areas, courtyards, houses and other elements expressed in surfaces are closed; whether the spatial relationship between the elements is reasonable; and whether the fineness of the geo metric expression meets the requirements and whether there are geometric anomalies.
The combination of automatic program checking and manual ch ecking is used to check the correctness of the expression of the geometric types of points, lines and surfaces in the data results a nd the existence of geometric anomalies; if necessary, field verif ication methods are adopted to check the correctness of the text ure expression and whether the fineness meets the requirements.

3.6 Attribute Accuracy

Check the correctness of the data result classification code, othe r basic attribute values, extended attributes and attribute joining edges; check the consistency of the combined entity proprietary attributes with the values of the entity proprietary attributes befo re the combination; whether the layer name conforms to the data specification requirements; whether the constraints such as the t ype, length, and value range of the layer attribute fields conform to the data specification requirements; and whether the mandat ory entries are empty.
The combination of automatic program checking and manual ch ecking is adopted to check the correctness of proprietary attribut e values of cartographic auxiliary elements and proprietary attri bute values of entities by comparing them with the attributes of basic geographic information element data; check the correctnes s of proprietary attributes of combined entities by comparing the m with the values of proprietary attributes of entities before com bination; check the uniqueness and correctness of the spatial ide ntity code against the rules of classification and coding; check t he correctness of extended attributes by comparing them with th e auxiliary data; and check the correctness of extension attribute s by comparing them with the auxiliary data. Check the correctn ess of extended attributes.

3.7 Quality Of Relationships

Check that the spatial, generic, temporal and geometric relations hips of the data results are in accordance with the requirements; and that the inclusion, dependency, attribution, connection and a ffiliation relationships are correct.
Reference data are used for comparative analysis to check the c orrectness of the relationship between the attribution, affiliation, proximity, connection, transit, flow, and convergence of basic g eographic entities, such as water systems, transportation, and po litical districts.

3.8 Logical Consistency

Check the correctness of the topological relationship of data res ults; the consistency of the positional relationship of different ty pes of data such as points, lines, surfaces, bodies, etc. of the sam e data results; the consistency and correctness of the relative pos itional relationship between different data results; the consistenc y of the same attribute value between different data results; the correctness of the logical relationship between the combined ent ity and the data results composing the combined entity; check w hether the organization of the file storage, the format of the data file, and the file Naming of the file is in line with the design req uirements; whether there are missing data files, redundant data c an not be read out; whether the data set definition, basic attribut e item definition (such as name type, length, value range, etc.), e ntity extended attribute item definition and entity semantic relati onship table item definition meet the requirements.

Using a combination of automatic program checking and manua l checking, check whether there are hanging points, pseudo nod es, overlapping and other anomalies in the line, and whether the distance of nodes is reasonable; whether there are voids, overlap ping and other anomalies in the surface, and whether the distanc e of nodes is reasonable; whether there are intersections, overlay s, voids and other anomalies in the points, lines and surfaces; w hether there is any consistency between the classification code a nd the data results; whether there is any consistency between the code and the name and the data results; and whether it is possib le to check whether the data generation time, demise time logica l correctness.

3.9 Data Organization And Structure

Check that data organization, document integrity, readability, str ucture, and attribute item definitions meet technical design requi rements.

A combination of automatic programmed checks and manual ch ecks are used to carry out the inspections.

3.10 Quality Of Annexes

Check whether the metadata attribute items and contents are cor rect and complete; whether the documentation is complete, and whether the related descriptions and annexes are complete; and whether the contents of the documentation are correct.

A combination of automatic programmed checks and manual ch ecks are used to carry out the inspections.

4. INSPECTION EXAMPLE ANALYSIS

4.1 Overview Of The Test

As an example, the checking of the real-life three-dimensional n ational-level basic geographic entity data was carried out by ext racting the basic geographic entity data results of individual dist ricts. By means of automatic program checking, manual checkin g and external checking, the results were quality checked in ter ms of spatial and temporal datum, temporal accuracy, geometric accuracy, completeness, representation quality, attribute accura cy, relationship quality, logical consistency, data organization a nd structure, and quality of attachments.

4.2 Main Quality Problems And Analysis

(1)Attribute Accuracy:Composition relationship table redundant representation line invalid base geographic entity unique identif ication code, the table recorded in the base geographic entity uni que identification code has not been recorded in the correspondi ng data layer. As shown in Figure 2 and Figure 3, for the river s elected in Figure 2, the corresponding single entity unique identi fier of the river combination entity is recorded in the compositio n relationship table in Figure 3, but one of the unique identifiers (marked in yellow in the table in Figure 3) does not exist in the corresponding data layer. The reason for the quality problems re lated to the unique identification code of basic geographic entiti es is often due to the lack of quality checking, imperfect product ion software, etc. This type of problem will lead to problems su ch as retrieval errors and statistical information anomalies of the basic geographic entities after the database is constructed, whic h cannot be modified in the database construction link and need to be modified and processed in time for handing over to the ne xt link. When checking, computer software can be applied to car ry out template analysis and checking, so that the templates esta blished according to the structure, naming rules or code lists stip ulated in the technical design can be compared and analyzed wit h the data to be inspected, and the degree of conformity between the structure of the data table, the structure of the attributes and the relevant technical requirements can be checked, and so on.

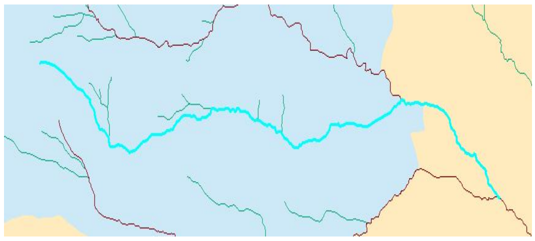


Figure 2. Marker code not recorded.

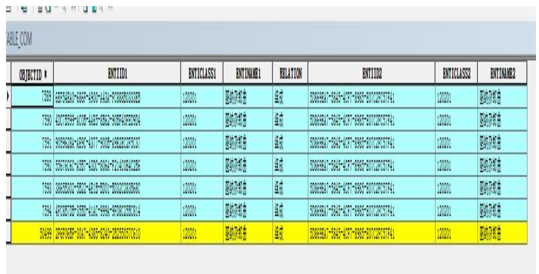
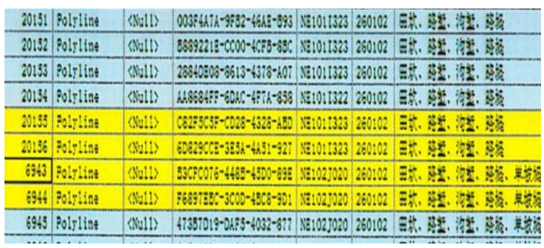


Figure 3. Marker code not recorded.

The assignment of classification names is not standardized, as s hown in Figure 4. The entity type is "field, riffle, ditch, embank ment" (260102), and part of the entity type is mistakenly filled i n as "field, riffle, ditch, embankment, single slope embankment". This type of problem is caused by the lack of mastery of the tec hnical requirements of the operation and the failure to assign val ues to the entity types as required. Can not be modified in the li brary link, need to be revised in a timely manner after the transf er of the next link. When checking, computer software can be a pplied to analyze and check the template, compare and analyze with the data to be checked, and check the degree of conformity between the data attribute value settings and the relevant techni cal requirements.



20151	Polyline	<Null>	003F4A7A-9FB2-46AE-B93	NE101I323	260102	田坎、陡坎、沟堑、路堤
20152	Polyline	<Null>	B889221E-CC00-4CFB-85C	NE101I323	260102	田坎、陡坎、沟堑、路堤
20153	Polyline	<Null>	2884DE08-8613-4378-A07	NE101I323	260102	田坎、陡坎、沟堑、路堤
20154	Polyline	<Null>	AA8684FF-6DAC-4F7A-858	NE101I322	260102	田坎、陡坎、沟堑、路堤
20155	Polyline	<Null>	C82F5C5F-CD28-4328-ABD	NE101I323	260102	田坎、陡坎、沟堑、路堤
20156	Polyline	<Null>	6D829CCE-3E3A-4A31-927	NE101I323	260102	田坎、陡坎、沟堑、路堤
6943	Polyline	<Null>	B3CFC076-448B-45D0-89E	NE102J020	260102	田坎、陡坎、沟堑、路堤、单坡堤
6944	Polyline	<Null>	F6897EBC-3C0D-4BC8-9D1	NE102J020	260102	田坎、陡坎、沟堑、路堤、单坡堤
6945	Polyline	<Null>	47387D19-DAF5-4032-877	NE102J020	260102	田坎、陡坎、沟堑、路堤、单坡堤

Figure 4. Name irregularities.

(2)Quality of relationships:The association relationship is incorrect, as shown in Figure 5. The association relationship for the road bridge is incorrectly assigned to the road attribute that intersects with the tunnel when there are two roads crossing above and below. The road attribute that should be associated with the overlap with the tunnel: "roundabout motorway". The problem of contradictory entity data information and relationship information cannot be modified in the database construction link, and needs to be modified and transferred to the next link in time. The check is assisted by computer-aided checking to check the correctness and consistency of the data by overlaying the data of different layers; the consistency is determined by correlating the contents of related data sets, layers and attributes.

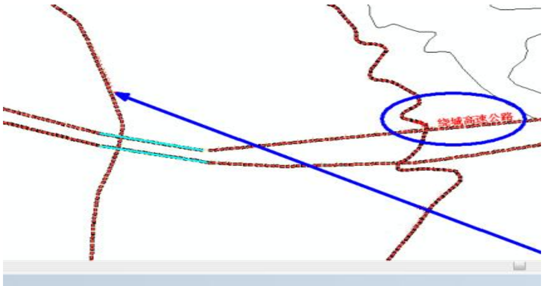


Figure 5. linkage error.

(3)Quality of representation:Roads are represented as unconnected, as shown in Figure 6. Provincial road S230 is not connected to indicate that the red road RN (road code) is S230; the black road is other highway, and the RNN (road network code) is S230. not according to the RNN copy of the other highway to complete the provincial road S230. This type of problem is caused by the lack of mastery of the technical requirements of the operation and the failure to ensure the continuity and completeness of the line data as required. It cannot be modified in the library building session, and needs to be modified and processed in time for handing over to the next session. The inspection is carried out through human-computer interaction checking, screening and manual analysis and judgment of the results of the inspection, based on the correctness of the association between entities and entities, entities and attributes, and attributes and attributes to determine the correctness of the data check.

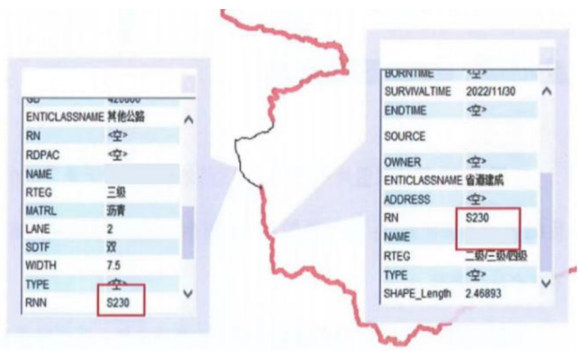


Figure 6. Road discontinuity.

(4)Logical consistency:Inconsistencies in the representation of the underlying geographic entities, as shown in Figure 7. Inconsistency in the representation of scaled overpasses exists in the case of framing by the outermost edges of vector overpasses, and also in the case of framing by a 20-meter buffer to the outermost edges of vector overpasses. The accuracy of the representation of the underlying geographic entities was checked manually. This type of problem is the result of inconsistent treatment of technical issues.

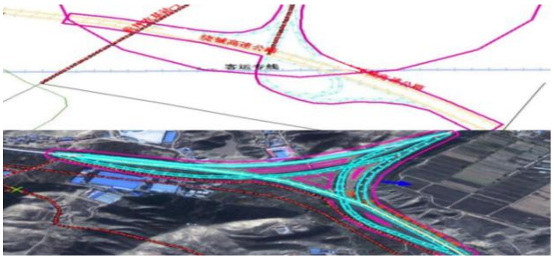


Figure 7. Inconsistency of expression.

5. CONCLUSION

With the accelerated process of globalization and the rapid development of regional coordination, it is urgent to promote the construction of a new type of basic mapping and to build a live three-dimensional China to meet the requirements of the new era. The quality inspection of basic geographic entities is an important part of the construction of real 3D China, and the production specifications related to the results of basic geographic entity data are still being formulated and perfected, so the specifications related to the quality inspection and acceptance of the results of basic geographic entity data have not been formally promulgated at present. In this paper, the technical characteristics of basic geographic entity data results are sorted out, and the contents and methods of their quality inspection are analyzed according to their quality characteristics. Combined with the quality inspection examples, it summarizes the main quality problems based on the results of basic geographic entity data, and researches and proposes the corresponding quality inspection methods to provide technical reference for the quality inspection and evaluation of basic geographic entity results. In the future, it is necessary to continue to work on the research and development of software and standardization of the results inspection of basic geographic entity data, and to explore and expand the quality inspection technology, means and methods, so as to keep pace with the natural resources management and economic development(Deng,2022) , in order to buttress the new type of basic surveying and mapping on the quality of the results demand.

ACKNOWLEDGEMENTS

This research was supported by Innovative Youth Talents Program,MNR (1211 0600 0000 1800 3901). Meanwhile, I would like to express my gratitude to my colleague Chen Haipeng.Without his full support and assistance, this paper would not have been able to be published.

REFERENCES

Cao,W.T.,Yao,Y.,Chen,S.,Li.H.T.,Technical realization of basic geographic entity for stock data conversion. Urban Surveying,05,24-30.

Deng,K.Y.,Yang,A.L.,2022:Exploration of ideas for the construction of basic geographic entity database. Surveying and Mapping and Spatial Geographic Information,45(S1),67-69+72.

Zhang,L.,Hu,H.,Shi,T.T.,Shao,J.,2021:Discussion on the construction of basic geographic entities. Geospatial Information,19(12),89-90+113+6.

Zhang,J.Y.,Liu,G.,2018: Research on the way of association and fusion of basic geographic entities and government thematic data.Urban Surveying,04,25-28.

Zhu,X.H.,Fu.T.J.,2022:Discussion on the conversion of basic surveying and mapping results into basic geographic entity data. Jiangxi Surveying and Mapping,04,51-54.

Zhang,J.X.,Zhang,L.,Zhang,H.,2018:New era quality inspection task for new basic mapping.China Surveying and Mapping,01,37-39.

Zhang,Y.R.,Jia,G.J.,Tao,Y.C.,Zhu,X.K.,Zuo,X.G.,Cui, L.X.,2020:Spatial organization and polymorphic features of basic geographic entities and their applications.Surveying and Mapping Bulletin,08,135-138.doi.org/10.13474/j.cnki.11-2246.2020.0265.

Zhang,H.,Wang,H.,Wang,W.,Wang,C.,2022:Quality characterization of two-dimensional basic geographic entities.Beijing Surveying and Mapping,36(11),1570-1575.