INTRODUCTION TO DATA QUALITY STANDARD FOR DIGITAL TOPOGRAPHIC MAP PRODUCT

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Abstract

In China, a new data quality standard for digital topographic map product has been developed and will be used for establishing the technical system of producing digital products of surveying and mapping. In this paper, data quality characteristics and their assessment criterion, testing methods and assessment principles of digital topographic map are introduced briefly.

1. Introduction

In the last ten yes, the research, establishment and applications of geographic information system and topographic map database are taken seriously and the great progress has been made on the key technique. With the development of computer mapping and geographic information industry, market requirement of digital topographic map products becomes more and more urgent. In China, 1:1000000 and 1:4000000 map database covering in whole country and 1:50000 map database in Hainan province have been established. Task of establishing 1:250000 map database is going on the way. In many districts and cities there are own topographic map database as the basic data of regional and urban geographic information system. Therefore the producer and customers all care about the data quality greatly.

The Data Quality Standard for Digital Topographic Map Product provides data quality characteristics and their estimation criterion, checking methods, acceptance check rule and comprehensive assessment principles of final products. It applies to the acceptance check final products which are produced according to the current national standard and local standard or profession standard. The quality check of production routine and last check of product can refer to it.

2. The quality characteristics of unit product

Unit product is a basic unit divided for acceptance. The basic unit of digital topographic map is a sheet of map or a database using "sheet" as a unit. Quality characteristic describes the basic properties that meet customer's use. The quality characteristics of unit product can be divided into:

2.1 Position accuracy which sub-divided into mathematical basis, plan accuracy, elevation accuracy and sheet-join accuracy;

2.2 Attribute accuracy which sub-divided into the completeness of the attribute item and correction of attribute value;

2.3 Completeness which sub-divided into data and layer's completeness, entity type's completeness and annotation completeness;

2.4 Logical consistency which sub-divided into entity's geographical suitability and topology relation's correction;

2.5 Graphic quality which sub-divided into symbol's quality and the format decoration's quality;

3. The quality criterion of unit product

The quality criterion needs to take account of two factors. First is average principle demand to quality control with development of producing the digital topographic map product produced in near future; Second is connect closely with present situation of the producing digital topographic map in China. In order to make the products meet quality requirements, the quality criterion should be accepted by both producers and customers.

3.1 *Mathematical basis*

The coordinate value of corner point of the format, intersection point of kilometer grid and geographic graticule as well as control points in the database should be the same as theoretical value of them; The position error of these points must be less than 0.1mm on the hard copy plotted on the high accuracy plotter; The error of neat line length must be less than 0.2mm; The error of the diagonal line length must be less than o.30mm.

3.2 *Plane accuracy*

For data measured in field survey, the distance between detail point and adjacent control point and the distance between two detail points should be limited in surveying standard of corresponding scale Map; For data digitized from source map, comparing the plotted map with the source map, the mean square error of point feature should be less than or equal to 0.30mm, line feature, 0.35mm.

3.3 *Elevation accuracy*

For the data measured in field survey, the mean square error of height for elevation point, contour and elevation control point should meet demands of the survey standard; The means square error of contour displacement for the digitizing data should be less than 0.35mm. Elevation point value can not contradict with contour.

3.4 *Sheet join accuracy*

The corresponding features going through the edge of two adjacent map sheets should be joined naturally without logical crack and geometric deflection. If geometric deflection is less than 2 2 times to the mean square error of acquiring objects, sheet joining can be made. Otherwise the reason of the deflection should be checked out.

3.5 *Correction of entity classification*

Entity classification and their code should meet a criterion of 《Land basic information data classification and code》 or coincide with the rules of interrelated technical files without mistake and omission.

3.6 *The precision of entity attribute value*

Correctly show attribute items and attribute values which describing quantity and quality properties, place name and so on.

3.7 *The precision of data layers*

All of entities presented in the map should be divided into different layers and saved according to the rule of technical specification, avoiding repeat and omission.

3.8 *The completeness of annotation*

Name of the entities and their describing information should not be omitted and mistaken; typeface, font size, characters, position and direction of the annotation should meet the rule.

3.9 *The geographical suitability*

The same type of entities should adopt a unite presentation method or symbol. Relationship among entities in deferent layers should be coincided, avoiding contradiction of geographical suitability.

3.10 *The correction of topological relation*

Correctly show contiguity, connection and inclusion between entities.

3.11 *Symbol quality*

Symbol to be used should meet the legend specification. The interval between lines or symbols should not less than 0.20mm.

3.12 *The format decoration quality*

The format decoration should meet the rule without mistake and omission.

4. Checking methods of unit product quality

4.1 *Determination of checked point*

Generally 50 checked point on the unit product should be chosen, in the particular, at least 20 checked points, which are well-distributed and well-distinguished. Moreover should at least 20 edges or distances be measured.

4.2 *Checking methods*

For digital topographical map data which were acquired by field survey, coordinates and elevation of checked points should be going through the field inspection according to accuracy of station point, distance of adjacent detail point is measured using steel ruler. For digital map data which were acquired by digital photogrammetry or analytic photogrammetry, the field inspection method could be used when the map scale is more than 1:5000, otherwise using pass point method , accuracy of checked points are the same as pass point.

For digital topographical map digitized from existing map, point features and line feature should be plotted on transparency film by high accuracy plotter. Then overlay the plotted map on source map

with registration of the corresponding corner points of the format or intersection of kilometer grid. Deflection of checked point is measured by microscope, while displacement mean square error is calculated. Elevation accuracy is determined by elevation of checked points and contour annotation value as well as their relations.

After gross error being eliminated , all these measured data can be used to calculate mean square error of point (Mp) and mean square error of height (Mh).

Mean square error of point:

$$M = \pm\sqrt{M_x^2 + M_y^2}$$

where,

$$M_x = \pm\sqrt{\sum_{i=1}^{n}(X_i - x_i)^2 \div n} \qquad M_y = \pm\sqrt{\sum_{i=1}^{n}(Y_i - y_i)^2 \div n}$$

Xi, Yi: coordinates of checked point

xi, yi: coordinates on digital map

Mx, My : respectively show the mean square error of detail point in x and y direction

n : account of checked points.

mean square error of distance:

$$M_s = \pm\sqrt{\sum_{i=1}^{n}\Delta S_i^2 \div n}$$

where, Δ Si: deference between measured distance in field survey and corresponding distance on digital map or the displacement defection of point and line feature after overlaying the plotted map on the source map to be digitized

n : account of checked distance.

Mean square error of height:

$$M_h = \pm\sqrt{\sum_{i=1}^{n}(H_i - h_i)^2 \div n}$$

where, Hi: measured elevation of checked point

hi: elevation value in plotted map

n: account of checked point.

After checking, mean square error of point or height of unit product is

$$M = \pm\sqrt{M_{specified}^2 + M_{check}^2}$$

The excess tolerance of error can be regarded as defect value according to its value.

Other quality attribute can have the aid of being checked on seeing or on computer by comparing plotted map with field survey or digitized image or digitized source map. To write down errors. And estimate the class of defect then give the corresponding deducted mark.

All kind of defects can be divided into three types: very critical defect, critical defect and general defect according to their influence on the usability of products. Each very critical defect deducts 42 mark; each critical defect deducts 12 mark (for 1:500-1:100000 map); Each general defect deducts 42/W mark (W is the standard working days of making each product).

5. Quality assessment of unit product

It is qualified product which total deduct mark is less than 40. Total mark of a qualified unit product can be calculated according to the following formula:

$$Q = P1*Q1 + P2*Q2$$

where:

M1: Account of checked points which mean square error are less than or equal to M
M2: Grand total of checked points
M: Point and height mean square error of checked points in an unit product
P: Weight of quality characteristic of unit product in estimating the grade of product
P1: Weight for the error value of plane and elevation of checked point
P2: Weight for the total deducted mark of other quality characteristics
Q1 = M1/M2*100
Q 2 = 100 - grand total of mark to be deducted
P1 = 0.6, p2 = 0.4 for 1:500~1:100000 digital topographical map
P1 = 0.4, p2 = 0.6 for 1:250000, 1:500000 digital topographical map
P1 = 0.2, p2 = 0.8 for 1:1000000 digital topographical map

The grade of qualified unit product depends on the value of Q. When Q lies in 80 ~ 100, excellent; in 75 ~ 80, fine; in 60 ~ 74, up to standard.

6. Conclusion

Data quality standard* of digitial cartographic map is important to permit determination of the useability of data for variouss products and to prevent incorrect use of data. This standard is too long to be introduced completely. In this paper, only the characteristics, qulity criterion and assessment method for unit product are introduced briefly. Improving on this standard is necessary in the feature.

* This standard was developed by Center of Quality Supervision and Inspection of Product of Surveying and Mapping, National Key Lab. for Information Engineering in Surveying , Mapping and Remote Sensing , WTUSM , and Beijing Academy of Surveying and Mapping.