Research on Geodetic Data Standard System

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Abstract: Aiming at importance of geodetic data standards in process of digitized geodetic production, application and service, this paper discusses the content framework of geodetic technical base standard, information system standard and data service standard. Hierarchy relation and category relation of geodetic data standard system are established in this paper.

Keywords: geodetic, data standard, data sharing, open system.

1. Introduction

In the process of geodetic informatization, scientific descriptions of geodetic data process described by geodetic data standard, as well as theories, methods and programme to realize the descriptions, are technical base that can't be transcended. Data standardization emerging with geodetic informatization going deep, depth and width of its application scope will exceed the degree and level of traditional standardization.

With the progress of surveying techniques, the operation of instrument is simpler and the field work become less restricted in techniques, but the data structure become more complicated. At the same time, socialization desire of data sharing is increasing urgent. So the focal point of geodetic standardization maybe changes from the work standards to the data standards.

2. Geodetic Data Standard System

Geodetic data standard system is the synthetical reflection of geodetic informatization level at a certain phase. The standard system is a structure combining hierarchy and category, a hierarchy relation in vertical direction and a category relation in horizontal direction. The relation is neither a relation of guiding and obeying nor a relation of individuality and commonness, but a relation of inter-relating, interacting, and inter-harmonizing. Standard of one category has requests on others and, on the other hand, satisfies other standards' requests in some way, thus harmonization is reached among different standards. According to characteristics of positioning control information and requirement of open system environment, hierarchy of positioning control data application standard can be established, consisting of technical base layer, information system layer and data service layer. Each layer is composed of several standards, forming a category. In hierarchy, the lower layer provide bases and references for the higher layer, that is to say, function of the higher layer is defined on basis of function of the lower layer. Technical base standards, being the base and reference of geodetic data standard, include geodetic reference system conceptual schema standard, geodetic codes and parameters standard. Information system standards, in relation to geodetic data characteristics and data access, include geodetic database content standard, geodetic metadata standard and geodetic data quality standard. Service standards, facing to different users' and different systems' needs for geodetic data, include geodetic data collection standard, geodetic data exchange standard and digital geodetic product format standard. These standards, on one hand, applies to realm of geodetic production, geodynamic research etc as relatively independent technical system, on the other hand, they applies to spatial information discipline and its application realm, combining with information standards of other disciplines of surveying and mapping realm, consequently forming spatial information standard system.

3. Geodetic Technical Base Standard

1) Geodetic reference system conceptual schema standard

This kind of standard defines the conceptual schema and guidelines for describing geodetic reference systems. Conceptual schemata describe modes of data structures and provide the basis for further standards development. A consistent suit of geospatial information schemata will allow spatial information to be integrated with information technology.

Any coordinate-based usage of spatial information needs a unique definition of the underlying reference system. A Standardized conceptual schema for geodetic reference system will increase the ability of spatial information to be shared among applications. This schema is to be used by geographic information system (GIS) developers and spatial information users to provide data with consistently defined reference systems.

This kind of standards mainly includes:

1.ISO19111 "*geographic information: spatial reference based on coordinates*" 2.Open GIS specification model "*spatial reference system*".

2) Geodetic codes and parameters standard

Technical specification on geodetic codes and parameters mainly are to solve problems as follows: the first is to define rules for the population of table of geodetic codes and parameters, the second is to identify the data elements within these tables, in compliance with "*geodetic reference system conceptual schema standard*", the third is to make recommendations for use of these tables. These recommendations should address the legal aspect, the applicability to historic data, the completeness of the tables, and a mechanism for maintenance.

This kind of standards mainly includes: ISO 19127 "*geographic information: geodetic codes and parameters*".

4. Geodetic Information System Standard

1) Geodetic data quality standard

Data quality reflects the ability of data to satisfy different applications. Only after data quality is determined can it be judged its suitability. So it is the precondition of data sharing to determine data quality characteristic.

In U.S. the old data quality standard defined in "*National Geodetic Reference System*"(NSRS) is contained in "*Standards and Specifications for Geodetic Control Networks*"(Federal Geodetic Control Committee, 1984) and "*Geometric Geodetic Accuracy Standards and Specifications for Using GPS Relative Positioning Techniques*"(Federal Geodetic Control Committee, 1988). In 1994, NGRS is re-defined as "*National Spatial Reference System*" (NSRS). Application aim of geodetic networks had changed. Federal Geodetic Control Subcommittee (FGCS) established a new data quality standard, i.e. "*Standards for geodetic Networks*" (FGDC, 1998).

The new standard for geodetic networks prescribes accuracy classification standard of NSRS and operational steps to determine accuracy class. Differing from old quality standard of NGRS, NSRS users' various accuracy requirements are considered in the new quality standard, which prescribes using "network accuracy" and "local accuracy" to valuate quality of control point. The condition is changed that only relative accuracy was used to valuate point quality in the past.

2) Geodetic database content standard

Data model is the assemblage of code types and data base elements. The American content standards for geodetic control data are presently contained in the NGS data base data dictionary. The NGS data base is operational both for data processing and data distribution activities. The entire surveying and mapping community of the United States depends on its well being. The NGS data base had contained approximately 10 gigabytes of stored information by 1995.

3) Geodetic metadata standard

Metadata standards are the catalogue and accessibility standards for data availability. Imbedded in the metadata profile elements are references to the components of the Fig.1 mentioned geodetic data standard, i.e. the accuracy, content, collection, and transfer components of geodetic data. Metadata explain their availability, or provide "data about data." Metadata help users of geospatial data find the data they seek.

The American metadata standards for geodetic data (FGCS, 1997) were established on basis of the FGDC Metadata Standards, i.e. *Content Standard for Digital Geospatial Metadata (FGDC 1998)*.

5. Geodetic Data Service Standard

1) Geodetic networks unified data structure standard (Geodetic data collection standard)

Geodetic networks unified data structure is the submission, processing unified format for all kinds of geodetic data sources. It is mainly used to put data into database. So geodetic networks unified data structure standards are actually put-data-into-database standards (or Collection Standards). The American Collection standards for geodetic control data are called "National Geodetic Survey Blue Book (NGS Bluebook), i.e. " the *Input Formats and Specifications of the National Geodetic Survey Data Base* (**Challstrom C.W., 1998**). This publication describes the formats and procedures for submitting data. In fact, collection standards can be considered a subset of Content Standards. However, since the "collection standard" for geodetic control, i.e. the Blue Book, has been in place since1980 and is a well-known nationwide data model, it has been listed as a separate major component. The standards in use at present are the version established in 1994 and revised in 1998.

Data into NGS data base will be component of NSRS. The NGS has determined that the value of geodetic observations for the NSRS obtained by other Federal, state, and local organizations compensates for the costs incurred by the Federal Government to

provide quality assurance, archiving, and distribution functions for surveys contributing to the public good. Organizations submitting data must adhere to the Blue Book requirements, which ensure geodetic data provided by other organizations to be put into the NGS data base.

By 1995 NGS had received data from other organizations for 88,000 horizontal control points and a total of 48,000 km of geodetic leveling. The cost savings to the nation's surveying and mapping community for these horizontal and vertical control data conservatively can be estimated at about $107.2 million. This data sharing program works because the donors (private, county, state, and other Federal organizations) want to ensure the accuracy of the points they observed (or had contractors observe) and earn NGS' stamp of approval as the Nation's highest authority on geodetic control. The data-sharing program also provides the mechanism for the publication of officially sanctioned values, the national distribution of these values, and automatic updates of the data as computations on the NSRS are performed.

2) Geodetic data exchange standard

Transfer Standards are formats of importing and exporting geodetic data. Trade, through growth in new informational/communications industries, causes the national economy to grow. Through the use of transfer standards, data sharing will be instituted, in the worldwide market place. In 1992, the United States published *Spatial Data Transfer Standard* (SDTS), which will be used in data transferring among different spatial information systems. Geodetic data are clearly spatial and the SDTS clearly applies to this data set. FGCS established "*SDTS-Part 6: Point Profile*"(FGCS, 1998), as a part of SDTS, to exchange geodetic data. Excluding defense systems and exceptional circumstances, the SDTS is mandatory for Federal agencies! This means that hardware/software systems procured by the Federal government for the processing of spatial data must include the capability of importing and exporting data sets which conform to the transfer standard, SDTS.

After SDTS was brought into effect, existing digital spatial data production and processing systems need to be retrofitted so that they will also import and export data sets which conform to the standard. Existing digital spatial data sets are produced in a myriad of formats; each data product has its own format. Adoption of SDTS will enable users of conforming hardware/software systems to import and use any conforming data set without further special programming.

Geodetic data are traditionally used by the surveying community. Production of geodetic data in SDTS extends the geodetic application realm and will enable GIS analysts to import and use geodetic data more effectively.

3) Digital geodetic product format standard

Traditional geodetic product table is published in form of paper product table. Digital geodetic product format is digitalization of this kind of product. Discrete control points being a information description object, a datasheet can be designed to include all kinds of coordinate data, coordinate explanation data, file data and descriptive data of a control network, stored in the form of sequential file. It reflects the data requirement of traditional users, who require paper product table of control point.

6. Conclusions

Accompanying with digitalized geodetic production and application, importance is attached to data standardization in advanced countries in the past few years. It is aware that sharing data and sharing processing among systems is impossible to realize without data standard. Hierarchy of geodetic data system includes: technical base layer, information system layer and data service layer. Each layer is composed of several standards, forming a category. They are normalized description of geodetic data sharing technology.

This paper issued that geodetic data standard system is composed of standards as follows: geodetic reference system conceptual schema standard, geodetic codes and parameters standard, geodetic data quality standard, geodetic database content standard, geodetic metadata standard, geodetic data collection standard, digital geodetic product format standard and geodetic data exchange standard. Techniques reflected in these standards are key techniques realizing geodetic data sharing environment.

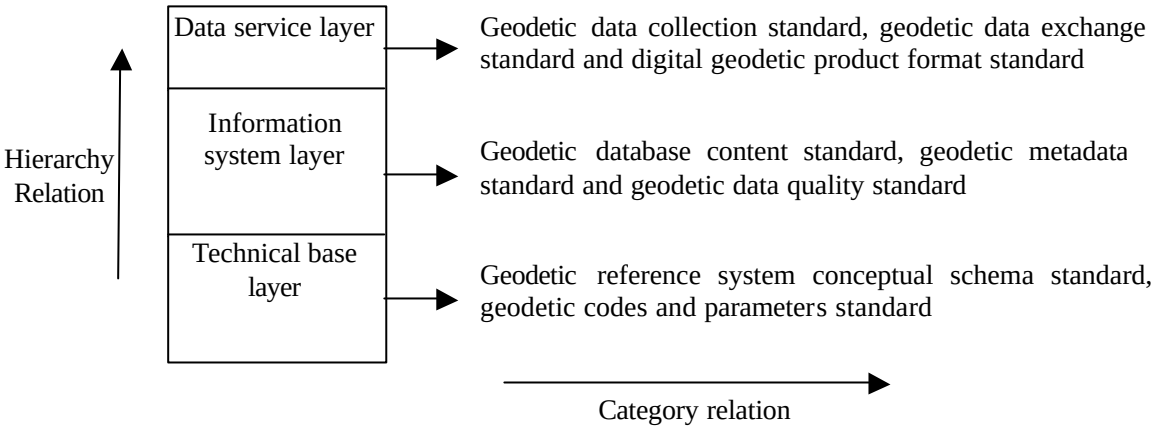

Fig.1 Geodetic data standard system

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