GEOSPATIAL METADATA STANDARDS FOR GEODETIC DATA

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BIOGRAPHICAL SKETCH

John F. Spencer, Jr., is Chief of the National Geodetic Information Branch, National Geodetic Survey, NOAA. He began his Federal service with the U.S. Coast and Geodetic Survey (C&GS) in 1965. He received his undergraduate degrees from Virginia Polytechnic Institute and George Washington University (GWU), and his M.S.A. in Information Systems Technology from GWU. He has published articles and technical papers and made presentations pertaining to geodetic and cartographic sciences, primarily discussing the use and availability of geodetic data, at local and national meetings throughout the country. He has been actively involved in the ACSM and AGU since the late 1960's.

ABSTRACT

The Federal Geodetic Control Subcommittee (FGCS) of the Federal Geographic Data Committee (FGDC) is responsible for the establishment of appropriate standards and specifications for the collection and storage of geodetic data and for the dissemination of these data to the Federal, state, and local levels of government and the private sector. The FGDC "Content Standard for Digital Geospatial Metadata", released on June 8, 1994, provides this mechanism of digital data exchange over the evolving National Spatial Data Infrastructure (NSDI). National Geodetic Survey (NGS) of National Oceanic and Atmospheric Administration (NOAA) developed the geospatial metadata elements for geodetic data using these metadata standards. These geospatial metadata standards for geodetic data are being used to support NSDI and to comply with the development of the National Geospatial Data Clearinghouse (NGDC), as required in the Executive Order 12906 of April 11, 1994, "Coordinating Geographic Data Acquisition and Access: The National Spatial Data Infrastructure". Current and planned activities that support the development of geodetic data standards and their contribution to the implementation of NGDC in accordance with FGDC metadata standards will be presented. The development and organization of geodetic data standards and their relationships to the profile elements and informational formats of the metadata standard will be discussed.

INTRODUCTION

On October 19, 1990, the Executive Office of the President, Office of Management and Budget (OMB) revised Circular A-16,
"Coordination of Surveying, Mapping, and Related Spatial Data Activities" (1). The goals of the circular are to develop a national digital geographic information resource, to reduce duplication, to reduce the expense of developing geographic data, and to increase the benefits of using available data and ensuring coordination of Federal agency geographic data activities. At this time, a major objective of OMB Circular A-16 is the development of the National Spatial Data Infrastructure (NSDI) with the involvement of Federal, state, and local governments, and private sector (2). This national information resource, linked by partnerships and standards, will enable sharing and efficient transfer of geospatial data between producers and users. OMB Circular A-16 established the Federal Geographic Data Committee (FGDC), chaired by the Secretary of Interior, to promote the coordinated development, use, sharing, and dissemination of geographic data. The committee oversees and provides policy guidance for agency efforts to coordinate geographic data activities. Federal agencies were assigned the responsibilities of leading coordination activities for categories of data, as shown in Table I. Agency responsibilities include providing government-wide leadership in developing data standards; coordinating data collection and analysis; and assisting information and data exchange. The NOAA's C&GS of the Department of Commerce provides leadership of the geodetic subcommittee.

Changes in technology, i.e., Global Positioning System (GPS), require standards for surveying, data reduction, and formatting to be reevaluated and amended as necessary. In addition, there are several aspects to data sharing that need to be considered dealing with issues such as data accuracy, completeness, timeliness, reliability, accessibility, security, and liability. The FGDC has developed a metadata standard, "Content Standards for Digital Geospatial Metadata" (3), that will incorporate these aspects and expedite sharing of geospatial data. To be in conformance with the national metadata standard, the National Geodetic Survey has prepared "Digital Geospatial Metadata Standards for Geodetic Data" (4). By assuring that these data comply with national standards and guidelines they contribute to and become an integral part of the NSDI.

NATIONAL SPATIAL DATA INFRASTRUCTURE

The Clinton Administration identified creation of the NSDI as one of the initiatives necessary to "reinvent government." Within Vice President Gore's "National Performance Review" summary report (5), the development of the NSDI, based on partnerships including non-Federal sectors, was recognized as key to minimizing redundancy in the creation of geospatial data and to maximizing access to the geospatial data needed to solve critical environmental, economic, and social problems. The FGDC was recognized as the Federal entity responsible for helping to guide development of the NSDI. The President has signed an Executive Order 12906 - "Coordinating Geographic Data Acquisition and Access: The National Spatial Data Infrastructure" (6) which will accelerate the development and implementation of the NSDI. This directive addresses a variety of activities, as shown in Table II, that must be carried out by the FGDC, by Federal, state, and local government agencies.
and by members of the nonpublic sectors to fully develop the NSDI. The success of the NSDI will hinge upon the ability to build and maintain partnerships among these entities to carry out the actions of this directive. The FGDC has described the NSDI as an umbrella under which organizations and technology interact to foster more efficient use, management, and production of geospatial data. The major objective of the NSDI is to foster enhanced use of geospatial data through better management of existing geospatial data and through more efficient collection and production of new geospatial data in ways that maximize data usefulness for multiple data users. The current elements of the NSDI include the geo-patial data standards and clearinghouse partnerships in various stages of development. A plan to develop the NSDI which specifically addresses steps to develop partnerships and standards is available from the FGDC (7).

PARTNERSHIPS

A partnership is a joint venture agreement whereby resources (and risks) are shared by the members to accomplish expected goals. Partnerships are required in order to establish the NSDI. These NSDI partnerships involve data acquisition, i.e., the geospatial data gathering, transferring, and developing of shared data bases between members. Geodetic data in standard formats form the basis for such data acquisitions. The FGDC, in accordance with the presidential directive on NSDI, will develop strategies during 1995 for maximizing participatory efforts with Federal, state, local, and tribal governments, and the private sector to share costs and improve efficiencies of acquiring geospatial data.

C&GS sponsors a cost-sharing advisory program with several states, Federal-state partnerships. The program provides a liaison between C&GS and the host state, with a jointly funded C&GS employee residing in the state to guide and assist the state's charting, geodetic, and surveying programs. This program is listed as part of the strategic goals to be accomplished within C&GS' National Geodetic Survey (8). The program is designed to fill a need for more accurate local geodetic surveys and is in response to the states' desire to improve their surveying and data processing techniques to meet National geodetic data standards and specifications. The following states have geodetic advisors: Alabama, Alaska, California, Colorado, Florida, Georgia, Idaho, Illinois, Kansas, Louisiana, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Montana, Nebraska, New Hampshire, New Jersey, New Mexico, Ohio, Oregon, South Carolina, South Dakota, Vermont, Washington, and Wisconsin. Many other states have requested advisors, but present funding levels will not allow expansion of these Federal-state partnerships. The National Research Council report recommends that NOAA should provide a well-trained State Geodetic Advisor to each state or region (9). When funding is available, the State Geodetic Advisor program will be expanded so that each state has access to a state advisor with the appropriate training and ability.

Secretary Babbitt of the Interior Department in his interview with GIS World (10) emphasized the importance of partnerships. He plans to have "FGDC facilitate more enduring and productive
partnerships for collecting, managing, and using geospatial data to solve real problems." Partnerships, such as geodetic advisor programs to collect, manage, and use geodetic data, will lead to the implementation of NSDI at the State and local level. However, these efforts must be based on good technical communication of requirements and established (or enhanced) standards to collect and transfer the data.

GEODETIC DATA STANDARD

A standard is really a model for what is acceptable to a community of users (i.e., a vendor, professional discipline, or a nation). There are two types of standards:

- De facto (by practice) standards are established, informally or without lawful authority, through extensive application by a community of users, (i.e., as a result of the popularity of a software package or hardware platform).
- De jure (by law) standards are based on legislative approval and formally decided by a recognized institution (i.e., professional, national, regional, or international) representing a community of users.

The geodetic data standard is composed of five components, i.e., data standards for quality, content, collection, transfer and metadata. This model was presented and described in "The Contribution of Geodetic Data to the National Spatial Data Infrastructure" (11) at the First Federal Technology Conference, Exposition and Data Mart in Washington, D.C. in September 1994.

In order to implement the geodetic data component of the NSDI, proposed data standards must be developed and endorsed by the FGCS who represent the Federal community of geodetic data users. Then, the proposed data standards must be approved by the FGDC and sent to the National Institute of Standards and Technology (NIST). NIST will evaluate the data standards and issue a Federal Information Processing Standard (FIPS) to be used by all Federal agencies. A report on the development of quality, content, collection, transfer, and metadata standards is given below:

QUALITY STANDARDS

Quality standards are the accuracy and operational standards for data collection. Quality standards for geodetic control data are presently contained in the "Standards and Specifications for Geodetic Control Networks" (12).

These standards were based on the classical system, the National Geodetic Reference System (NGRS). However with the transition from NGRS to the new National Spatial Reference System (NSRS), new quality standards are required. Therefore, the FGCS Methodology Work Group has proposed revision of the geodetic accuracy standards of the quality standard component.

The FGCS has released a "draft" report on the new accuracy standards and the implementation schedule of specification testing for operational proof of concept. Comments and suggestions during the developmental stages of the new accuracy standards are welcome.
standards and specifications would be greatly appreciated. If you wish to comment or need a copy of the report, write to the following:

Chief, National Geodetic Survey
NOAA, SSMC-3, N/CG1
1315 East-West Highway
Silver Spring, Maryland  20910-3282
Telephone 301-713-3222; Fax 301-713-4175

CONTENT STANDARDS

Content standards are the assemblage of code types and data base elements pertaining to data holdings for storage and management. Content standards for geodetic control data are presently contained in the data dictionary of the NGS data base. The NGS data base presently contains approximately 10 gigabytes of stored information. 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. Questions concerning the data contents or the data dictionary can be directed to George Frank, NGS Data Base Administrator, phone 301-713-3251, or Internet address, george@ngs.noaa.gov.

COLLECTION STANDARDS

Collection standards are the submission, processing, and data base format standards for data sources. Collection standards for geodetic control data are presently contained in the "Blue Book," the "Input Formats and Specifications of the National Geodetic Survey Data Base" (13). This publication describes the formats and procedures for submitting data for adjustment and assimilation into the NGS data base. Separate volumes of this publication refer to horizontal control data (Volume I), vertical control data (Volume II), and gravity control data (Volume III). Guidelines for submitting GPS positioning data are contained in Annex L of Volume I. These can be considered a subset of the above Content Standards. However, since the "collection standard" for geodetic control, i.e, the Blue Book, has been in place since 1980 and is a well-known nationwide data model, it has been listed as a separate major component.

The NGS has determined that the value of geodetic observations for the NSRS obtained by Federal, state, and local governments and private 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 and its accompanying policy statement regarding the incorporation of geodetic data of other organizations into the NGS data base.

NGS has received data from contributing organizations for 88,000 horizontal control points since 1980. Also, there has been a total of 48,000 km of geodetic leveling submitted to NGS from contributors since 1980. 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, whereby 88,000 points x $1,000 per horizontal point = $88,000,000 and 48,000 km x $400/km of vertical data
$19,200,000 have been incorporated into the national framework. This data sharing program works because the contributors (private, county, state, and 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 provides the mechanism for the publication of officially sanctioned values, the national distribution of these values, and, when necessary, updates to the data as computations are performed by NGS.

TRANSFER STANDARDS

Transfer standards are the importing and exporting digital data exchange standards used for data transfer. Through the use of transfer standards, data sharing will be instituted, in the worldwide market place. Trade, through growth in new informational/communications industries, causes the national economy to grow. NIST has recently published the revised "Spatial Data Transfer Standard" (SDTS) which will be used by the FGCS to standardize the data transfer elements of geodetic data (14). Excluding defense systems and exceptional circumstances, the SDTS is mandatory for Federal agencies! This means that hardware and 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. Federal agencies are also encouraged to retrofit existing digital spatial data production and processing systems 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; in most cases, each data product has its own format. Adoption of SDTS will enable users of conforming hardware and software systems to import and to use any conforming data set without further special programming. Geodetic data are clearly spatial and the SDTS clearly applies to this data set. Geodetic data are traditionally used by the surveying community. However, production of geodetic data in SDTS will expand the user community and enable GIS analysts to more efficiently import and use the basic geodetic data. The digital geodetic data that are produced and used as "de facto" transfer standards by our present user community are being developed into SDTS products by NOAA (15) in order to comply with the "de jure" standard and to improve data transfer.

METADATA STANDARDS

Metadata standards are the catalogue and accessibility standards for data availability. Imbedded in the metadata profile elements are references to the components of the above mentioned geodetic data standard, i.e., the accuracy, content, collection, and transfer components of geodetic data. Metadata explain their availability and use, or provide "data about data." Metadata help users of geospatial data find the data or references they seek. Metadata standards for geodetic data conform to the FGDC "Content Standards for Digital Geospatial Metadata" (3).

Table III contains the major elements of the metadata standard.
The information included in the standard was selected on the basis of four characteristics that define the role of metadata:

- availability--data needed to determine the sets of data that exist for a geographic location;
- fitness for use (quality)--data needed to determine if a set of data meets a specific need;
- access (content)--data needed to acquire an identified set of data; and
- transfer--data needed to process and use a set of data.

The final form of the "Digital Geospatial Metadata Standards for Geodetic Data" (4) was submitted to FGDC on Oct 1, 1994. Copies are available to conference attendees at the C&GS exhibit booth. The document was much too large to publish in the conference proceedings. A copy is also available over the NGS' "Home Page" through Internet by using Mosaic, a World Wide Web software browsing tool. The Uniform Resource Locator (URL) address for NGS' Home Page is: http://www.ngs.noaa.gov.

These metadata for geodetic data were also placed in the FGDC's National Geospatial Data Clearinghouse (NGDC) to provide nationwide access to geodetic data. The NGDC (16) is defined in the Executive Order on NSDI as "a distributed network of geospatial data producers, managers and users linked electronically." NGDC is a network-based information resource intended to help users find and retrieve geographically referenced data sets, in this case, geodetic data.

The NSDI Executive Order required Federal agencies to comply with the provisions of the metadata standard by January 1995 and to provide public access to each agency's geospatial data by April 1995. NOAA's National Geodetic Survey has complied with the Order.

CONCLUSION

In essence, geodetic data provide the basic framework in developing a common coordinate system reference for all other geographic features of the NSDI. For example, at the FGDC conference in Charleston, South Carolina (17) the question was asked, "What are core (base) data?." When comparing the results of base data for NSDI that were categorized, it was realized that geodetic data are required in all cases, as shown in Figure IV.

Geodetic data and the metadata concerning geodetic data are critical to the nation's infrastructure, and are available for use in accordance with the Executive Order 12906 (6). Contact the Clearinghouse to access the geospatial metadata elements for geodetic data or other related metadata sets at the following address:

FGDC Secretariat
C/o U.S. Geological Survey
REFERENCES


Geospatial metadata (also geographic metadata, or simply metadata when used in a geographic context) is a type of metadata that is applicable to objects that have an explicit or implicit geographic extent, i.e. are associated with some position on the surface of the globe. Such objects may be stored in a geographic information system (GIS) or may simply be documents, data-sets, images or other objects, services, or related items that exist in some other native environment but whose features may be