Practical Applications of the Geographic Coordinate Data Base in Arkansas

by

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Abstract

Though not intended for these applications, the General Land Office (GLO) survey notes are a primary source of historical, ecological, and cultural information, making it imperative that their spatial coordinates be as reliable as possible. The Geographic Coordinate Data Base (GCDB) is a statistically-based coordinate fitting program that uses the GLO notes and other related chains of evidence to determine truer geodetic coordinates of public land survey system (PLSS) corners. To date, the most reliable PLSS geographic coordinates have been digitized from 7.5 minute quadrangle maps, and some corners may have hundreds of feet of error. The GCDB can reduce this discrepancy by an order of magnitude or better. Additionally, the GCDB could provide a standardized data input and registration structure for witness trees or other natural features. Another benefit is the use of the GCDB in nationwide mapping efforts like the USGS National Map, USDI Bureau of Land Management National Integrated Land System (NILS), USDA Forest Service Automated Land Project (ALP), and GeoSpatial One-Stop.

INTRODUCTION

In addition to doubling the size of the fledgling United States of America, the Louisiana Purchase became the first widespread implementation of the Public Land Survey System (PLSS) by the General Land Office (GLO). Between 1815 and 1855, the GLO instituted the rules and regulations of the PLSS to describe and convey property in the state of Arkansas. During these decades, a small band of surveyors canvassed the wilds of Arkansas, battled hostile working conditions, and laid the foundation for the legal settlement of the state (Warwick 2003). In the process, they recorded volumes of information on the lands they traversed.

Though not intended for applications other than those related to surveying and property distribution, the GLO notes have become a primary source of historical, ecological, and cultural information. In addition to locating and monumenting corners, surveyors witnessed these locations (where possible) using live trees. They were also instructed to record observations on the natural and human communities they encountered, which have provided a wealth of descriptions from a period of time about which little is known. For example, GLO records have helped identify bottomland forest communities in the Mississippi River Alluvial Plain of eastern Arkansas (Foti 2001), tree species composition and size class distribution in Ashley County, Arkansas (Bragg 2003), and presettlement vegetation patterns in the Ouachita and Ozark Mountains (Foti and Glenn 1991, Tucker 1991). Archaeologists have also associated the vegetation described in the Arkansas GLO with prehistoric remains (Rolingson 1991).

Many of the studies based on the GLO records associate contemporary landforms and discoveries with historical features. Thus, it is critically important that the spatial coordinates of each corner prove as reliable as possible. Furthermore, their accessibility needs to be improved in order to increase their utility. This paper describes a joint research effort focused on the incorporation of new technology with historical surveying information.

METHODS

The GCDB

The Geographic Coordinate Data Base (GCDB) is a statistically-based coordinate fitting program that uses the GLO notes and other related chains of evidence to determine "truer" geodetic coordinates of PLSS corners. To date in Arkansas, GCDB coordinates have been developed by the USDI Bureau of Land Management (BLM) and the USDA Forest Service for the Ozark, St. Francis, and Ouachita National Forests. These agencies are using the GCDB to assist their land management efforts through their incorporation in and improvement of the data layers contained within their Geographic Information Systems (GIS).

Data Management

Recorded measurements, both historical and modern, are entered into the Geographic Measurement Management (GMM) software. The GMM module is

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available at no cost to the user from the official distribution site (Appendix A) operated by its author, Kurt Wurm (New Mexico State University). User manuals, technical support, and a tutorial are also available online.

Selected PLSS corner monuments are located using Global Positioning System (GPS) technology. Coordinates for the PLSS can be retrieved from USGS 7.5 minute quadrangle maps. These coordinates provide the links between the record measurements and their geodetic locations. However, the accuracy of the GCDB depends on the accuracy of the representation of the PLSS on the map. To date, the most reliable PLSS geographic coordinates have been digitized from quad maps, even though some corners may have hundreds of feet of error.

The GMM program uses appropriate procedures for the subdivision of sections and townships to provide a framework of coordinates for the PLSS down to the level of a 1/16th section, commonly known as a "forty" due to its being approximately 40 acres in size. Currently, digitized survey corner coordinates are only available down to the level of an entire section.

Data Maintenance and Updating

The GCDB coordinates are updateable, so greater accuracy can be attained by increasing the number of GPS coordinates. As new coordinates are entered, the framework configuration established by the original survey remains and corners that are intended to be midpoints shift to maintain that relationship to surrounding corners. For instance, data that was entered as a specific distance from the corner will be updated to maintain that distance when the corner coordinates are improved.

The results of the GMM process can be saved as a "shapefile," which is a common GIS output that allows the GCDB coordinates to be used in almost all commercial GIS software. This universality is highly beneficial to large-scale, multi-agency efforts because it allows the data to be shared regardless of which software package is chosen.

OUTCOMES AND OPPORTUNITIES

Potential Uses

In some instances, the GCDB has the potential to reduce the discrepancy between coordinates digitized from quad maps by an order of magnitude or better. Improved spatial precision will allow for more accurate assessment of resource issues, especially those that associate historical vegetative conditions with contemporary natural features.

Another benefit is the use of the GCDB in nationwide mapping efforts (Appendix A) such as the USGS National Map, USDI BLM National Integrated Land System (NILS), USDA Forest Service Automated Land Project (ALP), and GeoSpatial One-Stop (an initiative to coordinate data formats). The advantages for users of a spatial coordinate system linked to other standards are considerable, and these are becoming more and more recognized. For instance, the Western Governors Association recently passed a resolution declaring the GCDB to be the best representation of the PLSS. They urged its use by government agencies as well as the surveying, mapping, and GIS communities. Adopting the GCDB as the PLSS standard is a first step towards data integration and enhanced data sharing (Zimmer 2004).

Current Arkansas Applications of the GCDB

In addition to the development of initial GCDB data layers for the national forests of Arkansas, several research projects at the University of Arkansas at Monticello (UAM) are examining the potential of the GCDB to improve and expand upon existing data. For example, UAM students working on this project have used the GCDB for corner reconnaissance in areas where they are available. The coordinates were downloaded into a GPS receiver and used to find the monument on the ground. Most of the corners sought after in the Ozarks and Ouachita Mountains were easily found using the coordinates.

The GCDB will also be used to catalog and retrieve survey information. The State Surveyor of Arkansas is responsible for maintaining and perpetuating the PLSS corner locations. Traditionally, this has been done by placing markers at corners, especially those that still had evidence of the original GLO survey. This information can be linked to the GCDB so that it is easily retrievable in a GIS.

Furthermore, a template based on the database structure of the GCDB can be used to ensure uniformity between spatial information users across the state, thereby permitting greater interaction between users. For instance, state archeologists, ecologists, surveyors, and university researchers all typically use unique systems to record and process their GLO information, making it very difficult to share. The GCDB provides an opportunity for standardized data input and registration structures for witness trees or other natural features.

CONCLUSIONS

The adoption of spatial technologies in the state of Arkansas is expected to increase dramatically as more agencies, industries, organizations, and individuals begin to work with digitally accessed data. Ensuring that these efforts are as efficient and effective as possible suggests that this information must be complete and accurate.

The Geographic Coordinate Database provides a unique opportunity to link historical and contemporary spatial data across a number of applications. The GCDB also provides a framework that will allow for the improvement of existing information, in addition to as yet unknown resource opportunities.

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APPENDIX: Important Internet access sites for more detailed information on the GCDB, including software downloads, and other large-scale mapping programs mentioned in this paper.

The GCDB national webpage, from which GCDB data can be downloaded:
http://www.blm.gov/gcdb/

The software to generate GCDB data along with tutorials, a users manual, and a reference manual are available from Kurt Wurm's webpage at New Mexico State University:
http://web.nmsu.edu/~kwurm/Software.html

"Cadastral Information for GIS Specialists" is an educational module written by the Federal Geographic Data Cadastral Subcommittee and the USDI BLM (Part Three deals with the GCDB):
http://www.fairview-industries.com/gismodule/PartThreeGCDB.htm

The Federal Geographic Data Committee (FGDC) is an interagency committee responsible for developing the National Spatial Data Infrastructure (NSDI) in cooperation with other organizations:
http://www.fgdc.gov/ and http://www.fgdc.gov/nsdi/nsdi.html

An intergovernmental project managed by the Department of the Interior in support of the President's Initiative for E-government, Geospatial One Stop helps improve access to geospatial information:
http://www.geo-one-stop.gov/

The National Map is the USGS online interactive map service that provides public access to geospatial data:
http://nationalmap.usgs.gov/