

**HISTORY OF COOPERATION IN SURVEYING AND MAPPING STUDIES
BETWEEN THE
STATE BUREAU OF SURVEYING AND MAPPING OF CHINA
AND THE
UNITED STATES GEOLOGICAL SURVEY**

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Abstract

Since 1985, the State Bureau of Surveying and Mapping of China and the U.S. Geological Survey have exchanged technology and ideas under the Protocol for Scientific and Technical Cooperation in Surveying and Mapping Studies. The Protocol was implemented under the 1979 Agreement on Cooperation in Science and Technology between the United States and the People's Republic of China. Protocol activities include reciprocal technical exchanges by scientists and managers, participation in cooperative research and applications projects, and jointly authored technical reports documenting the results of cooperative mapping and remote sensing projects. Areas of cooperation include digital cartography, geodesy, satellite remote sensing research and applications, geographic information systems (GIS) research and applications, data archiving and dissemination, and program management. Both the United States and China have gained knowledge and technical expertise by participating in cooperative mapping, GIS, and satellite mapping projects and by sharing information on the management and technical development of their mapping programs. Under the Protocol, the United States and China have achieved a significant degree of harmonization in their respective civilian mapping programs, providing an excellent example of constructive Sino-U.S. engagement that has proven to be beneficial to both nations.

Introduction

In the early 1980s, the U.S. Geological Survey (USGS) began cooperating with counterpart organizations in China through a series of agreements for scientific and technical cooperation in the areas of seismology, earth sciences, and surface water hydrology. At about the same time, the former National Bureau of Surveying and Mapping of China (hereafter referred to by its present designation, the State Bureau of Surveying and Mapping, or SBSM) sought to enhance its capabilities in the areas of digital mapping and geographic information systems (GIS). Several letters and visits were exchanged during the period 1982-83 with regard to establishing a formal

agreement between the United States and China for cooperation in the mapping sciences.

In September 1984, a delegation from the SBSM traveled to the United States to visit governmental mapping authorities, to investigate geographic information systems development, and to discuss possible technological cooperation in mapping, charting, and geodetic activities. The delegation visited the Bureau of the Census, the Defense Mapping Agency, the National Geodetic Service, and the USGS, as well as State agencies and commercial vendors. In early 1985, the SBSM sent a communication to the U.S. Embassy in Beijing suggesting that the mapping activities of the USGS of the Department of the Interior were most closely in line with SBSM's needs and objectives and that the SBSM would like to enter into a scientific and technical exchange with the USGS. This message was transmitted to the U.S. Department of State in Washington, D.C., and relayed from there to the USGS.

Developing the Protocol

Although the U.S. Government has no specific law defining the responsibilities of the various departments and agencies for mapping, charting, and geodesy, the U.S. Congress' budget appropriations place the primary responsibility for these functions in several Federal departments. The Department of Commerce has the primary responsibility for the national geodetic networks, both horizontal and vertical. The Department of Defense has the responsibility for large-scale mapping outside the continental boundaries of the United States. The Department of the Interior, through the USGS, has the primary responsibility for domestic base mapping programs, for producing small-scale maps of selected themes internationally, and for coordinating digital cartographic data standards throughout the Federal Government.

Because of these divisions of responsibility, the U.S. Department of State held a meeting in early 1985 to discuss the SBSM proposal with representatives from the Defense, Commerce, and Interior Departments. It was agreed that the USGS, under the purview of the State Department, would further explore developing and implementing a surveying and mapping protocol between China and the United States. It was agreed that this protocol would be implemented under the existing Sino-U.S. Agreement on Cooperation in Science and Technology (S&T Agreement) that was signed by President Jimmy Carter and Vice-Premier Deng Xiaoping for their respective nations on January 31, 1979.

In April 1985, a delegate from the USGS attended the Third Conference of the Chinese Society of Geodesy, Cartography, and Photogrammetry held in Wuxi, China, and then met with authorities from the SBSM in Beijing to discuss in further detail what the proposed surveying and mapping protocol would encompass. They agreed to develop a protocol that would initially address two major subject areas: geographic information systems/digital cartography and remote sensing. Details of such an agreement would be documented during a visit by a delegation from the USGS to the

SBSM after the inclusion of appropriate language from the enabling U.S./China S&T Agreement. This was accomplished in the Protocol for Scientific and Technical Cooperation in Surveying and Mapping Studies between the USGS and the SBSM signed in Washington, D.C., on April 16, 1985. The signed Protocol included an addendum, Annex I, that addressed several legal and administrative issues that are required to be in any agreement between the United States and other nations, such as intellectual property, rights in data and publications, and funding contingencies.

Operating the Protocol

In August 1985, a five-person delegation from the USGS met with SBSM representatives in Beijing to develop and document the methodology to accomplish the objectives of the Protocol and to establish the oversight group required under the provisions of the Protocol. It was agreed that all activities conducted under the Protocol would be managed through a Joint Working Group (JWG), co-chaired by representatives of the SBSM and the USGS, with membership to include experts from the respective mapping disciplines. As a way to measure progress and accomplishments, it was agreed that reports of the activities of each Protocol project annex would be shared at annual JWG meetings to be held alternately in China and the United States. At the annual JWG meetings, the parties would develop work plans to implement objectives in the specific discipline areas for work to be accomplished in the coming year.

The newly formed JWG then agreed upon a number of research projects and technical exchanges that would constitute the initial 1985-86 program of work. The initial working parts of the Protocol were adopted as project Annex II for GIS/digital cartography and Annex III for remote sensing. Project Annex IV (1988) and Annex V (1994) were later adopted to address program and technical management issues and to facilitate the exchange of geodetic data, respectively. The results of the August 1985 meeting were recorded as Minutes of the First Meeting of the Joint Working Group. Chen Junyong, Director General of the SBSM, and Rupert B. Southard, Chief of the USGS National Mapping Division, signed the Minutes, and the formal program of cooperation began.

The development of this agreement required a significant amount of effort on the part of both parties, and it has been proved over time that a significant document resulted from those efforts. The Protocol has been consistently extended at 5-year intervals and has remained essentially unchanged since its inception, now more than 16 years ago. From 1985 to 2000, 13 JWG meetings were held between the USGS and the SBSM, either in China or in the United States, for reviewing the implementation of cooperative projects and developing new work plans.

The USGS and SBSM jointly develop and implement a program of work to be reviewed and approved at the annual JWG meetings. Work is performed under project annexes, each of which has both a USGS and an SBSM coordinator to ensure that the annual program of work for that annex is carried out. In a typical year, a delegation

representing each project annex visits the other cooperating organization to work with counterpart scientists and program managers for a period of 2 or 3 weeks. The annex visits include topical seminars and briefings, technical discussions and demonstrations, and hands-on research. The traveling delegation usually visits multiple work sites of the hosting organization, and there are also frequent visits to areas of scenic and cultural interest. The annex coordinators manage the work performed under the project annexes and report results and accomplishments at the next JWG meeting.

Accomplishments

A summary of the project annexes and the cooperative work accomplished under them follows, with a more detailed listing, including selected joint publications, appearing in the appendix to this document.

Annex II - Developing Geographic Information Systems. The parties agreed to cooperate in developing GIS applications for such purposes as land planning, agriculture, and environmental protection. Cooperative investigations were to include digital cartographic data collection, spatial data management systems, digital terrain modeling, land use mapping, techniques of digital map revision, and GIS applications.

The work under Annex II essentially follows the evolution of the GIS field over the same period. Early work focused on digitizing techniques, coding standards, data validation, and quality assurance issues. This was followed by work on spatial database design, data management procedures, and data standards. Work on product generation at various scales, data generalization, and data revision came next. As each of the technical themes evolved, so did a concern with the standards and protocols required for wider use and application of the data. Work on spatial data transfer standards grew into looking at the spatial data infrastructure, the development of framework data sets, and the establishment of clearinghouse nodes. Current Annex II activities include working toward national spatial data standards compatible with evolving global standards, working to improve data access and dissemination by means of the Internet, improving data integration and quality assessment, and demonstrating GIS applications for resource management, disaster relief, urban modeling, and human health concerns.

Annex III - Application of Remote Sensing Information to Cartography. The parties agreed to cooperate to promote the development of remote sensing techniques and their application to surveying and mapping. Cooperative investigations were to include geometric and radiometric rectification of remote sensing data, including satellite and radar data; enhancement, classification, and interpretation of remote sensing data; and application of remote sensing data to map revision, thematic mapping, and land use mapping.

Cooperative activities under Annex III have included using Landsat, AVHRR, and SPOT data for image mapping and for vegetation and land cover mapping, using

SBSM data to help build global data sets, and using satellite images for urban and regional change analysis in the United States and China. Scientists from the USGS and the SBSM have jointly authored technical reports (see appendix) documenting satellite remote sensing research conducted under the Protocol. Current Annex III activities include using high-resolution satellite data to monitor urban and regional change dynamics, evaluating Landsat 7 and NASA/Terra satellite data for use in restoring ecological landscapes, using satellite Radar data for terrain modeling and map revision, and exchanging technical information on Landsat 7 data acquisition, processing, management, and dissemination.

Annex IV - Management and Technology of Surveying and Mapping Production.

At the third JWG meeting in 1988, the parties agreed to a proposal by SBSM to add an additional project annex (Annex IV) to the Protocol. This was done to help address the management of surveying and mapping programs that were incorporating new digital technologies. The Chinese had recognized that putting new technology in the workplace meant that new management skills were required. The parties agreed to cooperate and exchange information on topics such as organizational structures, laws, regulations, and guidelines for surveying and mapping production; methods for planning, organizing, and managing surveying and mapping production; financial management; and utilizing new technologies in modernizing surveying and mapping programs.

Cooperative activities under Annex IV have included exchanges on production organization, program and data management systems, modernization of mapping and data production, and evolving government and industry roles in national technical programs. The parties have conducted evaluations of USGS and SBSM mapping software and have presented seminars on evolving mapping, remote sensing, product generation, and data management techniques. Current Annex IV topics include mapping contract management and quality assurance, licensing arrangements for commercial satellite data, improvement of data archiving and dissemination techniques, and exchanges on coordinating multiple agency requirements and building data partnerships with other organizations.

Annex V - Application of Geodetic and Geophysical Data to Mapping, Charting, and Geodetic Programs. At the seventh JWG meeting in 1994, the parties agreed to cooperate in the collection, processing, and exchange of geodetic and geophysical data and in their application to surveying and mapping programs. Accomplishments to date include joint operation of a global positioning system (GPS) tracking station near Beijing, completion of a project to collect and process absolute gravimetry (AG) data for seven ground stations in China in support of an improved earth gravity model and geoid, and technical training in installing, operating and maintaining GPS and AG equipment.

Benefits of the Protocol

The Protocol has provided both tangible and intangible benefits to the participants. The United States has acquired maps and geographic data from China that have now been used for global and regional mapping and environmental applications. The United States has also gained access to advanced digital mapping software produced by SBSM and China's technical universities. China has received assistance in enhancing its mapping and geographic data programs and has gained expertise in GIS applications and in managing large geographic data sets. Both parties have benefited from participation in cooperative satellite mapping and land characterization projects, from cooperation in developing geographic data standards, from joint research to improve data access by means of the Internet, and from sharing information on the management and technical development of their respective mapping programs.

One of the intangible benefits of the Protocol has been the opportunity for reciprocal visits to field offices in our respective nations to see the different perspectives of the counterpart organization. Early in the Protocol, the SBSM began to focus on what were referred to as "the three S's," geographic information systems (GIS), global positioning systems (GPS), and remote sensing (RS). They began to view these three critical technologies as integral components of a national mapping program. To their U.S. counterparts, who had seen each of these disciplines evolve from different roots and only begin to converge late in their development, this synergistic view of related mapping technologies from a national mapping perspective was a visionary concept.

A similar realization emerged after several years of Protocol exchanges when both the SBSM and the USGS began referring to "the four D's," whether the conversation was in Chinese or English. This was in reference to digital elevation models (DEM), digital line graphs (DLG), digital orthophoto quadrangles (DOQ), and digital raster graphics (DRG). Both agencies had now evolved a common terminology regarding their essential geographic data themes used for mapping and GIS applications. This harmonizing of organizing principles and basic data themes within our respective civilian mapping programs has encouraged the ongoing exchange of ideas and technical information as our programs, and the technologies behind them, continue to evolve.

Conclusion

When one considers both the tangible and intangible benefits that have resulted from this historic exchange, perhaps the best measure of its success is its continued existence for the past 16 years. The fact that our respective governments have continued to commit both financial and human resources to this effort is testimony to the benefits that our respective organizations have shared. The USGS and the SBSM are working to extend the Protocol for another 5-year period, from 2001 to 2006, and to develop the general objectives of cooperative activities for the next 5 years. We in the USGS consider the studies conducted under this Protocol to be a most effective use of resources and we are confident that the SBSM shares in our opinion that highly

significant accomplishments have resulted from this unique exchange and that there will be many more successes to follow.

Appendix

Activities and Accomplishments of the USGS/SBSM Mapping Protocol For the Period 1985-2001

Annex II

- Review and exchange of software for automated cartography and GIS
- Exchanges on spatial database design, data management, and data standards
- Exchanges on digital revision, product generation, and data generalization techniques
- Collection and application of GPS and geodetic gravity data (with NGS and DMA)
- Seminar on geographic names database design and links to GIS
- Translated 1:4M SBSM digital map data to the Spatial Data Transfer Standard
- Prepared shaded-relief maps of China from SBSM's 1:1M elevation and vector data
- Joint 1996 ESRI Users Conference paper Creating Relief Maps of China
- Terrain visualization using SBSM elevation data and Landsat images
- Technical exchange on Census GIS applications in the United States and China (with Bureau of the Census)
- Exchanges on spatial data infrastructure, framework data sets, clearinghouse nodes
- Exchanges on metadata and spatial data transfer standards
- Jointly designed SBSM Web site to enhance Internet access to geographic data
- Exchanges on integrating multiple source spatial data sets for GIS applications
- GIS applications for resource management, urban modeling, disaster relief, and human health concerns

Annex III

- Exchanges on applications of satellite remote sensing to surveying and mapping
- Joint research using Landsat TM and SPOT for image and thematic mapping
- Technical support for installing China's AVHRR receiving station
- Training in using AVHRR data processing software and preparing image mosaics
- Joint 1992 publications in English and Chinese on satellite image mapping of the Black Hills, USA, and Ningxiang, China.

- USGS Open File Report 93-355 A Comparison of Change Detection Methods Using Multispectral Scanner Data for Dallas-Ft. Worth, USA, and Shanghai, China
- Interpreted 30 vegetation/land cover classes in north-central China using AVHRR
- Joint 1994 ISPRS Symposium paper Recent Experience in Mapping Land Cover from AVHRR Data: People's Republic of China Test Sites
- Joint 1996 technical report Seasonal Land Cover Characteristics Data Base of China for Global Change Research
- Generated 1-km resolution global data sets using SBSM's terrain and hydrologic data
- International AVHRR Workshop, Beijing, October 8-9, 1997
- Cooperative Pearl River land cover project using Landsat TM and SPOT data
- Urban land cover change analysis using Landsat MSS and TM data
- Seminar on satellite radar interferometry and its applications
- Seminar in China on NASA Terra satellite sensors MODIS and ASTER
- Seminar at the USGS EROS Data Center on Landsat 7 data acquisition, processing, and applications
- Joint research on regional land cover classification using Landsat 7 data

Annex IV

- Exchanges on production organization, program and data management systems
- Exchanges on modernizing mapping and data production using new technologies
- Exchanges on evolving government and industry roles in national technical programs
- 1993 joint 3-day seminar in Beijing on topographic map revision
- Seminars on DOQ, DLG, DEM, and DRG production
- Seminars on digital data revision and product generation
- Evaluation of USGS RevPG software to revise 1:50K topographic maps (Longkou and Ku Er Le Shi) of China
- Evaluation of China's VirtuoZo NT stereographic mapping software
- Exchanges on mapping contract management and quality assurance
- Exchanges on interagency requirements coordination and data partnerships
- Seminar in China on spatial information management, data archiving and delivery

Annex V

- Joint operation of GPS tracking station near Beijing
- Collection of absolute gravimetry (AG) data in support of an improved earth gravity model and geoid
- Technical exchanges for installing, operating, and maintaining GPS and AG equipment
- Installing software for automated transmission of GPS data