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The Role of the Mapping Science Committee in assisting the mapping of the United States

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Abstract

In 1863 President Abraham Lincoln signed into being the National Academy of Sciences, to "investigate, examine, experiment, and report upon any subject of science or art"... In 1989, the National Research Council, one of the divisions of the National Academy established The Mapping Science Committee to provide "independent advice to society and to government at all levels on scientific, technical, and policy matters related to spatial information. It promotes the informed and responsible development and use of spatial data for the benefit of society". The committee, comprised of a diverse group of experts from academic, government and private industry who donate their services has conducted 12 studies that have addressed a wide range of issues relating to the mapping and the spatial data enterprise in the United States. From its inception, the committee has embraced the notion that a successful set of mapping resources in the United States must involve appropriate roles for each sector of government as well as a robust private sector. This concept was articulated under the umbrella of the National Spatial Data Infrastructure (NSDI). Therefore, a central theme of the committee has been the analysis of institutional issues associated with organizations such as the Federal Geographic Data Committee. Concurrently, it also has monitored the transformation of the federal mapping enterprise into a digital environment. This includes a recent evaluation of the U.S. Geological Survey's vision and implementation plans for The National Map. Current studies are investigating the impact of licensing on the sharing of spatial data, the ways that spatial data and technologies are impacting society, and the technical alternatives for integrating topographic and bathymetric data. This paper highlights the value of the committee, its operational structure as well as some specific findings and recommendations from its reports.

Introduction

For more than 110 years the United States government has relied on the National Academy of Sciences to provide objective scientific advice on issues of national importance. Since 1989, The Mapping Science Committee of the National Research Council, has served as the Academy's focal point for advice relating to a wide range of issues associated with the creation and maintenance of a diverse set of nationwide mapping and spatial data. The formal statement of the mission is:

"The Mapping Science Committee provides independent advice to society and to government at all levels on scientific, technical, and policy matters related to spatial information. The committee provides advice on geographic information science and spatial data infrastructures. It promotes the informed and responsible development and use of spatial data for the benefit of society. The committee recommends and oversees studies responsive to the geographic information science and spatial data infrastructure interests of sponsors. Additionally, it recommends and oversees studies addressing geographic information science and policy issues and issues germane to domestic and international spatial data infrastructure programs."

How the committee operates

The committee consists of a group of experts from academic, government and private industry who volunteer their services usually for a three-year term. The former chairs of the committee have been:

Thomas C. Finnie, Consultant (former Associate Director, DMA) (1987-1990)

John D. Bossler, Director, Center for Mapping, Ohio State University (member, 1987-1990; chair, 1990-1994)

Larry Sugarbaker, Washington State Department of Natural Resources (member, 1992-1994; chair, 1994-1996)

Michael F. Goodchild, Director, National Center for Geographic Information & Analysis, University of California, Santa Barbara (member, 1992-1996; chair, 1997-1999).

Over the past thirteen years the committee has conducted a number of studies that have resulted in the twelve published reports (Table 1). Often these studies are the result of a specific task developed by one or more sponsoring organizations. In other cases, the committee itself has initiated studies. Normally, a study committee, composed of experts on the particular subject, conducts the research and writes the final report. The research phase of the process usually consists of a series of workshops and presentations by authorities representing a wide breadth of opinions on an issue. Often, the participants in the workshop will develop white papers that are available on the Internet. For example, twenty-three white papers submitted by the participants at a recent workshop on the vision of The National Map are available on the committee's website. (http://www7.nationalacademies.org/besr/Mapping_Science.html). These papers provide an excellent opportunity for the public discussion of the alternative views on often-contentious issues. A study committee has the difficult task of assimilating the diverse opinions into a final report. The report describes the institutional and policy context of the topic, any specific technical alternatives and specific findings and recommendations. The final draft of the report is sent to a set of anonymous reviewers who can raise factual concerns or question the justification for the findings and recommendations. Before the National Academy Press approves a report for publication the committee must address each issue raised by the reviewers. This rigorous review process provides a critical level of quality control for all National Academy studies.

Reports are shared with sponsoring agencies for a final review before they are released to the public. Sponsors are allowed to comment on factual errors, omissions or misinterpretations, but cannot influence the views of the committee or its recommendations. Final printed reports are published by the National Academy Press and made available through its outlets (ISBN numbers are included in Table 1). The full text of some of the early reports is available over the Internet. More generally reports can be read only one page at a time through a web browser interface. Often a study can serve as focal point for further discussions within the sponsoring agency or the broader community. The recommendations may lead to changes in policies and procedures or form the basis for changes in priorities. For example, the recent study [Down to Earth: Geographic Information for Sustainable Development in Africa \(NRC, 2002\)](#) became a major part of the United States participation in the 2002 World Summit on Sustainable Development in Johannesburg. Additionally, the committee's most recent report [Weaving a National Map: Review of the U.S. Geological Survey Concept of the National Map \(NRC, 2003\)](#) has become a part of the deliberations on the appropriate strategy for implementation of a accurate, current, and seamless series of spatial data resources for the United States. In all cases the intent of the studies is to provide an objective and unbiased perspective on an issue.

The scope of the committee

The scope of the activities of the committee focuses around six general areas relating to the NSDI, the transformation of mapping into a digital environment, and broad societal impacts. The following section describes these areas and highlights some of the major accomplishments of the committee and its key recommendations.

The first major area of interest is **Fundamental research and science for advancing geographic information technologies**. Under this heading the committee played a key role in providing advice to the National Mapping division of the USGS in terms of its need to modernize the traditional production of paper cartographic products and the transformation into the digital world (NRC 1990 and 1991). These two studies identified the need to accelerate the move to the digital environment and the need to develop systems that could generate non-standardized products. In fact, the committee laid out a clear role for the National Mapping Division and the specifics of the National Digital Cartographic Data Base, which have evolved into the recently proposed National Map.

Establish plans for and begin prototyping a national spatial data base, which would be an enhancement of the NDCDB and would be feature-oriented and on-line by the year 2010, if not sooner. (NRC, 1990)

The committee also proposed that the National Mapping Division needed to expand its customer base to encompass all sectors of society.

The committee recommends that the NMD develop programs to produce and facilitate a wider variety of "non-standard" spatial data products in support of diverse user requirements for data and information within and beyond federal agencies (NRC, 1990)

The second major focus of the committee concerns the **Fundamental research on policies affecting the development and use of spatial data throughout society**. Under this heading the committee recently completed one of its most important studies. The committee was commissioned by the Geography Division of the U.S. Geological Survey to review its vision of the National Map (NRC, 2003). The study focuses on the technical and institutional issues relating to the implementation of the vision for a nationwide spatial data resource. The report suggests that this far-reaching vision will require an extraordinary set of partnerships and institutional arrangements throughout all levels of government. In order to succeed the committee believes that The National Map must change the culture and policies relating to how spatial data are funded and shared in the United States. Another ongoing study is examining ways that NOAA and the USGS can cooperate in the development of an integrated digital representation of topographic and bathymetric data.

A third general area concerns the **Technological and institutional developments needed for improving the capabilities of spatial data infrastructures**. For example, the committee has worked directly with the Marine Board, Commission on Engineering and Technical Systems and the Committee on Nautical Charts and Information to help identify the technical and institutional issues relating to transformation of paper nautical charts into the digital world (NRC, 1993b and 1996). The studies have highlighted NOAA's need to be concerned about user acceptance, distribution, liabilities and copyright. The committee has recently begun a study that has the working title of "Licensing Geographic Data and Services". This study is examining the impacts of the expanding use of licensing by government to acquire or distribute spatial data and related services. Since licensing agreements for spatial data can profoundly affect the operation of government this study should be of interest across the globe. It is exploring the experiences of federal, state, and local government agencies in licensing geographic data and services from and to the private sector. For example, it will include case studies that examine the policy implications of licensing satellite data. The published report in 2004 should provide an excellent source for the current arguments in favor and in opposition to spatial-data licensing arrangements. The

recommendations could shape future policies that impact the way organizations acquire and maintain spatial data.

One of the central tasks of the committee has been to monitor the **Coordination opportunities and efforts from local to global scales for the collection and dissemination of spatial data**; (NRC, 1993a, 1994, 1995, 2001, and 2002). In particular, the committee has focused on the identification of problems and issues relating to the creation and operation of the National Spatial Data Infrastructure (NSDI). The committee initiated the use of the term "NSDI" in a 1993 report Toward a Coordinated Spatial Data Infrastructure for the Nation (NRC 1993a). That report provided the vision for the NSDI and made the following finding and recommendation.

Effective national policies, strategies, and organizational structures need to be established at the federal level for the integration of nation spatial data collection, use and distribution.

Procedures should be established to foster ready access to information describing spatial data available within government and the private sector through existing networks, providing on line access by the public in the form of directories and catalogs. (NRC, 1993a)

It is important to note that this report closely coincided with President Clinton's issuance of executive order 12906 that identified the importance of the NSDI, mandated the creation of spatial metadata and strengthened the Federal Geographic Data Committee (FGDC).

"The National Performance Review has recommended that the executive branch develop, in cooperation with State, local, and tribal governments, and the private sector, a coordinated National Spatial Data Infrastructure to support public and private sector applications of geospatial data in such areas as transportation, community development, agriculture, emergency response, environmental management, and information technology" (Office of the Federal Register, 1994).

The importance of the NSDI and the FGDC was recently reaffirmed in the 2001 revision of the Office of Management and Budget Circular A-16 (Office of Management and Budget, 2001). This circular mandates the coordination of spatial data activities within the federal government and assigns authority for data base development to different agencies. The FGDC is charged with the overall guidance and coordination of these diverse spatial data development activities. Over the past decade the committee has served as the primary independent observer of FGDC programs and activities. For example, the 1995 study on partnerships (NRC, 1995) emphasized the importance of developing partnerships and provided examples of good federal partnerships.

It is imperative that state and other organizations be involved in the standards development process and that only standards essential to NSDI objectives be required of partnership agreements (NRC, 1995)

A recent study (NRC, 2001) provided an assessment of how well the FGDC partnership programs were working. While the committee applauded the efforts of the FGDC to stimulate the NSDI, it offered the following suggestions:

The partnership programs should have more rigor so they can be a true assessment of whether the funds have made a difference

The partnership programs need to take a long-term view. One-year funding is inadequate to assess the real success.

The committee also has played a major role in defining the data content and characteristics for the NSDI. Its 1995 study (NRC, 1995) clearly articulates the foundation layers for the NSDI.

The Mapping Science Committee recommends that geodetic control, orthorectified imagery, and terrain (elevation) data be considered the critical foundation of the NSDI.

It also strongly endorsed the role of the FGDC in developing these framework layers.

The FGDC should (a) coordinate identification of the various components of existing framework data through its clearinghouse, (b) encourage efforts to integrate those data with the foundation, and (c) identify gaps in data coverage and encourage the establishment of programs that include partnerships to populate these framework data themes.

This study suggested that there is a need for a greatly extended vision of the spatial data framework that includes a major role for state and local government in the creation and maintenance of spatial data.

On the international scene, members of the committee have participated in each of the six Global Spatial Data Conferences (Global Spatial Data Infrastructure, 2003) and conducted a major study on the use of spatial data in Africa. The committee has provided expertise to GSDI efforts by taking a lead role in issues relating the legal and economic impediments. Working jointly with the Committee on Geography the committee was asked by the State Department to develop a committee to conduct a study that evaluated the existing remote sensing and GIS efforts that support natural resource management and development issues in Africa. This report *Down to Earth: Geographic Information for Sustainable Development in Africa* (NRC, 2002) provides an assessment of the role of technological innovation and the impediments to successful implementation in less developed parts of the world.

Another important function of the committee is to assess the **Human resources and education in support of the advancement of geographic information science**. The committee's current activity in this area is entitled "Beyond Mapping". This study is an assessment of the current status of the mapping sciences and their impacts on society. The study committee, which includes a representative from the UK, is examining the intellectual base and associated research agendas for the mapping sciences. It is also concerned with the sources of research funding, their organization within educational institutions, and current and future demand for professionals. It will also investigate linkages with other more broadly based disciplines such as computer and information science, and future competitive prospects for U.S. industry based on the mapping sciences.

A final area of interest relates to the **Hardware and software systems in support of the advancement of geographic information science and spatial data infrastructure developments**. In order to meet these needs the committee has conducted two workshops that focused on the impact of broad technological changes on the collection, dissemination and use of spatial data. The first one (NRC 1997) assembled a group of experts who developed their vision of the future of spatial data and its technological base. The group highlighted the trends toward greater restrictions on the public access to data, the licensing issues, and the pervasive impact of the Internet. The second study (NRC, 1999) focused directly on the concept of a distributed geolibrary or a digital library filled with geoinformation. Over the past couple of years a number of initiatives have built on the foundation of distributed geolibrary. These include FGDC data clearinghouses and "Geospatial One Stop" which is one of five E-Government elements of the President Bush's Management Agenda and Performance Plan. (Geo Spatial One Stop, 2003)

TABLE 1. LIST OF MAPPING SCIENCE COMMITTEE REPORTS

Number	Year	Title	ISBN / HTML
1	1990	Spatial Data Needs: The Future of the National Mapping Program	
2	1991	Research and Development in the National Mapping Division, USGS: Trends and Prospects	
3	1993	Toward a Coordinated Spatial Data Infrastructure for the Nation	0-309-04899-0 HTML
4	1994	Charting a Course into the Digital Era: Guidance for NOAA's Nautical Charting Mission	0-309-05139-8
5	1994	Promoting the NSDI Through Partnership	0-309-05141-X
6	1995	A Data Foundation for the NSDI	HTML
7	1996	Technical Issues in NOAA's Nautical Chart Program	HTML
8	1997	The Future of Spatial Data and Society	0-309-05735-3
9	1999	Distributed Geolibraries: Spatial Information Resources	0-309-06540-2
10	2001	National Spatial Data Infrastructure Partnership Programs: Rethinking the Focus	0-309-08356-7
11	2002	Down to Earth: Geographic Information for Sustainable Development in Africa	0-309-08478-4
12	2003	Weaving a National Map: Review of the U.S. Geological Survey Concept of the National Map	0-309-08747-3
13	In Progress	National Needs for Coastal Mapping and Charting	
14	In Progress	Beyond Mapping: The Challenges of New Technologies in the Geographic Information Sciences	
15	In Progress	Licensing Geographic Data and Services by Government: From and to the Private Sector	
	Planning Stage	Planning For Catastrophe: A Blueprint For Improving Geospatial Data, Tools, And Infrastructure	
	Planning Stage	Cadastre (Land Parcel Databases: A National Vision)	
	Planning Stage	Access to Spatial Data: Issues of Security and Privacy	

Web site http://www7.nationalacademies.org/besr/Mapping_Science.html

Note: HTML indicates that the full report can be read over the internet. The contents of most reports can be read one page at a time.

Conclusions

Over the past fifteen years the Mapping Science Committee of the National Research Council, has provided an objective source of expertise to examine the evolution of mapping and spatial data in the United States. One of its primary functions has been to monitor the institutional arrangements and technology that support or thwart development and utilization of spatial data. Its twelve published reports provide a useful history of the evolution of the mapping enterprise in the United States. While some of the topics relate to specific issues in the United States, many of these studies assess broad technical and policy issues that are relevant throughout the world. The accelerated demand for spatial data and the increased recognition of its importance have elevated the significance of the work of the committee. For example, two current studies will provide a good benchmark for how society is being impacted by the availability and use of spatial data and how licensing arrangements are influencing the ways data are collected and shared.

References

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