A Retrospective Look at the Need for a Multipurpose Cadastre

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Introduction

The 1980 NRC[1] study "Need for a Multipurpose Cadastre" represented a landmark in the history of the automation of land records systems in the United States. At the national policy level it boldly asserted that the parcel of property ownership should be the fundamental building block for an integrated system of land information to support a wide range of decision-making. Furthermore, in no uncertain terms, it stated that the creation and maintenance of the cadastre can only be done at the local government level; however, it is the responsibility of the federal government to foster the integration of these local datasets through a set of consistent standards, funding programs and coordination with each state. The purpose of this paper is to review the recommendations of the report, attempt to assess the status of those recommendations, summarize subsequent related NRC activities, highlight what has not changed, and assess the current federal geospatial landscape. We also examine the issues that will impact the evolution of the multipurpose cadastre from this point forward.

1980: Need for a Multipurpose Cadastre

The preface of the NRC report laid out the need for a multipurpose cadastre and a Panel on a Multipurpose Cadastre, stating that:

> The increasing demand for land information at all levels of government and in the private sector, and the increasing involvement of federal agencies and program in the development and maintenance of land information systems, induced the federal agencies to request the NRC to define a federal role in the development of the multipurpose cadastre applicable on a national basis (NRC 1980, p. v).

The report also specified the components of a multipurpose cadastre:

- A reference frame consisting of a geodetic network;
- A series of current, accurate large-scale maps;
- A cadastral overlay delineating all cadastral parcels;
- A unique identifying number assigned to each parcel that is used as a common index to all land records in information systems;
- A series of land data files, each including a parcel identifier for purposes of information retrieval and linking with information in other data files (NRC 1980, pp.1-2).

The panel took an extremely broad view of the utility of a multipurpose cadastre: "There is a critical need for a better land-information system in the United States to improve land-conveyance procedures, furnish a basis for equitable taxation, and provide much needed information for resource management and environmental planning" (NRC 1980, p. 1).

The authors of the report believed that the benefits of a multipurpose cadastre justified a substantial, proactive involvement by the federal government to establish and fund a three-tiered hierarchy for dealing with land records. For example they recommended:

> … that federal legislation be prepared to authorize and fund a program to support the creation of a multipurpose cadastre in all parts of the Nation (NRC 1980, p. 3).

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[1] The NRC (National Research Council) is the principal operating agency of the National Academy of Sciences and the National Academy of Engineering. The academies have a responsibility for furthering knowledge and advising the federal government. The earlier NRC reports mentioned in this article were conducted under the auspices of the Committee on Geodesy; later ones by the Mapping Science Committee. For more information, see http://www.nationalacademies.org/.

> … that the Office of Management and Budget designate a lead agency for the multipurpose cadastre (NRC 1980, p. 3).
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> … that the Bureau of Land Management proceed with its plans to position the network of Public Land Survey monuments that mark the corners of sections and quarter sections that are located on federal land and to integrate them with the national geodetic control network (NRC 1980, p. 83).

They saw the need to impose certain requirements on the federal government, such that:

> … federal agencies that impose restriction on the use of lands should be required to file those restrictions with the appropriate state or county recording office (NRC 1980, p. 89).
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> ... all federally funded programs that produce components of the multipurpose national cadastre, such as right of ways surveys or large-scale maps, should be required to adhere to a federal plan that establishes the format for these components or, until such a plan is adopted, to the individual state plan, if any (NRC 1980, p. 89).

The authors also recognized the need for additional research and training in the field. They wanted to see federally funded academic centers of excellence in "land information science" with curriculum focused on the direct experience with land data system problems (NRC 1980, p. 96). While the federal role was to coordinate and fund the program, they clearly recognized that the actual data collection must come from the "bottom up" at a series of county-level Offices of Land Information Systems. Local governments were seen as the primary access point for local land information: "We recommend that local governments maintain data compatible with a multipurpose cadastre and transmit these data to high levels of government when needed" (NRC 1980, p. 77). In order to maintain the local multipurpose cadastre, each county would develop an integrated system that included the local recorder of deeds, county surveyor and the assessor.

The 1980 panel recognized the need for state governments to provide the interface between the local and federal governments. State Offices of Land Information Systems would promote effective, efficient, and compatible land-information systems across governmental levels, working with the federal government to ensure compatibility on a national basis. They would pass legislation that regulated survey monumentation and mandated recording of field notes and plans. In return, the states would provide matching funds augmented by the federal grants to local cadastral systems that met state standards.

Many aspects of the 1980 report could just as easily have been written today. The needs for a multipurpose cadastre are more widely recognized, and the benefits from maintaining a system have been clearly demonstrated in numerous local government jurisdictions. The 1980 panel emphasized the need for standards, envisioned data clearing houses, and called for the federal government to encourage increased involvement by the academic community. It is interesting to note that the panel was optimistic and visionary in its assessment of the current and future technological environment. They were absolutely on target when they wrote:

> Current technology is adequate in most cases for the surveying, mapping, data collecting, filing, and dissemination of information. Improved surveying and mapping instruments and techniques will probably reduce the cost of some of the mapping required. Advancement in computer applications, communication networks and copying processes promise of more efficient use of the multipurpose cadastre (NRC 1980, pp.101-2).

The members of the panel wrote a report that was optimistic and visionary. They painted a picture of the benefits of a coordinated multipurpose cadastre and laid out an idealized blueprint for how the Nation could position itself to reap those benefits. Nevertheless, they were also realists when they concluded that, "The major obstacles in the development of a multipurpose cadastre are the organizational and institutional requirements (NRC 1980, p. 102).

1982: Modernization of the Public Land Survey System

A second report, *Modernization of the Public Land Survey System* was published by the NRC in 1982. The report focused on the specific needs for creating the multipurpose cadastre in the states west of the original 13 colonies, where all parcels are legally tied to the Public Land Survey System (PLSS). The problems of this system include lost corners and lack of good locational information. The 1982 report recommended a new federal Surveying and Mapping Administratoin to coordinate the geodetic, cadastral, and mapping activities necessary for the modernization of the PLSS. In the interim, the report recommended the for-

mation of an interagency working group with the "participation of all relevant federal agencies and interested groups at the state, local, and private sector levels to integrate the geodetic, cadastral, and mapping activities necessary for the modernization of the Public Land Survey System (NRC 2003, p. 99). This working group was to be interim, pending the formation of a Federal Surveying and Mapping Administration.

1983: Procedures and Standards for a Multipurpose Cadastre

The third study, *Procedures and Standards for a Multipurpose Cadastre*, written in 1983 by a panel operating under the Committee in Geodesy, Commission on Physical Sciences, Mathematics and Resources. This study was intended to build on the 1980 report by addressing questions of how the public sector, especially local government, could carry out those earlier recommendations. The report laid out the technical specifications for the components of a multipurpose cadastre. The guidelines included the use of State Plane Coordinate Systems and a dense set of survey monuments that should be distributed across the county at intervals no greater than 0.2 to 0.5 miles in urban areas and 1 to 2 miles in rural areas.

The 1983 study advocated that accuracy standards be expressed in terms of boundary tolerances (maximum probable error in feet or meters), rather than the traditional boundary survey miscalculation ratio (e.g., 1/5000). Although the requirements were not clearly established, the study highlights the Maritime Provinces of Canada where the following tolerances were recommended: $\pm$0.1 ft in urban areas, $\pm$0.3 ft in suburban areas, and $\pm$1 to $\pm$2 ft in rural areas. In addition, the report provided an excellent review of the various surveying and photogrammetric procedures that could be used to compile a map, and a glimpse of future technology such as GPS, but surprisingly, it did not mention COGO as an option for building land parcel databases.

The 1983 panel continued to view the multipurpose cadastre as a key component of how government should fulfill its mission. They listed twenty-five functional areas of government that could benefit from a complete inventory of all currently existing parcels and their legal identifiers. Property tax assessment, deed recordation, and planning were developed in the most detail. The report called for new county land offices and assigned them "the responsibility for managing the development of the systems of maps and files that will comprise the multipurpose cadastre for that locality and for compiling the common set of standards for definitions of data elements, file formats, accuracy, frequency of updating, and completeness of the records (NRC 1983, p.108). It emphasized the need for the standards to be developed in cooperation with other jurisdictions.

The panel also addressed the funding issue by calling for a program of federal grants to counties (or their equivalents) to cover about 40 percent of the cost for the multipurpose cadastre. They estimated that the cost of a matching federal program would be $90 million per year over a 20-year period for a total federal contribution of $1.8 billion. In 2003 dollars, this is $165 million/year for a total of $3.3 billion. The combined federal and local investment would be $8.2 billion. This estimate is in line with the recent estimates by others[2] of $7-8 billion dollars to create a nationwide multipurpose cadastre. As will be seen later in this and other articles in this journal, much of that local investment has already been made.

Assessment of the NRC Recommendations

The type of coordinated three-level organizational structure envisioned by the multipurpose cadastre panel in 1980 was an extremely idealized model of how government can work. It was developed with the assumption that the benefits that would accrue from a national multipurpose cadastre were so pervasive that enlightened public officials would quickly jump on the band wagon and either push down the system from the state level, or local government officials would demand that their state officials adopt the necessary legislation and funding mechanisms to implement the coordinated approach. It also assumed that the federal government would endorse the program and would be prepared to accept the coordination responsibility and write the checks. Idealized models quickly confront the realities of the organizational, financial, and technical worlds.

The multipurpose cadastre panel made a persuasive case for a nation-wide multipurpose cadastre, and there is no doubt that tremendous benefits at all levels of government would have resulted from the type of robust and coordinated effort outlined in the reports. It can be argued that as a nation we would have saved countless millions

[2] Extrapolated from Wisconsin experience by Koch, et al. 2002. Sum of state-by-state estimates by Burgess (2002).

of dollars in duplicative spatial data acquisition efforts. We would have greatly simplified and streamlined the systems for handling property records. These systems would have dramatically reduced the cost of land transfer transactions, created a logical, systematic, and objective system for property appraisal, and increased the revenues to local government in a fair and equitable manner. At the state and federal levels we would have a much better way of determining and mitigating land-use conflicts, insuring property, and responding to natural disasters. In effect, we would know the value and ownership of property across the Nation. Furthermore, we would have an integrated system for handling E911 calls and other emergency response needs. We would know who is in harm's way, and first responders would have saved thousands of lives.

Given all those benefits, we are perhaps surprised by how little progress has been made toward the recommendations outlined almost a quarter of a century ago. As noted above, the NRC panels in the early 1980s recognized that the institutional and organizational issues would be the most difficult to overcome. It must also be acknowledged that many public officials take a minimalist view of the role of government. Issues regarding property rights, issues of eminent domain, land-use zoning, and even the taxation of property are fiercely debated. In the absence of any overarching policy at the federal or state level, the development of local multipurpose cadastres varies enormously across the United States. The fundamental building block is the property parcel, and oversight of land ownership and taxation typically rests with the county government.

The representation of the boundaries of the individual parcels has presented major legal and spatial problems. In many early systems, the tax maps were digitized and roughly geo-referenced to create a GIS file of parcels that could be joined to property assessment and zoning data. While these systems provided good general planning tools, they were generally considered sketches or "cartoon" representations of the legal parcel. Many communities have begun the next step of converting the legal description of property found on deeds into spatial data. The conversion of the legal description of property records into a coordinate environment with software tools such as COGO could profoundly change the way property records are recorded and handled by legal and financial institutions.

The range of approaches for handling these responsibilities is extraordinary. A large proportion of the 3,232 counties in the country have land records systems that are no different today than they were in 1980, or even 1960. A computer may generate the tax bills, but the supporting spatial information consists of a series of paper or mylar maps and analog aerial photographs. In many states there is only minimal oversight that requires new aerial photography on a regular basis to support the property appraisal process. At the other extreme, an increasing number of counties have accepted that the creation and maintenance of a digital multipurpose cadastre is the only way to do business in an information society. They not only track property transactions on a continuous basis but also willingly share these data with the public over the Internet. These counties have demonstrated that the multipurpose cadastre is not only a cost-effective way to monitor property transactions and land use, but also the proper way for government to function in a modern information-based environment. Administrators and elected officials recognize that taxpayers deserve access to public information and accountability from public officials.

Federal, State and Local Roles

Those who believe that it is the proper role of government to grant rights and privileges to individuals who own property would argue that a nation-wide multipurpose cadastre is a justified, affordable, and necessary way to run a country. This model has been widely accepted in Scandinavian countries where a benevolent role for government is embraced and accepted. The 1980 Multipurpose Cadastre Report called for a similar level of federal involvement in the United States. Clearly this has not occurred. In fact, most of the leadership has come from state and local governments. Local governments, after all, are responsible for maintaining records on land ownership and value; many of them have switched to automated methods to support this work.

Nevertheless, local governments rely on state coordination and oversight. Some states have taken a very active role in supporting the coordination of county-level cadastre efforts while others have not (GeoAnalytics 2003). David Stage's article in this journal describes the current situation of parcel automation in the fifty states The general problems states face include incompatibility across counties that are developing digital cadastres and inequity in the mix of counties that can and cannot afford to participate.

Many state governments recognize parcel mapping as a critical part of their spatial data

infrastructure (http://www.fgdc.gov/I-Team/). In fact, The Western Governors' Association is in favor of federal support of Public Land Survey and cadastral databases (WGA 2003). The National States Geographic Information Council (NSGIC) and the New York City GIS Utility have developed a white paper calling for federal support for states and local government to develop cadastral and other information that could support homeland security and public safety activities; over three-dozen states have added their signatures to that document (NSGIC 2002).

A few states are either supporting local cadastral development or creating parcel maps themselves (GeoAnalytics 2003). For example, Oregon and Tennessee have programs that provide matching funds to counties looking to modernize their land records. Kansas had such a program, but lost it due to budget cuts. The state of Montana has assumed responsibility for parcel mapping for all but a few of its larger counties.

While an increasing number of state governments may understand the importance of coordinating county-level multipurpose cadastre activities, Wisconsin probably comes closest to fulfilling the state role outlined in the 1980 report. The Wisconsin Land Information Program started in 1989, following several years of careful study and debate (Koch et al. 2002). Based on a small increase in fees for recording documents, about $7 million dollars have been raised each year and distributed to counties that are modernizing their land records; those funds are usually matched 1:1 with local investment.

All seventy-two counties participate, and each county has a land information officer to coordinate local activities. Foundational data elements of the system include: geodetic reference frameworks, parcels, zoning, soils, wetlands, administrative boundaries, street centerlines and addresses, land use, natural resources, and infrastructure and facilities management. Some 78 percent of the state's tax parcels have been automated. Significant benefits have been documented including reduced costs for land transfer and improved land-use planning. It must be noted, however, that despite the dedicated effort by enlightened public officials and solid academic research, the Wisconsin system still lacks consistent standards across the seventy-two counties. Therefore, even there it would be difficult to weave county parcel maps into a seamless, statewide, multipurpose cadastre (GeoAnalytics 2003).

What Would Rip Van Winkle Find in 2003?

The members of the 1980 panel were visionaries with an extraordinary view of how technology would assist in the modernization of parcel-level data. There are many operational systems that have followed many of the standards for data content and accuracy that they had recommended. In fact, in can be argued that the basic representation of spatial features and the functionality of today's multipurpose cadastre is an implementation of their model with modern hardware, software, and networks.

While it would have been difficult for the panelists to envision all the specific technological advancements of the last 23 years, they certainly recognized that 1980 was only the start of an era of unprecedented technological advancements that would affect the mapping professions. Organizationally, the panel had envisioned an extremely active and authoritative role for the federal government. In 2003, we cannot find a web site for the "U.S .Federal Multipurpose Cadastre." Nevertheless, it is not fair to suggest that over the past quarter of a century the federal government has just been a spectator in the development of the multipurpose cadastre. While some visionaries would give the federal government a failing grade for its role in fostering the creation of a nationwide cadastre, it is more constructive to examine where we are as a country and to assess what can happen in the future.

One way to assess the role the federal government has played in the coordination of a nationwide multipurpose cadastre would be to speculate about what a member of the 1980 panel would find if he awoke like Rip Van Winkle from a twenty-three-year sleep. He certainly would be surprised to find that from a $1,000 computer in a home office he could access something called the World Wide Web and use a search engine to investigate the status of his panel's recommendations. His web search for "Federal Cadastre" would retrieve about 43,000 potential sites with content linked to the topic. Many of these sites would be in Europe, and several would be commercial sites offering services and software. However, he would eventually find the site for the Federal Geographic Data Committee (FGDC) (www.fgdc.gov). This site offers an excellent history of the evolution of the coordination of spatial data over the past two decades. He would quickly learn that the FGDC was established in 1990 by the Office of Management and Budget's circular A-16. He would be very excited

to learn that President Clinton signed Executive Order 12906 in 1994 that endorsed the concept of the National Spatial Data Infrastructure (NSDI) and directed the FGDC to establish a geospatial data clearinghouse, implement consistent standards for data format and content, and work on the implementation of national geospatial data framework by 2000. And he would be gratified to see that President George W. Bush supported this concept by signing Executive Order 13286 in 2003, which extended this initiative with minor amendments. Rip's committee was a strong advocate of data repositories and standards.

Our cadastral Rip Van Winkle would also see that "cadastre" is considered one of the seven framework layers (along with elevation bathymetry, hypsography, geodetic control, transportation, governmental units, and orthoimagery). Furthermore, he would find that there is a cadastral subcommittee comprised of 39 representatives from federal, state, and local pubic agencies, professional groups, as well as the private sector. He would open a 114-page document entitled "The Cadastral Data Content Standard for the National Spatial Data Infrastructure" and probably be shocked by the extent and detail of the document. On the second or third reading he would likely think that his group in 1980 had grossly underestimated how difficult standards setting issues would be.

Rip would be pleasantly surprised by other cadastral products from federal agencies. His panel had singled out the Bureau of Land Management; therefore he would be pleased to see BLM's efforts in building the GCDB (Geographic Coordinate Data Base) (http://www.blm.gov/gcdb/). This system has provided western states with a solid coordinate base of Public Land Survey System information. On the technical side he would see that the BLM and the U.S. Forest Service have created the National Integrated Land System (NILS) (see article by Leslie Cone in this issue) which provides local governments with the tools they need to manage land records. His search would also discover that the Federal Geodetic Control Committee has developed a 25-chapter *Guidebook* to help those interested in learning about and developing a multipurpose land information system (www.ngs.noaa.gov/FGCS/).

Rip would enjoy probing around the FGDC site to learn more about stakeholders, partnerships, funding opportunities, and something called "I-teams." [3] He would see a horde of programs and players that have proclaimed an interest in furthering the NSDI. These range from formal professional organizations that represent the interests of cities, counties, and states to official standards-setting organizations to loosely structured groups of interested citizens. His investigation of the I-Teams site would confuse him a bit. How come every state does not have one of these? Ultimately he would be dazzled by the ability to probe different paths to actually generate color maps on his computer monitor. Even though, in 1980 he was optimistic about the GIS software tools that would be needed to support the multipurpose cadastre there is no doubt that he would be surprised by the high-resolution graphics and user-friendly graphics interface to these interactive mapping functions from a home computer. He is sure to be intrigued by something called "Geospatial One Stop" (http://www.fgdc.gov/geo-one-stop/) and its link to "*The National Map*." The ability to use this site to retrieve extraordinarily high-resolution orthophotography and overlay a wide range of vector GIS data in a seamless fashion as he pans across the country is sure to amaze him.

On balance, our well rested panelist would probably conclude that he found a mixed bag. Clearly, the federal government has not been the catalyst for wholesale adoption of a nationwide multipurpose cadastre. It has not provided the administrative or legislative mandates to create such a system. However, he must be encouraged with the efforts to create the infrastructure for such a system, and he can be optimistic about the future.

The National Research Council's Mapping Science Committee

We believe that much of what has happened over the past twenty-three years has impacted the feasibility, affordability, and desirability for creating a nationwide multipurpose cadastre. The NRC's Mapping Science Committee, formed in 1989 to provide "independent advice to society and to government at all levels on scientific, technical, and policy matters related to spatial information," has tracked many of these changes in a series of twelve reports. The Committee whose members serve finite terms of three to six years is probably the only standing advisory group for federal mapping activities in the World (Cowen 2003). Following the tone set by the Multipurpose Cadastre Panel, the Committee has embraced the notion that a successful set of mapping resources in the United States

[3] An I-Team facilitates an integrated community approach towards producing, stewarding and exchanging geographic information.

must involve appropriate roles for each sector of government as well as a robust private sector. The role for each of these sectors was articulated in the 1993 report "Toward a Coordinated Spatial Data Infrastructure for the Nation," which also defined the National Spatial Data Infrastructure (NRC 1993).

The Committee has heeded the advice of the cadastre panel that the institutional barriers are much more complex than the technical ones. Therefore, a central theme has been the analysis of institutional issues that impact the creation of spatial data in the United States. For example, the Committee's 1995 report "A Data Foundation for the National Spatial Data Infrastructure" highlighted the need for the federal government to coordinate the integration of spatial data. The report recommended that the newly created Federal Geographic Data Committee "should be responsible for coordinating the development and certification of a foundation and for its maintenance and availability" (NRC 1980, p. 2). It also spelled out the importance of framework data (geodetic control, orthorectified imagery and terrain) that would support the creation of other framework data, including the cadastre. In fact the report suggested that there should be a single nationwide formatting system for cadastral data (NRC 1995, p. 38).

It should be noted that the FGDC Cadastral Working Group is an excellent example of how the federal government can foster the cooperation of several levels of government to address the institutional issues that inhibit the implementation of a successful NSDI. This group has actually developed a fully documented national standard (see article by von Meyer in this issue).

The NRC Committee has also been a strong advocate for partnership activities among different levels of government. In addition to its 1994 report on "Promoting the National Spatial Data Infrastructure Through Partnerships**,"** the Committee developed a 2001 report "National Spatial Data Infrastructure Partnership Programs: Rethinking the Focus" that examined the FGDC partnership programs. That report reminded the community of the early work of the Panel on a Multipurpose Cadastre. In addition to highlighting the recommendations of the earlier reports, the 2001 report emphasized that improved decision-making will require a move to much-higher-resolution spatial data than the standard 1:24,000 topographic series. In order to assist decision-making, the Committee advocated the concept of an "Extended Framework" in which local and state spatial data infrastructures complement the NSDI. This extended framework identifies that local governments must take the primary responsibility for building and maintaining cadastral data, however there are important supplementary roles for state and local government. In effect, the report called for the same type of partnerships outlined in the original Multipurpose Cadastre Study.

The NRC Committee examined fundamental research on policies affecting the development and the use of spatial data throughout society. Many of its studies have monitored the transformation of the federal mapping enterprise into a digital environment. Most recently, this included an evaluation of the U.S. Geological Survey's vision and implementation plans for *The National Map* (NRC 2003). That report focuses on the technical and institutional issues relating to the implementation of the vision for a nationwide spatial data resource that will require a close partnership with local governments and could become the home for a multipurpose cadastre. Echoing many of the concerns of the Cadastre Panel of 1980, the report encourages the U.S. Geological Survey to change the culture and policies relating to how spatial data are funded and shared in the United States. The report outlines a vision in which the federal government is responsible for creating and maintaining a uniform set of spatial data "blankets." It would also provide the technical and institutional support to concurrently support a patchwork quilt of tiles of local and state government data. It should be noted that several counties have already started the process and contributed their parcel-level "quilt squares" to the USGS for inclusion in the on-line version of *The National Map*. It could be argued that this voluntary program constitutes the beginning of a truly national multipurpose cadastre.

The NRC Committee is currently conducting an important study that examines the impact of spatial data licensing agreements on the creation and sharing of spatial data. This study promises to have particular relevance to the cadastre community that often outsources much of its work to the private sector. It should be noted that the multipurpose cadastre reports recommended that spatial data development would be funded through a series of coordinated activities with liberal subsidies from both the federal and state governments to support local efforts. Furthermore, the panelists assumed that spatial data would move freely within the public domain. It is clear that there are several legal and financial barriers that can impede that type of free flow of data.

Collectively, the reports of the Mapping Science Committee provide a glimpse into the evolution of the federal activities in the geospatial arena. They also have provided a forum for reminding the broader community about the importance of cadastral data and laid out specific recommendations concerning how a nationwide multipurpose cadastre should be developed.

The Current Federal Milieu

There are several current federal initiatives that could benefit greatly from a coordinated approach to collecting and maintaining information about the location and representation of property (or, the cadastre). Of particular note are the needs of the Department of Homeland Security and the Bureau of the Census. The 2001NRC report, which recommended the creation of a high-resolution extended spatial data framework, appears coincidentally to have outlined the roadmap that would take the Nation from the events of September 11, 2001, to the subsequent creation of the Department of Homeland Security (DHS). High-resolution spatial data are exactly what is required for the new billion-dollar Flood Map Modernization project that is underway at the Federal Emergency Management Agency (FEMA) which is now part of DHS. As outlined by Lowe (Lowe 2003, p. 1134), land ownership is one of eight layers of spatial data required to produce a digital flood map. The overlay of the FEMA Flood Insurance Rate Maps (FIRMs) with detailed parcel-level data including ownership and value provides the basic foundation for a spatial decision-support system that assesses risk and aids managers in responding to disasters.

A closely related federal initiative is focused on creating spatial data bases of critical infrastructure. According to Kelmelis and Loomer (2003, p. 127), critical infrastructure is the infrastructure "necessary for maintaining a society or conducting a war." The contents of this critical infrastructure were originally defined by President Clinton's Commission on Critical Infrastructure Protection in 1997. Since 9/11 these have been defined as the Minimum Essential Data Sets (MEDS). The seventeen elements of MEDS include economic activities and utilities. Kelmelis and Loomer (2003, p.135) maintain that: "A robust spatial data infrastructure (SDI) is needed to provide information about the critical infrastructure." In order to meet this need, the National Imagery and Mapping Agency and the USGS jointly initiated the 133 Urban Area Project which aims to "identify the highest priority location to collect high resolution, accurate and extensively attributed base data" (Kelmelis and Loomer 2003, p. 135). It is interesting to note that the original multipurpose cadastre panel expressly noted the linkage between a cadastre and the needs of the utility industry (NRC 1980, p. 74).

Following the same security theme, the FGDC has stated that improved homeland security will require "Nationwide geospatial data compatibility for E911 operations" (FGDC 2003). These 911 systems are highly visible and provide the basic infrastructure for first responders to locate addresses where their services are needed. The backbone of every local 911 system is an accurate set of addresses and street centerlines, in other words, an accurate, complete, and current 911system requires a multipurpose cadastre. This critical life-saving application cries out for a national multipurpose cadastre based on a truly integrated series of local, state, and national spatial data infrastructures in which changes in addresses are captured through property record transactions.

In 1990 the Census Bureau's implementation of the TIGER system demonstrated that it is feasible to create and maintain a seamless nationwide database of transportation and hydrological features. TIGER also provided a set of street centerlines and address ranges that supports nationwide address matching capabilities. It can be argued that the public-domain TIGER data provided the impetus for the development of a robust private-sector GIS market.

Over the past decade the Bureau also recognized the need to improve the positional accuracy of street and other features. In fact, the Bureau specified that they needed to represent streets with a positional accuracy of at least 7.6 meters (25') (Broome and Godwin 2003). This accuracy would enable them to use GPS technology to create a point-level representation of every residential dwelling. In other words the Bureau of the Census is creating a point level multipurpose cadastre. There is no doubt that this resource could form the basis for the locating of critical infrastructure and for improving 911 systems. However, there are legal and personal privacy barriers that will prohibit this nationwide cadastre from being used for anything other than Census operations. It should also be noted that the Census Bureau will spend $200,000,000 to survey all 3,232 counties and begin to create this resource (Broome and Godwin 2003).

The street centerline framework for this point-level cadastre will become the road component

of *The National Map*. The sequence is simple. The Department of Homeland Security needs *The National Map* which needs the Census street centerlines and the Census needs the local government multipurpose cadastre. The important question in 2003 is how are we as a Nation addressing these interrelated needs? The simple answer is not very well. For those counties with a fully operational multipurpose cadastre, the Census Bureau's needs are trivial, and many of them have already shipped their data to the Bureau. Unfortunately, for a vast part of the Nation there is no good source for street centerlines that will meet the needs of the Census, and they will have to be created.

The good news is that these federal data collection efforts will significantly improve spatial data resources in hundreds of counties. The bad news is that institutional barriers relating to licensing arrangements in many of the most advanced and wealthy counties will prohibit the local governments from sharing their data with the Census Bureau. As a result, taxpayers are going to pay for the Bureau to create street centerlines that duplicate, and are of inferior quality, to data that already exists!

Conclusions

It is in our national interest to coordinate data collection efforts. This theme has been repeated in almost every one of the Mapping Science Committee's reports and was articulated in a 2001 report that stated:

> A fundamental goal and driving force behind an extended Framework is that data will be collected once and maintained regularly. In other words, if a data layer is part of the NSDI, and also a component of a State Spatial Data Infrastructure (SSDI) and a Local Spatial Data Infrastructure (LSDI), the data for these layers need to be collected at the lowest level and generalized to the other levels. This ensures logical consistency among the parts of the extended NSDI (NRC 2001, pp. 61-63).

The bottom line is that many of the principles laid out in the early 1980s could be used to address many immediate needs in this decade.

The 1980 report, and its complimentary reports, led to little change. Wisconsin and a few other states followed the recommendations. Response at the federal level has been minimal. Certainly no grant program has developed; there seem to have been other priorities; obviously the report did not present a convincing argument that a nationwide cadastre is in the national interest.

However, interest in a national cadastre appears to be growing. The Western Governors' Association has investigated this issue in two forums and made recommendations for its implementation; for many the issue is how to provide equity and meet the needs of smaller rural counties. The National States Geographic Information Council sees this as critical to public safety and homeland security, with over half the states signing letters of support. No federal advocates for such a system exist; specifically there is no coordinated federal voice calling for a nationwide cadastre. Individual departments may see a need, but the current checkerboard of available parcel data is too sparse and too unstructured to provide value to any agency with nationwide needs. The potential benefits of a nationwide multipurpose cadastre have not been articulated in a convincing way.

In locales across the country we have experiments underway that could inform discussions about how to define and support land information systems that serve many purposes. They provide documentation of what is possible. These elements need to be pulled together so as to refocus the vision of a nationwide multipurpose cadastre and to develop a strategy for achieving it.

REFERENCES

Broome, F.R., and L.S. Godwin. 2003. Partnering for the people: Improving the U.S. Census Bureau's MAF/TIGER Database. *Photogrammetric Engineering and Remote Sensing* 69(10): 1119-26.

Burgess, B. 2002. Funding allocation for state data production. Paper and spreadsheet distributed for discussion at the annual meeting of NSGIC (National States Geographic Information Council). [http://www.nsgic.org/hot_topics/security/spreadsheet_memo.doc; http://www.nsgic.org/ hot_topics/ security/ US_Mapping_Costs_STIA_Excel.xls].

Cowen, D.J. 2003. The role of the Mapping Science Committee in assisting the mapping of the United States. *Cambridge Conference Proceedings*, 8.4. Ordnance Survey, Southampton, U.K.

FGDC (Federal Geographic Data Committee). 2003. Homeland security and geographic information systems: How GIS and mapping technology can save lives and protect property in post-September 11th America. FGDC. [http://www.fgdc.gov/publications/homeland.html referenced November 17, 2003].

GeoAnlytics. 2003. Institutional models: Land records modernization state profiles. A report prepared for the Nebraska GIS Steering Committee. [http://www.calmit.unl.edu/gis/LRM_Index-Page.htm].

Kelmelis, J.A., and S.A. Loomer. 2003. Critical infrastructure. In Cutter, S., D. Richardson, and T.

Wilbanks (eds), *The geographical dimensions of terrorism*. New York, New York: Routledge. pp.127-37.

Koch, T., T. Krauskopf, A. Miller, D.D. Moyer, B. Niemann, and S. Ventura. 2002. State of land record modernization in Wisconsin: Then (circa 1960-70s) and now (2002). URISA conference handout. 13p.

Lowe, A.S. 2003. The Federal Emergency Management Agency's Multi-Hazards Flood Map Modernization and *The National Map*. *Photogrammetric Engineering and Remote Sensing* 69(10): 1133-6.

NRC (National Research Council). 1980. *The need for a multipurpose cadastre*. Washington, D.C.: National Academy Press.

NRC (National Research Council). 1982. *Modernization of the Public Land Survey System*. Washington, D.C.: National Academy Press.

NRC (National Research Council). 1983. *Procedures and standards for a multipurpose cadastre*. Washington, D.C.: National Academy Press.

NRC (National Research Council). 1993. *Toward a coordinated spatial data infrastructure for the Nation*. Washington, D.C.: National Academy Press. [http://books.nap.edu/openbook/0309048990/html/index.html].

NRC (National Research Council). 1994. *Promoting the National Spatial Data Infrastructure through partnerships*. Washington, D.C.: National Academy Press. [http://www.nap.edu/books/030905141X/html/].

NRC (National Research Council). 1995. *A data foundation for the National Spatial Data Infrastructure*. Washington, D.C.: National Academy Press. [http://www.nap.edu/books/NX005078/html/index.html].

NRC (National Research Council). 2001. *National Spatial Data Infrastructure partnership programs: Rethinking the focus*. Washington, D.C.: National Academy Press. [http://books.nap.edu/openbook/0309076455/html/index.html].

NRC (National Research Council). 2003. *Weaving a national map*. Washington, D.C.: National Academy Press. [http://www.nap.edu/books/0309087473/html/.

NSGIC (National States Geographic Information Council). 2002. Saving lives and saving money: An urgent call to build the National Spatial Data Infrastructure in support of public safety. NSGIC. [http://www.nsgic.org/hot_topics/security/NSDI_public_safety.pdf].

WGA (Western Governors' Association). 2003. Public Lands Survey System and Ownership Database, WGA Policy Resolution 03-05. [http://www.westgov.org/wga/policy/03/plss3-5.pdf].