A PROSPECTIVE CASE FOR A NATIONAL LAND DATA SYSTEM: TEN YEARS LATER

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ABSTRACT

Geographic information systems are emerging as powerful tools for the handling of spatial data. In the past, a geographic information system was often designed to meet the needs of a specific problem, and the data capture, management, and analysis functions were often restricted to the unique characteristic of specific data sets. More recently, systems have been designed for generic data types and functions to provide much greater flexibility and a wider range of applications.

The emergence of these systems, along with a new national data base being developed jointly by the Bureau of the Census and U.S. Geological Survey offer the opportunity to establish a solid foundation for a National Land Data System.

OVERVIEW

"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." (National Research Council, 1980).

The need for a national file of land information is obvious. In fact, some describe the lack of such a data base as a glaring gap in our knowledge of the United States; probably resulting from the pioneer-inspired notion of an endless frontier and enough land for everyone. Several European countries, Canada, and Australia are much further along in developing a national data base of land parcels--but they also are far more involved in the development of administrative records systems. This paper presents an idea that might be viewed as the "ultimate" solution to a national land records system. Development of such a system would probably need to be handled in phases over many years or decades. It also recognizes "The Big Risk" involved in developing a national system. Specifically, there is a

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serious question to be answered about the "big brother" aspects of a national system that allows easy access to records on land use and property holdings.

The idea of a national land data system is not new. The Greeks and Romans established elaborate land-record systems primarily in support of land taxation policies (Richeson, 1966). Approximately 10 years ago, the U.S. Geological Survey (USGS) and the National Aeronautics and Space Administration developed a report on the state of then current technology entitled "Toward a National Land Use Information System." (Ackerman and Alexander, 1975). They concluded, "In spite of striking progress made in the improvement of both the hardware and software needed for functioning geographic information systems ..., the ideal system for national use is not yet in sight."

Much has happened in the 10 years since that report was presented. While the ideal system still does not exist, it is in sight. The Governments Division of the U.S. Bureau of the Census conducts the Survey of Taxable Property Values every 5 years. While this is a limited data set, the Census Bureau has gained a considerable amount of expertise and data concerning the Nation's land inventory. The USGS is using high technology to produce digital data which serves as the basic foundation for many modern GIS activities. USGS also produces a series of maps compiled from remote sensing to portray general categories of land use at a scale of 1:250,000. Many State, county, and municipal governments are developing automated land records systems. Most recently, the Topologically Integrated Geographic Encoding and Referencing (TIGER) System being developed by the Geography Division at the U.S. Bureau of the Census uses the computer-readable 1:100,000-scale map base from the U.S. Geological Survey, to provide the potential mechanism for linking data sets at the Federal, State, and local levels. Finally, the Geological Survey is exploring the potential for linking Census Bureau data files, USGS cartographic, geographic, resource, minerals, water, and natural hazard files, as well as available geographically based files of other Federal, State, and local agencies to create a national land data system. This paper explores the potential for accomplishing this objective and the potential benefits.

INTRODUCTION

A modern nation, as a modern business, must have adequate information on the many complex, interrelated aspects of its activities in order to make decisions. Land use is only one such aspect, but knowledge about land use and land cover has become increasingly important as the Nation plans to achieve minerals independence and overcome the problems of haphazard, uncontrolled development, inequitable property tax assessment, deteriorating environmental quality, loss of prime agricultural lands, destruction of important wetlands, and loss of fish and wildlife habitat. Land use data are needed in the analysis of environmental processes and problems if living conditions and standards are to be improved or maintained at current levels.

One prerequisite for better use of land is information on existing land use patterns and changes in land use through time. The U.S. Department of Agriculture reported that during the decade of the 1960's, 730,000 acres (296,000 hectares) were urbanized each year, transportation land uses expanded by 130,000 acres (53,000 hectares) per year, and recreational area increased by about 1 million acres (409,000 hectares) per year. Knowledge of the present distribution and area of such agricultural, recreational, and urban lands, as well as information on their changing proportions, is needed by legislators, planners, and governmental officials at all levels to determine better land use policy, to protect transportation and utility demand, to identify future development pressure points, and to implement effective plans for regional development. As Clawson and Stewart (1965) stated: "In this dynamic situation, accurate, meaningful, current data on land use are essential. If public agencies and private organizations are to know what is happening, and are to make sound plans for their own future action, then reliable information is critical."

The variety of land use and land cover data needed is exceedingly broad. Current land use and land cover data are needed for equalization of tax assessments in many States. Land use and land cover data also are needed by Federal, State, and local agencies for water resource inventory, flood control, water supply planning, and waste water treatment. Many Federal agencies need current comprehensive inventories of existing activities on public lands combined with the existing and changing uses of adjacent private lands to improve the management of public lands. Federal agencies also need land use data to assess the environmental impact resulting from the development of energy resources, to manage wildlife resources and minimize man-wildlife ecosystem conflicts, to prepare national summaries of land use patterns for national policy formulation, and to prepare environmental impact statements and assess future impacts on environmental quality (J.R. Anderson and others, 1976).

Information on changes in land use is needed for water resource planning. As land is changed from agricultural or forestry uses to urban uses, surface water runoff increases in magnitude, flood peaks become sharper, surface-water and groundwater quality deteriorates, and water use increases, thereby reducing water availability. Statistics on the acres of agricultural, urban, and other types of land inundated by floodwaters would be invaluable in estimating damages, further crop losses, and consequent economic impacts. By monitoring and projecting land use trends, it will be possible to develop more effective plans for flood control, water supply, and waste water treatment.

THE PROPOSED LAND DATA SYSTEM

Many differing viewpoints exist about the role of land use planning and the need to regulate land use at a local, State, or Federal level. Regardless of these differences of opinion, there is a basic need to know how the Nation currently is using its land resources and what changes in

land use are occurring. Unless an objective assessment of the current land use situation is made, and unless a process for measuring change is initiated, no one will have the facts necessary to evaluate trends and problems associated with the use of land resources.

The proposed land data system will be based on the computer-readable version of the Geological Survey's 1:100,000-scale maps. This file, once enhanced by the Census Bureau with the names of all mapped features, address ranges for each side of every addressable road between intersections, and the boundaries for all the tabulation units recognized in the decennial census, will provide a machine-readable geographic framework for the entire United States at the "city block" level. This nationally consistent geographic framework, is the key ingredient that has been missing in the past. The primary task then becomes developing the linkage mechanisms between systems.

Once the TIGER File is available in 1988, existing geographically based machine-readable land data files from other Federal agencies, State agencies, local governments, and private organizations can be related to one another using standard polygon overlay techniques. For example:

- The land use and land cover information contained in the USGS files can be related to the demographic information from the Census Bureau. Researchers can begin to derive relationships between the characteristics of people and the characteristics of the existing land information (for example, use, ownership, transfer, development potential, and so forth).

- The Environmental Protection Agency can assess proposed hazardous waste sites in terms of surrounding land uses and demographic characteristics.

- The Federal Emergency Management Agency can determine the extent of damage from natural disasters, such as floods or hurricanes, with detailed knowledge of the demographic characteristics of the people affected and the uses of the affected land.

- The extent of land in Federal or State ownership and the location of mineral and energy resources can be studied to develop comprehensive management strategies.

Many State and local data files use geographic area codes in common with the Census Bureau's scheme. The agencies can link their data files on this set of keys as follows:

- State and local agencies with data files organized using Census Bureau geographic codes can display those data graphically in relation to USGS land use and land cover information and Census Bureau demographic data.

- Private organizations can study the location of their facilities in relation to the characteristics of their service population and determine the nature of the surrounding land uses.

Using more sophisticated computer programs now being developed to match and merge two different, but similar computer-readable files:

- Local officials with parcel-based land records files can fit these files into the national file and analyze the characteristics of the people occupying the land parcels comprising each block.

- The coordinates of the national file can be upgraded in this process to the high-precision characteristic of parcel-based files and thus improve the overall utility and accuracy of the national file.

TESTING THE CONCEPT

Finishing the geographic base for the proposed land data system will take several years but the computer files for some areas will be ready much sooner. The USGS files for the State of Florida were part of the pilot project to test the use of 1:100,000-scale maps for the 1990 census. These Florida files will be among the early files processed through the remaining Census Bureau operations. Coincidentally, the State of Florida has a strong interest in a computer-based land data system and has given the task of coordinating developmental activities to Florida State University (Friedley, 1984). This offers the prospect for a State and Federal cooperative test. The suggested sequence of events for such a test is as follows:

1. The USGS captures the data from the 1:100,000-scale maps and edits/converts the information to a digital line graph (DLG) format.

2. The Census Bureau assigns classification codes to the road features in the file while the USGS assigns classification codes to the water, railroad, and other features.

3. The Census Bureau collects map update and feature name information using USGS 1:24,000-scale maps as the base.

4. The Census Bureau merges the road, water, railroad, and other features in the USGS separate files into a single file and enters the map update and feature name information from the 1:24,000-scale maps.

5. The Census Bureau collects the boundary and area name information for all geographic areas to be represented in the file.

6. The Census Bureau enters the boundaries and names for counties, townships, cities, census tracts, and so forth along with the names and geographic codes for these areas.

7. The Census Bureau collects address range information for areas and streets not already covered by existing files.

8. The Census Bureau enters the address range information for new areas.

9. Florida State University develops computer programs to match/merge State and local files with the geographic base.

10. The USGS develops computer programs to match/merge other Federal files with the geographic base.

11. All three agencies work together to test matching/ merging State and Federal files with the geographic base.

POTENTIAL BENEFITS OF A NATIONAL LAND DATA SYSTEM

Despite the difficulty of implementing a national land data system, the potential benefits of such a system merit its further evaluation. This is true even if operationally such a system needs to be phased in over a period of 20 to 30 years, or even longer. The following is a partial list of potential benefits to various user groups of a multipurpose, standardized land data system.

- State Governments
  - --Provides accurate inventories of natural and manmade assets.
  - --Accurately locates State ownership or other interests in land.
  - --Provides a standardized data base for management of public land.
  - --Simplifies coordination among Federal, State, and local officials.

- Local Governments
  - --Improves accuracy of real property assessments.
  - --Provides a linkage to Federal and State maps for local planning and engineering base maps.
  - --Provides a standardized data base for neighborhood, municipal, county, or regional development plans.
  - --Avoids the cost of maintaining separate local map systems and land data files.
  - --Encourages coordination among public programs affecting land.

- Private Firms
  - --Provides accurate inventories of land parcels, available as a public record.
  - --Produces standard large-scale maps that can be used for planning, engineering, or routing studies.
  - --Speeds administration of public regulations.

- Individuals
  - --Provides faster access to records affecting individual rights, especially land titles.
  - --Clarifies the boundaries of areas restricted by zoning, wetlands regulations, pollution controls, or other use constraints.
  - --Reduces costs to public utilities by replacing present duplicative base-mapping programs.

- The Census Bureau
  --Provides a data base so the decennial census can match its address control file of residential structures and select a sample of unmatched parcel records. This sample of supposedly nonresidential parcels can be used in a coverage evaluation survey to see what percentage actually has people living in commercial, industrial, public, or "vacant" space. (Some of the sample parcels might even be found to contain houses!)
  --Provides a data base so the agriculture census can match its mailing list and select a sample of supposedly nonagricultural parcels for follow-on evaluation studies. In addition, over several census cycles, this will provide a record of the shift in land use from agricultural to nonagricultural pursuits.
  --Provides a data base so the economic censuses can match the Standard Statistical Establishment List and Business Master File to select a sample of supposedly nonbusiness properties. The Bureau can survey this sample to help measure the significance of "cottage industries" in the American economy.
  --Creates a file that the Governments Division can use as part of the periodic reporting of real property data: property uses, assessed values, parcel sizes, selling prices, property tax rates and so forth. In the short run, the birth of and support for a land data system can result in local governments moving toward a standard format for maintaining their land ownership/taxation records. This development can reduce the effort involved in collecting the assessed value and related information.
  --Produces, ultimately, a data base that all of the censuses and surveys can use as a master control file for selective mailings and coverage evaluation studies. With this data base, the Census Bureau can begin to consider seriously the potential for an administrative records census--a dream of many in the Bureau and the nightmare of others.

- The Geological Survey
  --Provides a geographic structure to integrate river basin data on stream flows, storage capacities, and water quality.
  --Creates a file that can be used to analyze mineral deposits in relation to land use, demographic characteristics, and Federal and State land holdings.
  --Provides a mechanism to organize and coordinate the land data records in Federal, State, and local agencies as part of the overall U.S. Department of the Interior stewardship of the Nation's lands.

- Other Federal Agencies
  --Produces a data base that can be used to record Federal lands records now held in numerous district offices and separate agencies.

--Provides standardized data needed in updating Federal maps and statistics; for example, at the U.S. Departments of Agriculture and Housing and Urban Development, the Federal Emergency Management Agency, and the Environmental Protection Agency.
--Provides a data base for monitoring objects of national concern; for instance, agricultural land use and foreign ownership of United States real estate.
--Provides a reliable record of the locations of Federal ownership or other interests in land.
--Provides a standardized records system for managing Federal assistance to local programs such as housing, community development, and historic preservation.

UPDATING THE SYSTEM

Knowledge about existing land use, along with the rates and trends of change, is essential if the Nation is to overcome such problems as haphazard and uncontrolled growth, declining environmental quality, loss of prime agricultural, residential, and recreational development, and strip mining of coal.

The Geological Survey is developing a methodological framework for updating its land use and land cover baseline maps and data. Required elements of this framework include that it be timely, relatively inexpensive, and appropriate for widely varying needs at national, regional, State, multicounty, county, and city levels. The same technology used to compile the baseline data, that is, remote sensing, offers a timely and efficient approach to the collection and mapping of basic land use and land cover change data with some limitations. Remote sensing techniques span a wide range of capabilities with the promise of even more sophistication in the future.

Similarly, it is important to recognize that even in areas where remotely sensed data coverage exists, these data may not provide all the land use information that may be needed by a specific user. Supplemental source materials and fieldwork may be necessary for some purposes. In fact, the present range of data characteristics, combined with intermittent coverage dictates that the update methodology be designed to make maximum use of complementary sources of data. Even though some inconsistencies exist in the use of remotely sensed data, it is by far the most effective technology available for the timely and economical mapping of land use changes.

Another major component of a land use updating framework is a geographic information system employing a broad-based computer technology. For the user who is faced with developing a set of baseline maps and data pertaining to land use and land cover, updating such maps and data periodically, and relating several sets of associated data to information about the land and its use, the use of a national land data system with the capability for entering, storing, retrieving, and manipulating data geographically on a computer is an invaluable asset.

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