Opening Address

Modern Land Data Systems—A National Objective

W. A. Radlinski, Associate Director, *U. S. Geological Survey, Reston, VA 22092*

This is the 22nd combined meeting of ASP and ACSM—a commendable record for two separate and, in a way, competing societies. It all started as an experiment in 1955 when ASP was holding its 21st Annual Meeting and ACSM its 15th. At that time, we called the convention the "ASP-ACSM Consecutive Meetings, Coexhibit and Joint Social Functions." I say "we" because I was involved in putting on the first meetings—together with Walter Dix, John Cain and others. Ray Smart, this year's Convention Director, handled hotel arrangements and exhibits way back then. Felix Wormser, Assistant Secretary of the Interior for Minerals, gave the keynote address. The experiment was a great success—so much so that the format of the first meetings is still followed today.

Having been involved in past years with our Conventions, I know how difficult it is to come up with a theme covering our diverse interests. The organizers this year, however, have done a remarkable job because the theme "Modern Land Data Systems—A National Objective" is most appropriate and very timely.

It is appropriate because almost all of the members of ASP and ACSM are concerned with land data, and many are engaged in the development, improvement, and operation of land data systems—or the development of supporting instrumentation and software.

The theme is timely because we must act now to bring order out of potential chaos. User clientele are clamoring for our kinds of data and expertise and yet very little has been done to establish compatible standards for the vast amounts of data that are being collected. And there are practically no mechanisms for coordination among organizations responsible for developing data systems. In many cases, coordination does not even exist within individual organizations. Modern Land Data Systems are thus a National Objective because no single organization can effectively function alone in this arena. The effort demanded is national scope in both conduct and participation.

Modern Land Data Systems are also a National Objective in the sense of a national need. Our country has reached a point where practically each new use of the land requires giving up or modifying some other use or uses. It is a trade-off situation which requires meaningful data of various types that lend themselves to rigorous analyses for critical decisionmaking. Do we use a given tract of land for agriculture to raise food for the people; or to feed the cattle which in turn are used to feed the people; or do we strip it for coal that may lie beneath the surface; or do we preserve it for recreation? Are the separate uses mutually exclusive or can we accommodate some or all of them by carefuly planning? What about the availability of water for agriculture or for coal mining—where is it, how much is there, what are the possible transportation routes? What are the boundaries of this tract of land? Who owns the surface and the mineral rights? What about its topographical shape?

These are typical questions that cannot be answered without meaningful data on the land. Are we prepared to provide it as output of a Modern Land Data System? Before answering this question, let's talk about what we mean by a "Modern Land Data System."

A Modern Land Data System consists of an explicit and comprehensive set of procedures for data handling and decision, with supporting hardware, designed to achieve some specific function. Some are *complex* in the sense that they have multiple objectives. Other are *integrated* systems which share data between them. As land data affects so many activities, a Modern Land Data System would tend to be both complex and integrated. Some may employ digital or analog technology—such as is used in computers, X-Y encoders, CRT displays, and plotters. Other are based on traditional map graphics.

Some are short-lived, ad hoc systems built to serve a single application, for example, data for a water-pollution enforcement action. Others are the continuing responsibility of a Government agency—census data is a good example. Still others are integrated and share data with one or more related systems, such as an energy data base which would contain data on various energy forms from worldwide sources. They serve widely differing objectives including:

- the recording and conveyance of property;
- tax assessment;
- regulatory enforcement in critical areas such as wetlands, the coastal zone, scenic rivers, and surface mined areas;
- site specific planning such as shopping centers, highway accesses, and urban neighborhoods;
- regional planning for the reduction of natural hazards, wildlife management, recreation, transportation, and economic development; and
- national policy planning involving strategies for the development of energy, food and fiber, minerals, and other resources.

Despite the variety of objectives of land data systems, common geographic bases are used and the same sets of Earth science, ecologic, economic, demographic, and sociopolitical data are utilized again and again. But not all data types are used by all systems and there are different requirements for scale, density, accuracy, and format. Some data systems retain spatial relationships while others aggregate the data into statistical forms.

Another point to recognize about land data systems is that they cannot be static. They have to react to external pressures. One such pressure is the increasing complexity of the problems that land related systems are being called on to help solve. Other external pressures are the increasingly greater cost of data collection and the cost of technology development. The combination of these are moving many of the existing systems toward network-like cooperation with related systems and to increased data exchange.

There are, however, practical limits to data exchange. High resolution data can be aggregated for use in a coarser, more generalized system but the reverse is impossible. For example, data compiled at the National Atlas scale of 1:7,500,000 cannot be disaggregated for use in a 1:24,000 land use planning application.

Another limitation is the cost of high resolution data, which can be so great that only coverage for the most critical areas is practicable. This leaves gaps and makes the data of limited value in applications where total coverage is needed. There are more subtle, but pervasive, technical problems involving data accuracies and logical structures which also inhibit access, retrieval, and data exchange.

Nevertheless, despite these limitations and problems, a substantial amount of data exchange is possible and land data systems are evolving toward cooperative network-like operations.

The developing networks allow both local expertise and local institutional skills to be exploited, and data storage and processing costs to be sized to specific objectives or programs. Modern Land Data Systems are thus characterized by networking, communication, and exchange between specialized systems serving different objectives and different user clientele. They will vary in their degree of automation (plastic overlays, for example, are better suited for some applications than digital computers) and many of these systems will be multidisciplinary to be more responsive to the wide range of needs for problem solving.

Please note that in talking about modern land data I use the plural "systems." A single, all inclusive, system is not advocated. The physical storage of data, alone, makes this concept an impossibility. Instead, existing systems through modernization and enhanced data interchange would, in effect, be nodes within a network, and collectively they can become a national land data system.

We recently completed a two-year study of spatial data systems in the U.S. Geological Survey in cooperation with the International Geographical Union's Commission on Geographical Data Sensing and Processing. I would like now to tell you about this study because I expect the findings reflect trends and problems that are common in other organizations.

The IGU team identified 54 land- or resource-related data bases or systems within the Survey. These represent about 500,000 megabits of current data storage which is estimated to triple by 1980, when the largest digital cartographic systems will begin to come in line. The USGS is changing from an organization that formerly stored all of its data in graphic or tabular form to one that collects, transmits, and processes massive amounts of digital data. The study showed, however, that much of this change has been occurring with insufficient coordination among key elements.

About 77,000 megabits, or 15 percent, of the data can be on-line at one time on our central computer systems. There is a substantial trend toward direct user access, which may require more on-line capability.

The primary use of USGS land-related data is in support of research projects and of specialized user communities, such as water managers and land-use planners, but secondary uses such as for environmental impact analyses and regional energy planning are increasing rapidly. This has created a requirement for multifile data management systems, access via remote terminals, and linkages to systems maintained by other organizations. Some of the specific findings of the study include the following:

- Even seemingly simple tasks need development—tasks such as estimating the digital equivalent of the data stored in a collection of maps or quantitatively measuring the accuracy of digitizing methods.
- Logical storage schema need to be devised for handling very large files—terra bit (10^{12}).
- More economical methods of digitizing and editing large amounts of graphic data are desperately needed.
- The ability to operate, within the same system, on point, line, area, network, and image data is needed.
- The inherent topological structures of mapped data and their significance need to be better understood.
- The development of rigorous methods of analyzing and interpreting data lag far behind the simpler capability of storing and retrieving digital graphic data.

But perhaps the most important finding of the IGU effort was the great need for agreement among data collectors and users on data formats, attribute codes, storage schema, resolution, scale, and accuracy of digital land related data. This is fundamental to multidisciplinary analysis, data systems integration, networking, and data exchange.

Slow evolution will produce these changes, but the process might be speeded up if some organization or group of organizations took upon itself the responsibility for analyzing requirements and preparing a strategic plan or guide to cooperative systems development. The areas in which cooperative development might take place include:

(1) *Standards*. Arguments between data collectors and data users over the best scales, resolution, and accuracy for data collection continue unabated, partly because there are few, if any, institutional mechanisms for arbitration. A critical analysis of data requirements may reveal that agreement on a few standard scales could satisfy most users, and a consensus on scale would facilitate data interchange.

(2) *Data Glut*. There are undoubtedly more potential data than can be economically collected, stored, or processed. Strategies for coping with this problem and for setting priorities could benefit both compilers and users.

(3) *Theoretical Research*. There are areas in information processing where basic research needs to be done. A strategy for clearly identifying and publicizing these could result in more resources being applied to key problems.

(4) *Cooperative Hardware Development*. In the past, government, primarily Department of Defense, requirements supported hardware development. Technology development useful for cartographic applications was taken for granted and somewhat neglected. This can no longer be the case. The civilian cartographic community will have to invest more of its own development dollars. Cooperative development could ease the burden on individual agencies.

(5) *Technology Forecasting*. Many land data systems that are being designed now will achieve full operational status in the 1980's. It is imperative that we know as much as possible about changes likely to be introduced by the data processing and communication industries during that time period. A strategy for technology forecasting is needed.

(6) *Institutional Mechanisms*. There are so many facets to the land data systems problem and so many organizations involved that a pluralistic approach is required. Professional societies, academia, industry associations, and state, local, and federal governments should be involved. It is impractical to consult with everyone, but how do you assure that at least the minimum communication required for coordinated development exists? What are the key institutional mechanisms needed and if they don't exist now, how can they be formed?

Of these six issues, the one dealing with institutional mechanisms must be addressed first. During the next five days, dozens of papers on land data systems will be presented, especially during the joint symposia which begin on Wednesday. I will ask the moderators of these symposia, and there appear to be seven, to include in their deliberations a discussion of the need for a national strategy for cooperative systems development. If there is agreement as to need, I will ask them also to recommend the best institutional mechanism for developing such a strategy, including the necessary interfaces between Federal and non-Federal agencies, and the roles of ASP and ACSM. If they will do this I would be pleased to collect the answers into a single document with appropriate recommendations to the Presidents of ASP and ACSM.

I suggest that in this manner we would take the first step towards cooperation, establish a preeminent position for our two societies, and make a significant contribution towards the accomplishment of the Convention theme—the establishment of a National Objective for Modern Land Data Systems.

Hostesses at Ladies Social.

Mrs. Mabel Smart cuts the ribbon for the opening of the Exhibits at the Annual Convention.