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LANDSAT'S ROLE IN HUD "701" PROGRAMS

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## THE LANDSAT EXPERIENCE

### History of Landsat and Use in State HUD "701" Programs

Landsat 1 was launched by the National Aeronautics and Space Administration (NASA) in July 1972. The next two--Landsats 2 and 3--were launched in January 1975 and March 1978 respectively. All three Landsats are remote sensing experimental satellites--that is, the instrumentation, the ground delivery system, and the application techniques for this new type of remote sensing data had never been available before.

It became obvious after a few years of research with these data, that there should be many useful applications in environmental programs in all levels of government. Almost from the first days of the Landsat program, NASA encouraged applications in various discipline areas--including land resource inventories of wetlands, forest and agriculture--to demonstrate the utility of these data to a wide variety of users. But it was not until the advent of a defined technology transfer effort at NASA that State government was clearly a candidate for technical assistance. Most of the states, whose experiences are summarized in the following case studies, are graduates of these NASA technology transfer efforts.

Involving operational government users with products from experimental satellites created some difficulties as well as some hoped for benefits. Those state users who were able to become familiar with Landsat data found that it provided several unique advantages. When applied to appropriate tasks, use of Landsat showed very favorable cost and time comparisons relative to the use of aerial photography and other data sources. Other advantages included the repetitive collection of Landsat data, the large area covered in a single scene, and the availability of data in computer compatible tapes.

Deterrents to the use of Landsat data initially involved the fact that the data was much different from familiar sources in data format, scale, and resolution. Cloud cover also must be recognized as a limitation with satellite data collection, reducing the number of cloud-free scenes available. Some of these limitations are inherent in the capabilities of satellite "flown" instruments--such as resolution and cloud cover--and must be taken into account when the data is used.

Some of the limitations to Landsat use, however, are more related to demands placed on the experimental system by the growing number of operational users. Symptomatic of these problems has been the long delivery time between data collection, and delivery of a Landsat product to the user. Waiting two to four months for images or computer tapes may be acceptable for a research activity, but can only dampen the enthusiasm among operational users who would need the data much sooner. "Real-time" uses of Landsat are not yet practical, although improvements can be made and are being planned.

NASA-sponsored research into using Landsat for land use and land cover inventories was just beginning to show potential for practical applications when Congress passed the Housing and Community Development Act of 1974 (42 USC ch. 69). This Act was designed to be an important federal initiative to develop and improve comprehensive state planning and coordination capabilities. The planning vehicles within the Act administered by HUD are Title I, Community Development

and Block Grants--designed for large cities and urban counties; and Title IV, section 701, the Comprehensive Planning Assistance Program--aimed mostly at small communities and rural counties. The "701" planning assistance program is where the need for new tools to perform large area resource inventories became especially important.

Important actions taken by HUD--to ensure application of the planning incentives as widely as possible by the states--were to supplement the Act with interagency agreements between HUD and (1) the Department of Commerce, Office of Coastal Zone Management-- to give HUD acceptance rights when 701 plans include the state coastal management plan; (2) the Environmental Protection Agency--to resolve impediments to cooperative air and water quality planning and implementation; and (3) the Department of Interior, Heritage Conservation and Recreation Service, and the Bureau of Land Management--for coordination of land use management planning activities.

Compared with most other federal grant programs, HUD 701 has had the fewest "strings attached" from the perspective of states, and funds have been used to supplement and coordinate a variety of state and local government activities. State activities were considered eligible for grant funding if they were consistent with the following objectives: (1) to improve the use and conservation of human and natural resources, (2) to develop energy conservation and facility siting plans, (3) to develop and implement comprehensive plans with respect to land use planning, public facilities, human and natural resources development, and historic sites.

States surveyed about the use of Landsat in support of HUD "701" comprehensive planning efforts had used, or were aware of uses of Landsat for inventorying land use and land cover at the state and local level. In some states, inventories of land use were conducted by substate regional planning councils or counties, and were not attempted by the state. For most of the land cover and land use inventories conducted with Landsat or other remote sensing data, the end product was a map. Area statistics were desired but not as important for traditional planning requirements.

Summary of State Program

The New Jersey Department of Community Affairs, Division of State and Regional Planning, is the state agency responsible for administering 701 Comprehensive Planning Assistance funds. The New Jersey program, as outlined in the annual grant proposal, is divided into the following categories describing the state's role: 100.00 - Management/Review Coordination, 200.00 - State Land Use Planning, 300.00 - Housing Research, and 1000.00 - Metropolitan Planning. Included within the first category are state-federal coordination activities in accordance with established rules and procedures under the Office of Management and Budget Circular No. A-95, and the Governor's Plan for Capital Budgeting and Planning. The State Land Use Planning category includes the update and revision of the State Development Guide Plan as well as coordination of the State Plan with other functional planning efforts--such as "208" water quality planning, state water supply, and transportation planning. Attention is also given within the State Land Use Planning category to data coordination activities related to community development, and to interdepartmental program coordination via technical review and comment following the HUD/EPA and HUD/OCZM interagency agreements. With respect to Housing and Metropolitan Planning, the state is mostly concerned with providing technical assistance and information services to the regional planning councils and other levels of government to ensure that local plans are compatible with the State Plan.

The State Development Guide Plan is an interesting document that describes the "condition" of New Jersey in 1976 and projected trends to 1980-2000 with maps and statistics. The Guide Plan outlines four State goals for future growth, and recommends strategies for achieving those goals. This Plan provides a decision-making framework for state and substate agencies; it is an ongoing planning process that takes into consideration present problems and future needs, physical realities and developmental impacts. Such a framework is an important tool for improving the quality of decisions and the basis for informed public participation which are important objectives of the HUD program.

## Rationale for Using Landsat

The Division of State and Regional Planning chose to develop an automated geographic information system using Landsat, because there was an increasing demand for up-to-date land use maps at a large scale. Landsat provided several new dimensions as a data source for producing maps and disaggregating the resultant information. For example, the digital format of the satellite data lends itself to various types of statistical analysis, and the 1.1 acre resolution of the data allows for the relatively detailed delineation and editing of land-based information at the state level. The potential for periodic coverage provides a uniform, quantitative data base that can be updated at a relatively low cost. For New Jersey, the cost of flying new aerial photography for statewide ortho-photoquad coverage at 1:24,000 scale--without analysis--is estimated to be \$270,000. In contrast, the acquisition, and computer-assisted analysis of Landsat data tapes for the entire state cost several orders of magnitude less or under \$3000. Also, most of the cartographic and interpretive work has been automated. The savings from using satellite data instead of conventional aerial photography for repetitive statewide inventories of land use information are therefore quickly realized.

## Landsat Applications

Landsat provided the initial base data for the automated geographic information system developed in the New Jersey Department of State and Regional Planning. The outputs were at first limited to computer printouts of land cover types generated from the satellite data. Later geographic base files of municipal and county boundaries, and watersheds were added along with a color graphics display "screen" to form an integrated system for graphic and statistical analysis. Analytical maps could then be produced showing population, housing and employment data, and land cover information from Landsat by watershed or political jurisdiction. One of the first applications of this capability was the completion of a 208 water quality management project for one-third of the State. Initiation of new applications--such as DOE-sponsored Coastal Energy Impact Planning activity, and a HUD Technical Assistance grant to further coordinate the system with other state and local agencies--indicate increasing acceptance of computer graphics as a cost-effective tool in New Jersey.

Of particular interest is the Coastal Energy Impact Planning activity (204.00) described in New Jersey's annual 701 program document for 1980. The Division of State and Regional Planning is using landsat data to inventory and map land cover conditions within a variable radius (e.g., one mile, two miles or five miles) of proposed major energy facilities. The mapping and inventory work at about one acre resolution is considered suitable for regional planning before more detailed site planning is conducted. The Division will also get public input on satellite mapping work when participating in meetings and forums.

Landsat use in New Jersey will be expanded indirectly through efforts to build more program-specific information systems that will incorporate the graphic display and analysis capability already developed. For example, in the 701 annual program document, the "development of information systems, including computer-based data and planning systems," and "coordination of the State Development Guide Plan with the State Capital Plan" are activities in the formulation of the Governor's Plan for Capital Budgeting and Planning. Another major program sub-category is the organization of a Community Development Information System, a goal for which is to develop computer-assisted ways to project land use futures. Such a capability could prove useful in the A-95 review of major growth-inducing public capital facilities, and provide a major policy tool for state government.

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South Dakota

Summary of State Program

The Comprehensive Planning and Management Assistance Program of South Dakota authorized by Section 701 of the Housing Act of 1954, as amended, is coordinated by the South Dakota State Planning Bureau. The annual program document for 1980 is divided into two basic parts--reflecting the State and Sub-state responsibilities.

The focus for the entire program is the State Comprehensive Plan, which is both an evolving policy document for the Governor, and also a state management tool. In reflecting the policy initiatives of the current administration, the plan: (1) forms the basis of the Governor's annual legislative package, (2) contains policy recommendations which are implemented at the direction of the Governor by executive agencies, and (3) provides the public with the means to judge the accomplishments of government. As a management tool, the plan: (1) aids state agencies to set program priorities, (2) provides a framework to monitor and evaluate agency activities, and (3) provides a basis for interagency coordination of policies and programs. Substate planning efforts must be considered in the maintenance of the State Plan.

A very important component of the South Dakota program is the capability for technical assistance provided to state agencies, local governments, and regional planning and development districts. Assistance is provided by the State Planning Bureau as part of the Planning Information Assistance System, and forms an important element in the program document submitted to HUD. A comprehensive information system is viewed as a powerful tool available to planners and decision-makers, which will allow them to assess the needs of citizens and evaluate the impact of alternative policy recommendations. To be effective, the system must have access to current social, economic, demographic and natural resource data as well as have the capability to analyze these data. Recent efforts of the Planning Bureau have integrated data available from individual departments and developed the analytical tools to create a meaningful and comprehensive planning information system. It is within this information system that remote sensing is being used for land cover and land use inventories in South Dakota.

## Rationale for Using Landsat

In the mid 1970's the Planning Information Section of the State Planning Bureau began the development of the Land Resources Information System (LRIS), as part of a more comprehensive planning information system. The LRIS is an automated geographic information system that has analytical capabilities for integration of natural resource and other spatially located data in the planning process. The initial activity of the LRIS was a statewide land cover and land use inventory to provide both rural and urban land cover information. Although field studies and aerial photography were also used in these initial inventories, Landsat was chosen to provide the base data, because (1) the data were already available in a digital format, (2) the data were compatible across the state, and (3) the data were available for the entire state within the five-year period preceeding the inventory. An added benefit was that the data would be relatively inexpensive to acquire and process for future updates, compared to aerial photography.

## Landsat Applications

A major effort of the Bureau's Land Resources Information System has been a digital land use inventory through the computer-assisted analysis of Landsat imagery. The Bureau is working toward completion and verification of a level II (15 categories) land cover inventory of the entire state using this Landsat base. These county maps at 1:24,000 and statistics provide a consistent data base upon which to assess resource conditions and to evaluate state and local land use decisions. The Bureau also uses Landsat data to support EPA 208 planning on various watersheds in the state. In addition, land use and land use change maps have been produced for some of the larger cities in South Dakota using aerial photography.

South Dakota plans to develop a level III land use inventory for the state supplementing the information derived from Landsat with aerial photography especially in urban areas.

An important analytical capability of the LRIS is land suitability/capability analysis to determine the land's intrinsic capacity for supporting particular activities. A land capability study is but one component of a comprehensive planning process and deals primarily with the analysis of natural resource and environmental data. Such a study was conducted at the request of the Spearfish Planning and Zoning Commission by the State Planning Bureau through technical assistance made possible with 701 funding. Although the base data used for this analysis was high-altitude photography, the following figures illustrate the computer capabilities of the LRIS that were used to support a similar analysis using Landsat data for the 208 planning process.

Without a doubt the use of Landsat will continue and even increase for appropriate applications at the state and substate level as use of the Land Resource Information System increases, since Landsat is an integral part of the

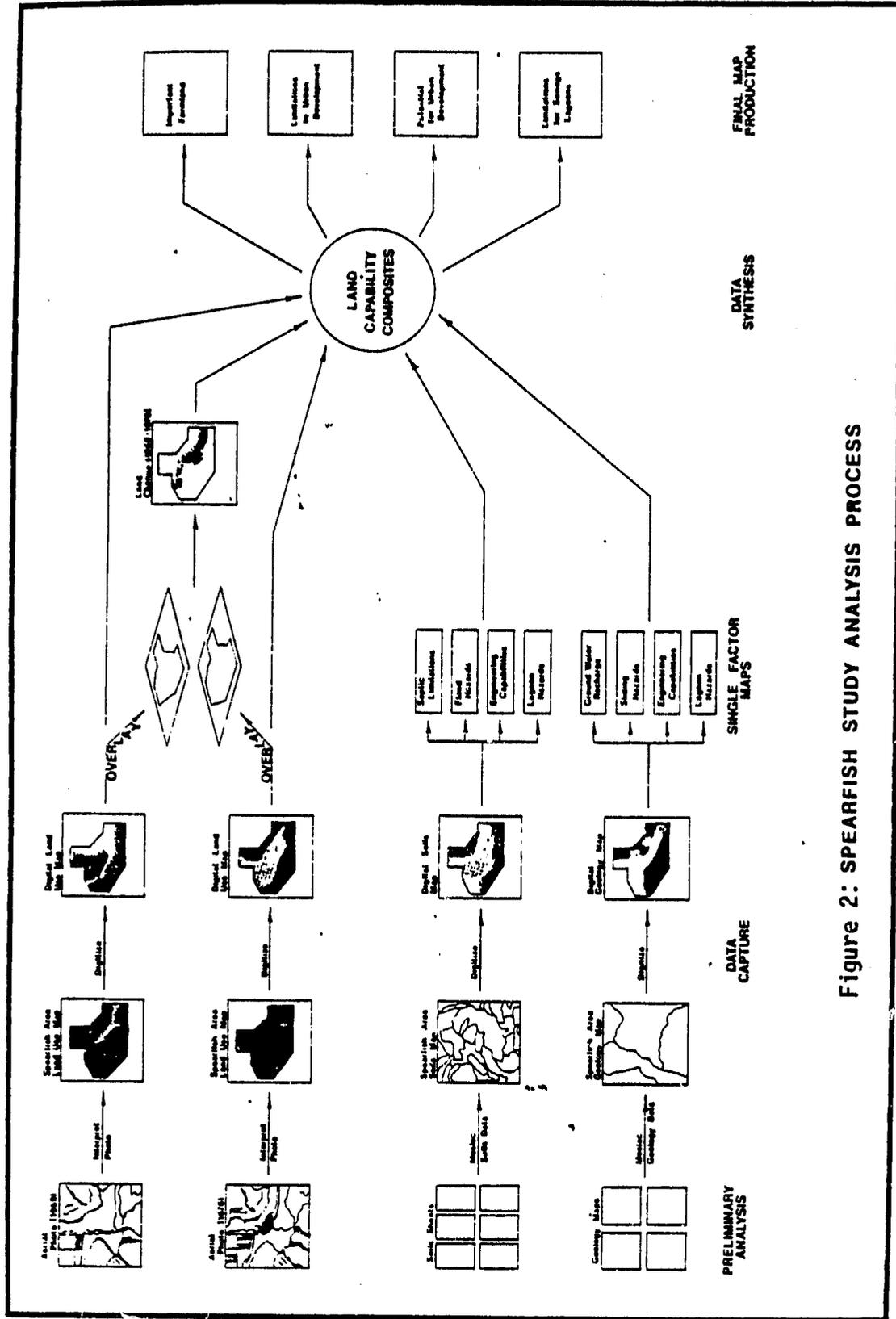


Figure 2: SPEARFISH STUDY ANALYSIS PROCESS

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Category	1969 Land Use		1976 Land Use		Land Use Change	
	Acreage	% of Total	Acreage	% of Total	Acreage Change	% Change
RESIDENTIAL	667	2.4	967	3.4	+300	45.0
MOBILE HOME PARKS	28	.1	49	.2	+ 21	75.0
COMMERCIAL & SERVICES	191	.7	271	1.0	+ 80	41.9
INDUSTRIAL	176	.6	303	1.1	+127	72.2
AUTO TRANSPORT.	0	.0	555	2.0	+555	555.0
AIR TRANSPORT.	112	.4	76	.3	- 36	32.1
URBAN OPEN-UNDEV.	173	.6	129	.5	- 44	25.4
URBAN OPEN-DEV.	90	.3	89	.3	- 1	.0
DRYLAND AG	5,813	20.4	4,943	17.4	-870	15.0
IRRIGATED AG	2,040	7.2	2,147	7.6	+107	5.2
RANGELAND	11,078	39.0	10,708	37.6	-370	3.3
FORESTLAND	8,013	28.2	8,044	28.2	- 31	.4
WATER BODIES	12	.0	9	.0	- 3	.2
SURFACE MINES	22	.1	125	.4	+103	468.2
TOTAL	28,415	100.0	28,415	100.0	---	---

Table 2. Spearfish Area Land Use.

Page No.	MAP TITLE	SOURCE			
		69 Aerial Photo.	76 Aerial Photo.	Soils	Geology
18	1969 Land Use	X			
19	1976 Land Use		X		
20	Land Use Change (69-76)	X	X		
21	Slope Classes			X	
22	Flood Hazards			X	
23	Potential for Building Sites			X	
24	Potential for Woodland Wildlife Habitat			X	
25	Potential for Rangeland Habitat			X	
26	Potential for Openland Habitat			X	
27	Limitations to Road and Street Construction			X	
28	Limitations to Septic Tank Absorption Fields			X	
29	Soils of Statewide Importance for Farmland			X	
30	Sliding Hazards				X
31	Groundwater Recharge Areas				X
32	Irrigation Potential			X	
33	Depth of Bedrock			X	
34	Limitations for Sewage Lagoons (Soils)			X	
35	Limitations for Sewage Lagoons (Geology)				X
36	Limitations to Sewage Lagoons (Soils/Geology)			X	X
37	Important Farmland		X	X	
38	Important Farmland Lost to Urban Development	X	X	X	
39	Limitations to Urban Development			X	X
40	Land Suitable for Urban Development but not Important Ag Land			X	X
41	Limitations for Septic Tanks/New Urban Land	X	X	X	
42	Limitations for Urban Development/New Urban Land	X	X	X	X

Table 4. Maps Produced in the Spearfish Study

# LAND USE - 1969

SYMBOL	FREQUENCY	PERCENT	LABEL
000000	687.	8.36	RESIDENTIAL
000000	88.	8.10	MOBILE HOME PARKS
000000	101.	8.67	COMMERCIAL & SERVICE
000000	176.	8.68	INDUSTRIAL
000000	9.	8.8	AUTO TRANSPORTATION
000000	118.	8.20	AIR TRANSPORTATION
000000	173.	8.61	URBAN OPEN-UNDEVELOPED
000000	96.	8.38	URBAN OPEN-DEVELOPED
000000	8013.	88.68	OUTLAND AGRICULTURE
000000	2008.	7.18	IRRIGATED AGRIC.
000000	11678.	36.95	RANGELAND
000000	8013.	88.28	FORESTLAND
000000	18.	8.84	RAISED BOOZIES
000000	88.	8.88	SURFACE MINES

LAND RESOURCE INFORMATION SYSTEM  
 SOUTH DAKOTA STATE PLANNING AGENCY  
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## SPEARFISH LAND CAPABILITY STUDY



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system. In addition, "implementation of procedures to thoroughly apply the capabilities of the system to state and local public policy problems" is a stated objective of the 701 program.

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## TOWARD MORE EFFECTIVE APPLICATIONS

The experiences of the states surveyed for this report indicate the potential for federal grant programs, such as the HUD 701 - Comprehensive Planning Assistance Program, to support the use of innovative techniques from satellite remote sensing, especially in conjunction with the development of computer data bases. These experiences also indicate the necessity of having an active technology transfer program tailored to state government needs that encourages and supports technology transfer between state agencies once a basic capability has been acquired by the state.

States were selected initially for previous involvement with NASA technology transfer efforts. However, no attempt was made to insure that successful applications of Landsat would be found in state 701 programs. Most 701 program managers in the states surveyed were knowledgeable of Landsat's potential, and had explored using some Landsat-derived information as part of their planning activities.

An observation of these state programs is that Landsat was used for regional inventories of land cover and land use, if recent inventories or aerial photography did not exist, or if a convenient supplier for the inventory product using landsat was readily available and known to the state or local planner. In other words, state programs tended to "borrow" land cover and land use information from another source whenever possible. For example, land cover mapping of Texas was originally conducted to support EPA 208 water quality planning. A second printing with 701 funds was distributed to the regional planning councils and rural counties to assist comprehensive planning activities. In South Dakota, the State Planning Bureau's Land Resource Information System was inventorying land use and land cover at level II for each county using Landsat with funding from state and non-HUD federal sources (Economic Development Administration and Old West Regional Commission grants). This inventory information, along with the analytical capabilities within a computer-based geographic information system, are being coordinated with the state comprehensive plan and available to provide technical services to local government units as part of the 701 program.

It is interesting that Landsat capabilities in states tend to be institutionalized within a state government information service where they can be more easily accessed by state agencies. State use of Landsat also has been associated with the development of automated geographic information systems--a computer capability to "handle" and analyze mapped information and other data tied to geographic coordinates and boundaries. It is this capability development, the geographic information system, in which state abilities to respond to demands for statewide comprehensive planning requirements will be dramatically increased. And Landsat data, as well as remote sensing data from future satellite systems, is anticipated to play an important and necessary role.

Although not always a visible or direct data source in state 701 programs, program managers expect that Landsat would provide cost savings for regional data, and support improved statewide planning performance. And even more important, Landsat has opened doors for more creative applications, using the

geographic information system concept, than could be attempted in most state budgets using conventional remote sensing data because of cost and time constraints. For most states, Proposition 13 or similar budget limitations have greatly reduced the available funds to purchase data or increase staff. It seems important that federal grant programs with the intent of expanding and improving state capacities to manage conflicting environmental and economic development concerns, should be sensitive and supportive of these developing capabilities in the states.