USE OF REMOTE SENSING TECHNOLOGY FOR INVENTORYING AND PLANNING UTILIZATION OF LAND RESOURCES IN SOUTH DAKOTA

ANNUAL PROGRESS REPORT

JULY 1, 1974 - JUNE 30, 1975

SUBMITTED FOR NASA GRANT NO. NGL 42-003-007

REMOTE SENSING INSTITUTE
SOUTH DAKOTA STATE UNIVERSITY
BROOKINGS, SOUTH DAKOTA 57006

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ABSTRACT

A comprehensive land use planning process is nearing completion in Meade County, South Dakota. The objective of the Meade County project was to provide the following from remote sensing technology; 1) a general county-wide resource survey of land use and soils to encompass areas of little development pressure, and 2) a detailed survey of land use for the environmentally sensitive area adjacent to the Black Hills, which is experiencing unregulated growth.

The process has relied heavily on resource derived by remote sensing technology. Resource surveys obtained through remote sensing and output product formats were selected by interaction of remote sensing specialists with local land use planners. LANDSAT-1 imagery was visually interpreted to provide Level I land use information for Meade county and a general soils map for the upper portion of the 2.2 million acre (890,000 ha) county. Interpretations from the soil information included: 1) limitations to urban development and 2) resource opportunities for the production of agricultural and forest commodities. A modified Level III land use map for the Black Hills Area of Meade County was interpreted from RB-57 photography. Interpretations of soil characteristics were input into a computer data base and mapped at the scale of the detailed land use data. The detailed land use data were used in conjunction with soil maps to provide detailed information for development of zoning ordinance maps and other land use planning in the Black Hills area. These data (County-wide and Black Hills Area are being used by the Sixth District Council of Local Governments, the Meade County Planning Commission, and the Meade County Planning and Zoning Administrator to assess the current use of land in relation to its potential and suitable uses.

In addition to the use of imagery as an interpretation aid, the use of photographs as base maps was demonstrated. A false color mosaic of Meade County at a scale of 1:250,000 was made from LANDSAT-1 imagery. In addition, color mosaics of the Black Hills Area were made from RB-57 at scales of 1:125,000 and 1:24,000.

The use of airborne thermography to locate spoilage areas (chimneys) in sugar beet piles was evaluated. The project appears to have great potential for locating the distribution of spoilage areas. Data are pro-

vided which can subsequently be used to schedule the processing of sugar beet piles to eliminate substantial waste.

Analysis of airborne thermal scanner data provides a technique to determine and map the apparent temperatures of rooftops from residential and business structures. A recent report describes the generalized relation between the amount of insulation in ceilings and rooftop temperatures. It illustrates the usefulness of remote sensing technology over large regions to provide information for a comprehensive energy conservation program. The operational nature of this program has been demonstrated by CENGAS, a division of Central Telephone and Utilities company, who contracted for the flight of five communities using this technique. CENGAS is making the data available to customers and advising them on the use of the data to infer possible needs for insulation in their homes.

Several Bicentennial activities are progressing. The Parks and Recreation Department of Sioux Falls, South Dakota, has actively used large scale black and white photographs for the detailed planning of the downtown portion of the Bicentennial Parkway. They are now using infrared color prints at approximately 1:5,000 to develope the conceptual plan for the remainder of the parkway. Personnel from RSI have suggested techniques for interpretation and methods of presentation of the materials. A LANDSAT mosaic of the state with principal agricultural areas, transportation routes, and notes of interest is in preparation.

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ACKNOWLEDGEMENTS

A number of individual and group efforts have promoted the success of the Meade County project. Although each individual effort will not be identified, we would like to acknowledge the following individual(s) for their contributions.

The Meade County Project was supported in part by the State of South Dakota and by the National Aeronautics and Space Administration (NASA) Grant. No. NGL 42-003-007. Appreciation is extend to NASA technical officers, Mr. Joe Vitale, for support and direction of the project.

Numerous individuals from the Sixth District Council of Local Governments have contributed to the project by identifying the needs and applying the results to ground decisions. Mr. Phillip B. Cerveny (Physical Planner) and Mr. Larry Finnerty (Director) have been especially active in the project.

Mr. Arnold Bateman SDSU Extension Rural Development Specialist has assisted in communicating to the public the needs for current resource surveys in planning efforts and the use of remote sensing for these surveys.

The Meade County Planning Commission has also actively supported this effort and Mr. Kirk Carlesten (Meade County Planning and Zoning Commissioner) has provided worthwhile suggestions on data requirements and presentations for actual use.

Appreciation is extended to the USDA Soil Conservation Service for providing soil survey data and interpretations for various parts of for Meade County. Mr. T.J. Ollila prepared the interpretion data for the Black Hills Area and Mr. Don Bannister, (State Soil Scientist), provided access to the soils data.

RESOURCE INVENTORY THROUGH REMOTE SENSING FOR LAND USE PLANNING IN SOUTH DAKOTA

INTRODUCTION

This activity by the Remote Sensing Institute has been directed toward the utilization of remote sensing products by action groups. This report describes progress for FY 1974-75. The efforts reported have been funded primarily by a NASA Office of University Affairs Grant and in part by the State of South Dakota and by each of the action agencies involved.

South Dakota is experiencing land use problems similar to those occurring throughout the country. Conflicting demands for limited land resources place severe strain upon social, economic and political institutions. Unfortunately, land use planning and management in the past have left a record of uncoordinated, haphazard and inefficient land use patterns which often do not reflect the desires of the people. This is often due to the lack of current surveys of land use and soil characteristics.

The 1974 South Dakota Legislature enacted a bill requiring county planning commissions to prepare a comprehensive land use plan by July 1, 1976. Many South Dakota counties do not have land use plans or personnel to acquire resource surveys for this task. The multi-county planning districts in the state will provide assistance if requested by the counties but their resources are limited and facilities for data collection are generally lacking.

Development of resource surveys (general and detailed) for land use planning using remote sensing technology is the main scope of the activity in Meade County, South Dakota. This differs considerably from past work in Pennington County which was directed primarily toward providing a soil survey from LANDSAT 1 for use as a guideline for tax equalization of agricultural land. However, the soil mapping techniques which were developed in Pennington County project were used to map the Northern half of Meade County to provide general soil interpretations (potentials, limitations) for land use planning. In addition detailed land use maps were prepared for Western Meade County and these data were combined with

detailed soil survey data for planning and zoning purposes adjacent to the Black Hills.

A publication entitled "Developing a Land Use Planning Process: The Meade County Story" describing the role of remote sensing in the Meade County planning process is in preparation. An extension rural development specialist, Sixth District Council of Local Governments Personnel, and Remote Sensing Institute personnel have contributed to the process.

MEADE COUNTY PLANNING PROBLEMS AND PLANNING NEEDS

Meade County is located in Western South Dakota and is the largest county in the state (887,200 hectares). The area is predominately rangeland with winter wheat and alfalfa the principal agricultural crops. A small portion of forest land (Black Hills) is also in the county.

Meade County was selected for study because the planning commission was in the process of developing a comprehensive land use plan in cooperation with the multi-county planning unit in that area, the Sixth District Council of Local Governments. The major land use planning problems in Meade County according to the planning commission are:

1. Unregulated and unorganized strip growth occurring adjacent to an interstate highway in the forested region of the county. Here the physical restraints of steep and unstable slopes, shallow soils, and floodplains present a variety of problems in providing sewage disposal, fire protection, road construction and maintenance and other public services.
2. Loss of highly productive agricultural lands to more intensive land uses, such as housing developments and trailer parks.

Meade County, like many other counties in South Dakota (and other states), lacked basic resource surveys to accomplish the comprehensive land use planning process. For example, the Northern half of the county had no soil survey and that for the Southern portion will not be published for several years. In addition, Meade County had no current county-wide inventory of major resource categories such as rangeland, prime agricultural land, etc. Previous estimates for these categories had been calculated

from the Conservation Needs Inventory (CNI) prepared in 1967. In addition to its age, the CNI is based on stratified sampling rather than actual delineation of categories and the quantitative determination of their areal extents. There was also a lack of detailed land use information along the interstate highway adjacent to the Black Hills where unregulated, uncontrolled growth is occurring and detailed data is a necessity for adequate land assessment, planning and zoning. An additional problem, not particularly unique to the Meade County group, was that most of the data that they required was not in a useable form for planning; that is it was tabular and from scattered sources.

COOPERATING PERSONNEL

The groups or individuals involved and their responsibilities in the Meade County land use planning process are listed below:

1. People of Meade County - determine data needs for county.
2. County Commissioners - legislative authority of county.
3. Planning Commission - preparation of comprehensive plan, advisory to county commissioners.
4. Planning and Zoning Administrator - administers zoning ordinances, advisory to planning commission.
5. Sixth District Council of Local Governments - technical consultants to planning commission.
6. Rural Development Extension Specialist - public education on land use planning process.
7. Soil Conservation Service Soil Scientist - provide soil survey information to aid zoning process in the Black Hills Area.
8. Remote Sensing Institute - Acquire data base for soils and land-use interpretations from remotely sensed data.

DATA REQUIREMENTS

Meetings were held with groups or individuals listed above to explain remote sensing procedures and to determine the role of remote sensing in the land use planning process. The following basic resource data were requested for development of a comprehensive plan:

1. General land use for county
2. General soils maps with interpretations for county
3. Detailed land use for the urbanizing portion of county (Black Hills Area)
4. Detailed soils for urbanizing portion of county (Black Hills Area)
5. Integration of the soil and land use information for detailed planning and preparation of zoning maps.

The Planning Commission and the Sixth District determined that a number resource interpretations were needed for planning and zoning. Table 1 lists the interpretations which were requested and completed for use in planning and zoning.

PROCEDURES FOR ACQUIRING DATA

County

General land use was interpreted from LANDSAT-1 imagery using Level 1 land use categories (Anderson, Hardy and Roach, 1972). The various land use areas were delineated by visual interpretation of a false color composite print of bands 4, 5, and 7 at a scale of 1:250,000. The LANDSAT-1 imagery was taken in July, 1973. Agricultural land, which consists of cropland and hayland, was distinguished by the geometric pattern and color characteristics of the fields. Rangeland areas had uniform color with few definite geometric patterns. Forest lands (principally coniferous) exhibited dark reddish tones at this date. Urban and built-up lands were distinguished by relatively bright white signatures. Areas covered by water appeared very dark blue.

LANDSAT-1 false color mosaic at a scale of 1:250,000 with a land use overlay was prepared for use in Meade County (Figure 1). The land use data were also transfered to a base map at a scale of 1:63,360 (1" = 1 mile) as requested by the Sixth District Council of Local Governments. This map was color coded for use by the planning commission.

TABLE 1. INTERPRETATIONS REQUIRED FOR MEADE COUNTY PLANNING PROCESS

1. County (regional interpretations)
   a. Soil limitations to development
   b. Resource opportunities for production of agricultural and forest commodities
   c. Floodplains (flood prone areas)
   d. Water areas
2. Black Hills Area (detailed interpretations)
   a. Slope information
   b. Floodplains (flood prone areas)
   c. Soil limitations to dwellings with basements
   d. Soil limitations to septic tank absorption fields
   e. Soil limitations to sewage lagoons
   f. Soil limitations to shallow excavations
   g. Soil limitations to area sanitary landfill
   h. Soil limitations to trench sanitary landfill
   i. Soil limitations to local roads and streets
   j. Soil suitability as a source of road fill

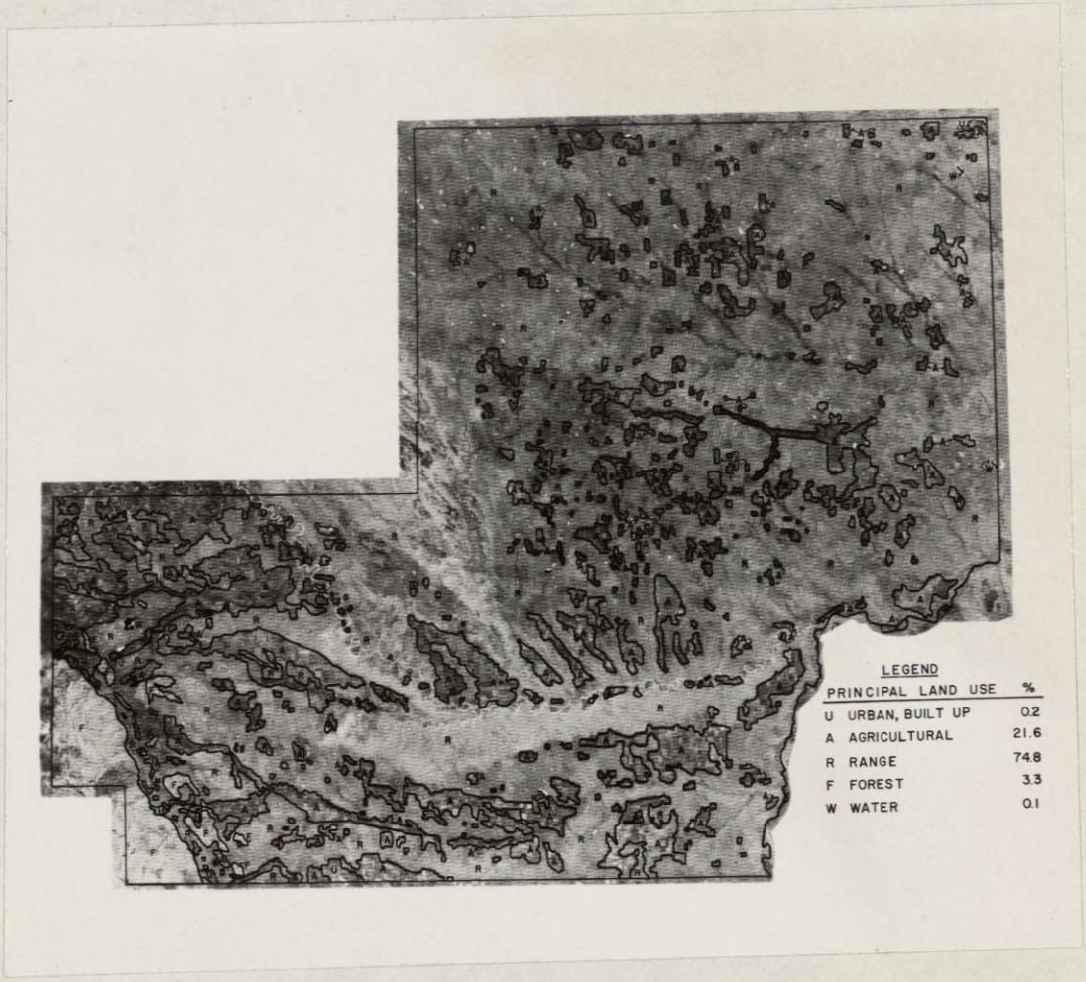

Figure 1. Level I land use interpretation of Meade County, South Dakota on MSS band 5. LANDSAT-1 image, July, 1973. Original scale 1:250,000. Interpretation from a false color composite of MSS bands 4, 5,and 7. (NASA ID #1351-17064 and 1353-17123)

Black Hills Area

Detailed land use data were prepared for the Black Hills Area in consultation with the Sixth District Council of Local Governments and was a modification of the Level III categories as listed in Table 2.

High altitude NASA color photography (July, 1974) was enlarged and printed at 1:24,000 for interpretation of detailed land use data. Topographic quadrangle maps were used to scale the photography. Interpretations were thoroughly field checked. A portion of the data is shown in Figure 2. These data were plotted on overlays to fit black and white ASCS photographs taken in 1968 which had been enlarged to a scale of 1:7,920 (8" = 1 mile).

SOIL MAPS AND MISCELLANEOUS PRODUCTS

The techniques developed in Pennington County by Frazee et al. in 1974 were used to develop a general soils map at a scale of 1:250,000 for northern Meade County. This map was and a general map prepared by the USDA Soil Conservation Service for southern Meade County were used to compile a soils map for the entire county (Figure 3). The legend for this map is in Table 2.

Interpretations of the general soils map were prepared to aid in developing the county zoning map. These include an interpretation of the soil limitations for development (Fig. 4) and resource opportunities for production of agricultural and forest commodities (Fig. 5).

Detailed soil survey data for the Black Hills area were placed in a computer data base to provide mapped interpretations of soil characteristics for planning and zoning activities in the area adjacent to the Black Hills. Data was procurred from the SCS survey for southern Meade County. Soil survey maps (1:15,840) were digitized at the 2.5 acre (ha) cell level using computer-drawn grid overlays. Maps of soil interpretations were computer-plotted at a scale of 1:7,920 to be used with detailed land use data which had been transferred to black and white photos at this scale. Maps of soil interpretations were then overlayed on the detailed land use data on the photographic base to provide information for planning and zoning. A computer-plotted map of the interpretation

TABLE 2. LAND USE CATEGORIES OF THE BLACK HILLS AREA

LEVEL I	LEVEL II	LEVEL III
Urban		
	Residential	
		Single family
		Multi-family
		Mobile home
		Mobile home park
	Commercial	
		General commercial
		Motel/Hotel
	Industrial	
		Light industrial
		Heavy industrial
	Transportation	
		Dual highway
		Primary road
		Secondary road
	Extractive	
	Institutional	
		Schools
		Churches
		Cemetaries
		Hospitals
		Public Buildings
	Parks/Recreational	
Agricultural Land		
		Cropland
		Hayland
Rangeland		
Forest land		
Water		
Barren land		

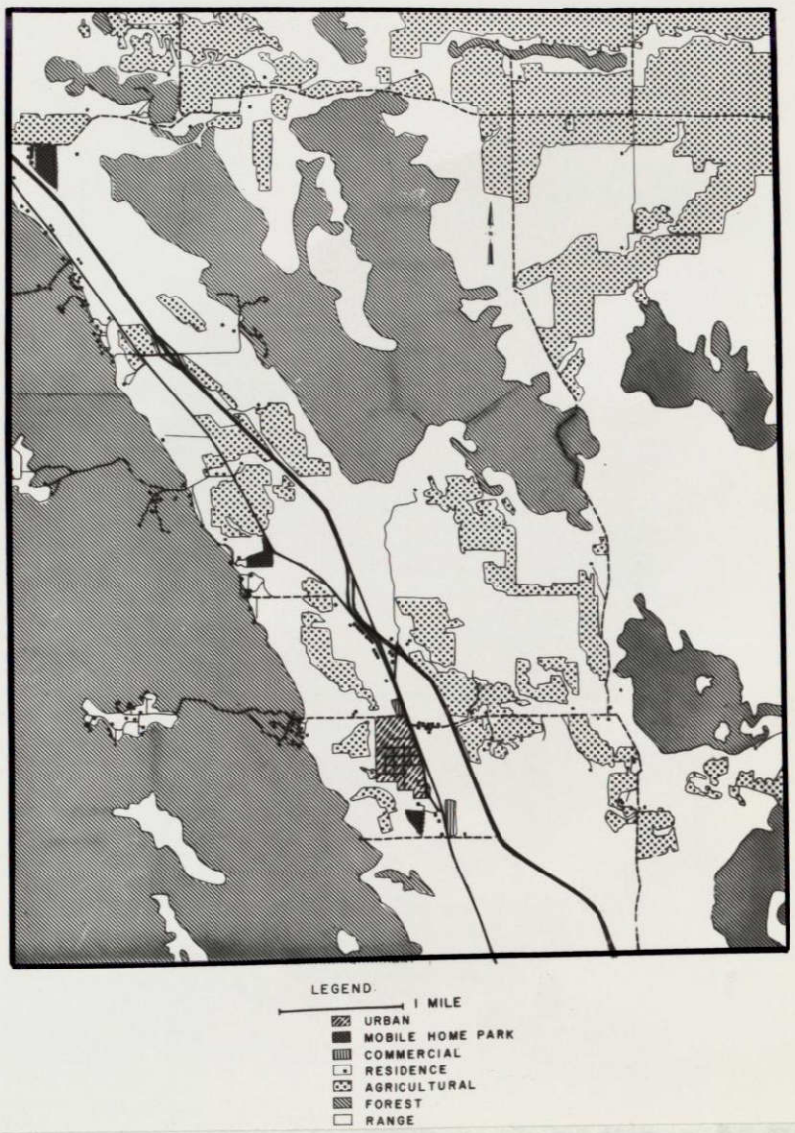

Figure 2. Modified Level III land use interpretation of a portion of the Black Hills Area. Original scale: 1:24,000. The urban area in the center of the lower third of the area is Blackhawk, South Dakota. The forested land to the left is in the Black Hills National Forest.

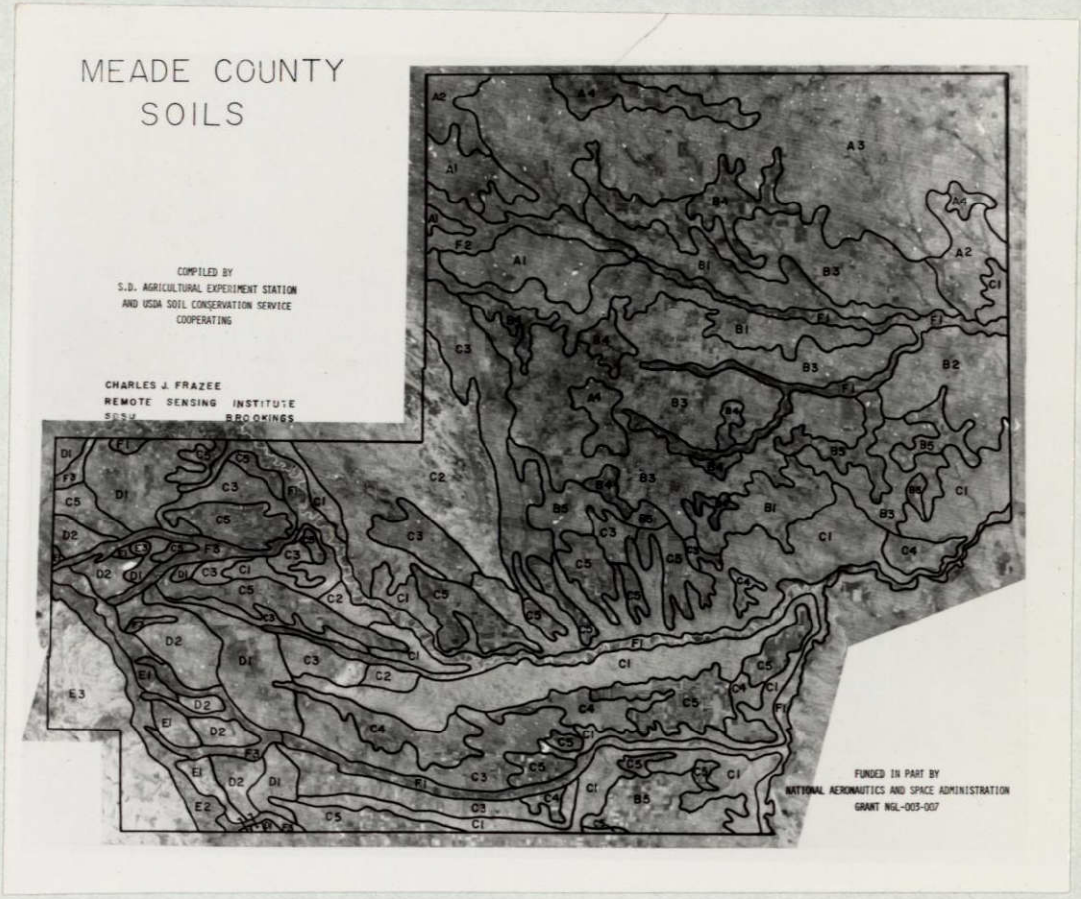

Figure 3. General soils map of Meade County, South Dakota. The northern half was mapped using remote sensing techniques, the southern part by conventional techniques. Original scale: 1:250,000.

Table 2. Soilscapes of Meade County

UNIT	LAND FORM	GEOLOGIC MATERIAL	SOILS	RANGE SITE	LAND USE	LCS*
A Soilscapes from Hell Creek formation						
A1	Sloping to steep uplands	Interbedded calcareous sand, silt, and clay and colluvium from Hell Creek formation	Shallow loamy and deep claypan soils	Shallow-thin claypan	Rangeland	7e-6s
A2	Undulating to moderately steep uplands	Interbedded calcareous sand, silt, and clay of Hell Creek formation	Moderately deep loamy and deep claypan soils	Sandy-thin claypan	Rangeland	6e-6s
A3	Undulating to rolling uplands	Colluvium from interbedded calcareous sand, silt, and clay of Hell Creek formation	Deep claypan, loamy claypan and moderately deep loamy soils	Thin claypan sandy claypan	Rangeland	6s-4e-4s
A4	Undulating to steep uplands and buttes	Colluvium from calcareous shales of Ludlow and White River formations	Moderately deep to deep clayey soils and shallow to moderately deep loamy soils	Clayey-silty-shallow	Cropland-Rangeland	3e-7e
B Soilscapes from Fox Hills Formation						
B1	Steep breaks	Calcareous sandstone of Fox Hills formation	Shallow loamy soils	Shallow	Rangeland	7e
B2	Rolling to hilly uplands	Colluvium from silty shale of Fox Hills formation	Shallow loamy and moderately deep clayey soils	Shallow-silty	Rangeland	6e-4e
B3	Rolling uplands	Colluvium from interbedded sand and silt of Fox Hills formation	Moderately deep to deep loamy soils	Thin upland-sandy	Rangeland-cropland	6e-4e

UNIT	LAND FORMS	GEOLOGIC MATERIAL	SOILS	RANGE SITE	LAND USE	LCS*
B4	Undulating to sloping uplands	Coluvium from interbedded sand and silt of Fox Hills formation	Deep loamy soils	Sandy-silty-thin upland	Cropland	4e-3e-6e
B5	Undulating to sloping uplands	Colluvium from silty shale of Fox Hills formation	Moderately deep to deep clayey soils	Silty	Cropland	3e-4e
C Soilscapes from Pierre Shale						
C1	Steep breaks	Pierre shale	Shallow to moderately deep clayey soils	Shallow-clayey	Rangeland	7e
C2	Sloping uplands	Pierre shale	Shallow to moderately deep clayey soils	Dense clay-shallow dense clay	Rangeland	6e
C3	Undulating to sloping uplands	Colluvium from Pierre shale	Moderately deep to deep clayey and deep claypan soils	Clayey-thin claypan	Rangeland-Cropland	4e-6e-6s
C4	Dissected sloping terraces	5-10' of terrace alluvium over Pierre shale	Thin to deep loamy and shallow gravelly soils	Thin upland-clayey-shallow to gravel	Rangeland-cropland	6e-4e-6s
C5	Undulating terraces	5-20' of terrace aluvium over shale	Deep loamy soils	Clayey-silty	Cropland	3e-3c
D Soilscapes of Black Hills Footslopes						
D1	Sloping uplands	Colluvium from Niobrara formation, Carlisle shale and Greenhorn limestone	Moderately deep clayey and shallow to deep loamy soils	Silty-thin upland	Rangeland-cropland	6e-7e-4e
D2	Sloping uplands	Terrace aluvium and colluvium from Graneros formation	Shallow to moderately deep clayey soils	Shallow-clayey	Rangeland	6e

UNIT	LAND FORM	GEOLOGIC MATERIAL	SOILS	RANGE SITE	LAND USE	LCS*
E Soilscapes of the Black Hills						
E1	Hilly to steep Hogback Ridge	Sandstones and shales of Inyan Kara group	Shallow to deep loamy soils	Shallow	Rangeland-Forestland	7e-6e
E2	Undulating to rolling valley	Colluvium from sandstone of Sundance formation and sandy shales of Spearfish formation	Moderately deep to deep silty and shallow gravelly soils	Silty-thin upland-shallow to gravel	Rangeland-Cropland	3e-3c-6e-6s
E3	Hilly to steep ridges and valley	Colluvium from Minnekata limestone, Opeche formation, Minnelusa sandstone and Pahasapa limestone	Shallow to deep loamy soils	Shallow	Forestland	7e-6e-7s
F Soilscapes of Floodplains						
F1	Nearly level floodplains and low terraces	Loamy and clayey alluvium	Deep loamy and clayey and deep claypan soils	Overflow-sandy-thin claypan	Rangeland	6w-3c-4e-6s
F2	Nearly level floodplains and low terraces	Clayey alluvium	Deep clayey and claypan soils	Overflow-thin claypan	Rangeland	4s-6s
F3	Nearly level floodplains and low terraces	Loamy alluvium	Deep loamy soils	Overflow-silty	Cropland	3c-3e

*LCS is Land Capability Subclass

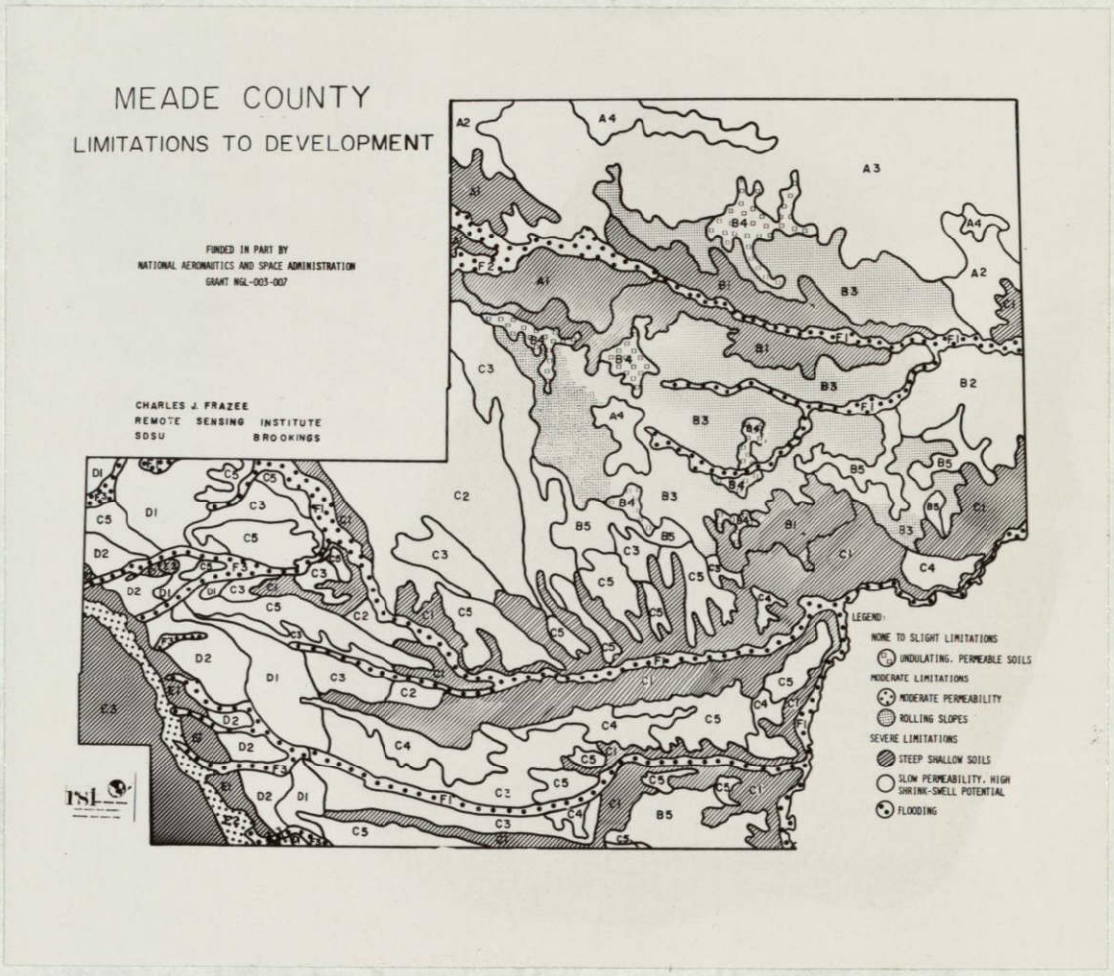

Figure 4. Interpretation of general soils map for developmental limitations, principally for structures and roads. Scale = 1:1,000,000.

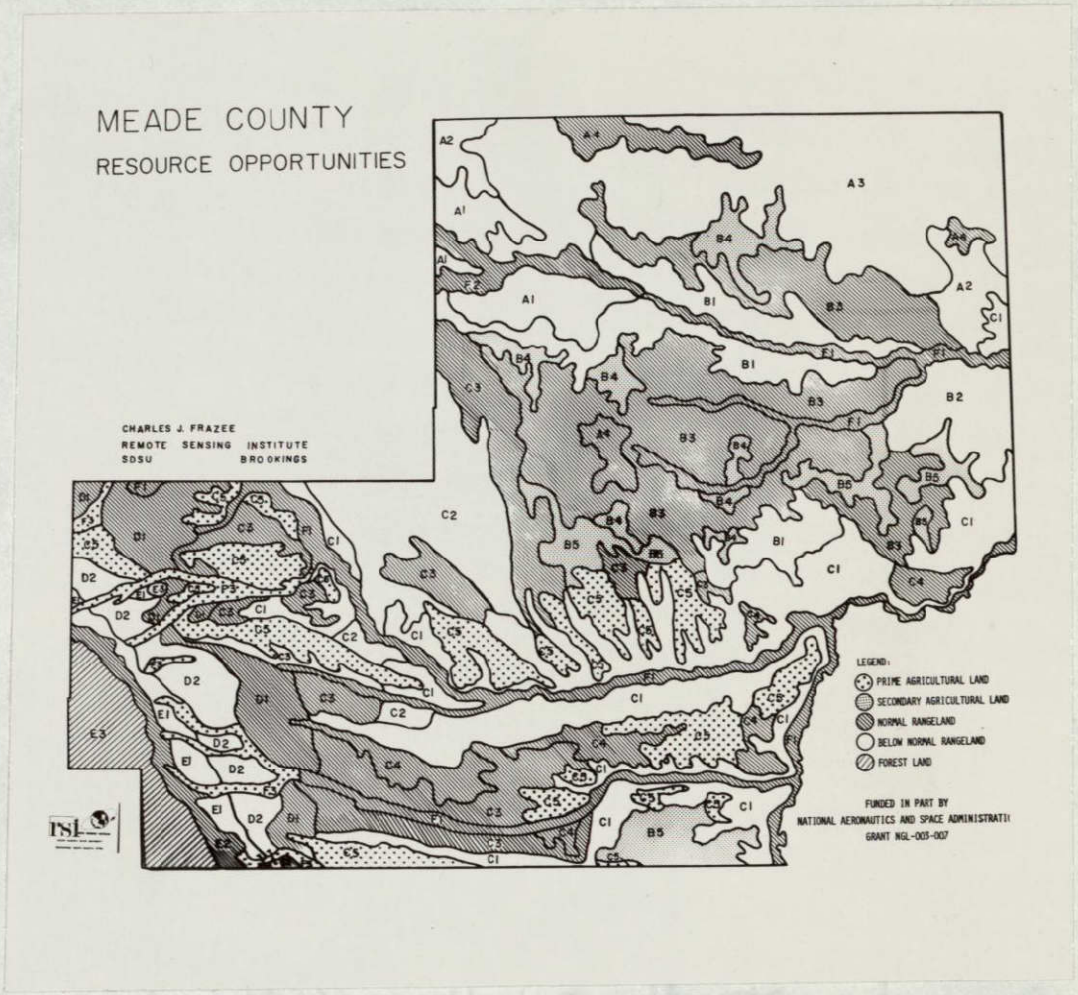

Figure 5. Interpretation of general soils map for resource opportunities for the production of agricultural and timber commodities. Scale = 1:1,000,000.

"limitations to dwellings with basements" is shown in Figure 6. Interpretive maps were generated for the seven other interpretations listed earlier in Table .

Several other resource maps were prepared for Meade County from LANDSAT I. General floodplain zones in Meade County were mapped to show areas that might be utilized for activities (e.g., agriculture, recreation, hunting, etc.) other than those susceptible to economic loss during periods of inundation. Water resources were mapped (Fig. 7) to provide the distribution of the major streams, rivers, lakes, and other water resources in Meade County. The water areas designated are considered perennial in nature and are of concern in the county zoning effort because they are vulnerable to degradation with improper land use.

In addition to the use of remote sensing imagery for interpreting land use and soils data, the use of imagery base maps was demonstrated. A mosaic at a scale of 1:125,000 (1/2" = 1 mile) was prepared from 1969 RB-57 color infrared imagery for the Black Hills Area so land use changes over the five-year period could be analyzed.

Another mosaic of the Black Hills Area was prepared at a scale of 1:24,000 (2.6" = 1 mile) from the 1974 RB-57 color photography. This mosaic has proved very useful to the planning commission for locating areas where future subdivision development has been proposed.

Overlays and slides of the above materials were distributed among the involved agencies for use at public meetings and planning sessions in Meade County. Materials were also given to individuals associated with other counties in the state to develop an awareness of the utilization of remote sensing tools in the planning process.

APPLICATION OF REMOTE SENSING TECHNOLOGY TO THE PLANNING PROCESS

Resource inventories provide basic data for the development of land use plans. In Meade County, inventories were developed for two levels of planning, the county or regional level and the more site specific planning adjacent to the Black Hills. Details of the uses enumerated here were provided by Mr. Phillip B. Cerveny, Physical Planner with the Sixth District Council of local Governments.

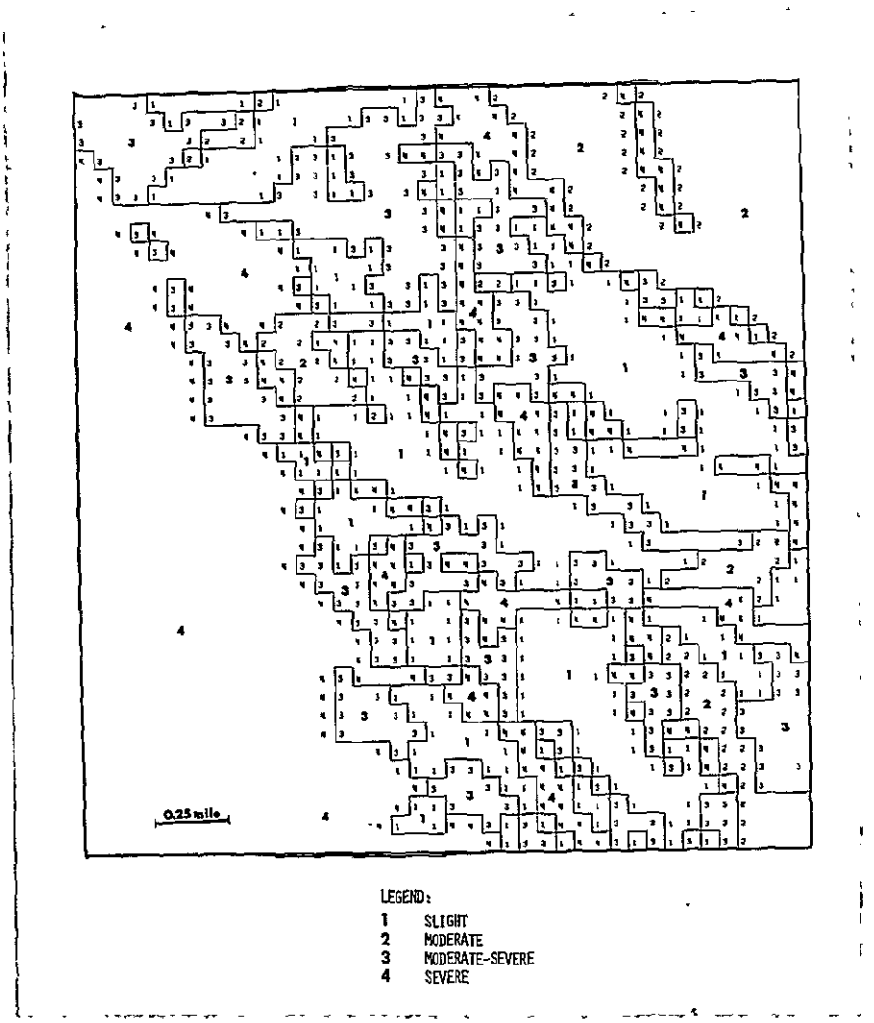

Figure 6. Computer mapped interpretation of soil limitations to dwellings with basements. Soil survey maps were digitized at the 2.5 acre (1ha) cell level and originally plotted at 1:7,920 (8" = 1 mile). Soils in level three (moderate-to-severe) are complexes in which one of the soils has moderate limitations and the other severe. These should be field-checked for location of each component during the ground surveys.

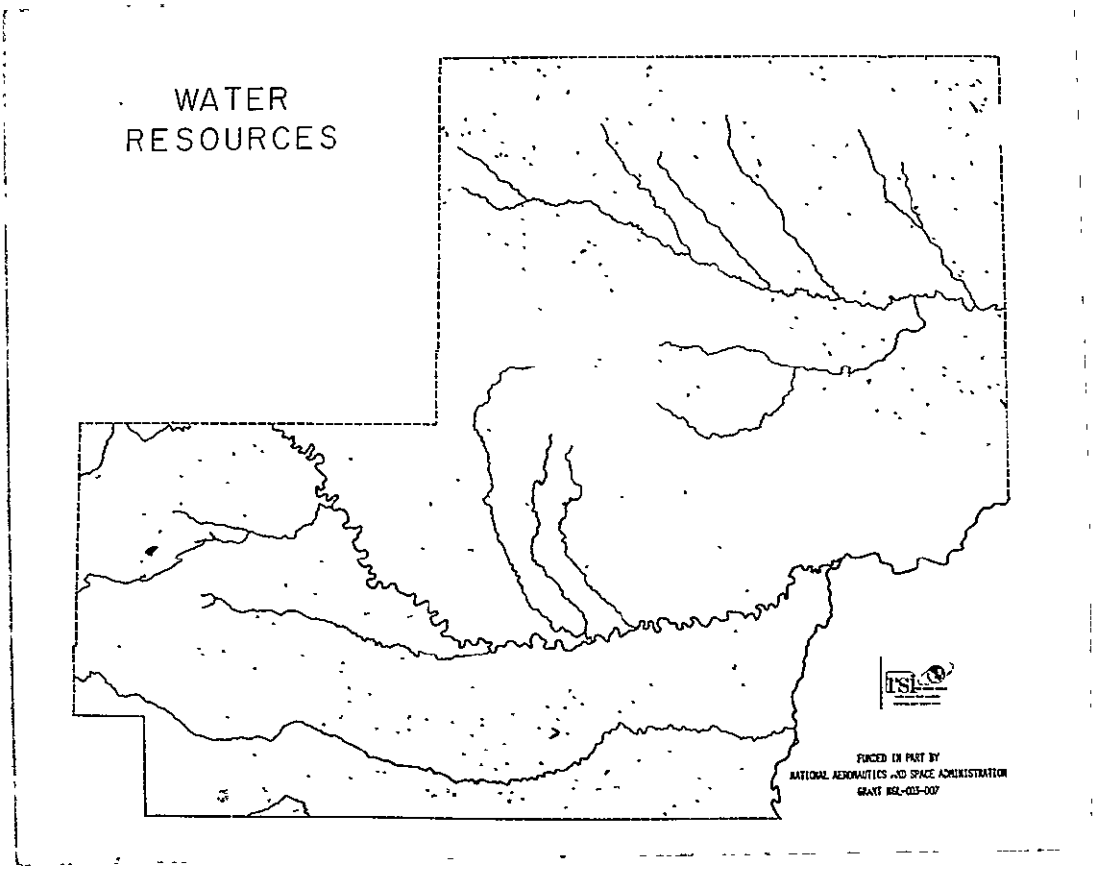

Figure 7. Water resources of Meade County interpreted from a band 7 LANDSAT-1 image at 1:250,000 scale (NASA ID#1351-17064 and 1353-17123). Scale = 1:1,000,000.

USES IN COUNTY-WIDE PLANNING

The land use map (Level I) of Meade County has been used separately and in combination with the various county-wide soil interpretations. The map was used to determine the extent and distribution of major agricultural regions to study their relationships to the areas where rapid growth is occuring (urban areas). Land use data were used in conjunction with soil interpretations to designate certain land use categories in accordance with their limitations and/or potentials. The County planning and zoning officials are giving special consideration to prime agricultural lands as well as good rangeland. They are also using the flood plain nd water resource maps with the land use maps to study relationships between urbanizing areas and flood prone areas, rarangeland and water resources, etc.

USES IN DETAILED PLANNING

Detailed land use data (Modified Level III, Table 2) have been especially useful in determining the actual extent and spatial distribution of development in the Black Hills Area. Quite obvious on the interpretations (Figure 2) are new mobile home courts and development in the forested slopes adjacent to the interstate highway. The detailed land use data provided increased information when used in combination with computer-mapped soil survey interpretations. For example, together the relationships between land use components (residences, mobile homes, etc.) and soil limitations are obvious. These data provide needed information for proper planning and zoning operations and are being effectively used for such in Meade County.

RELATED PUBLICATIONS

Two publications illustrating the applications of remote sensing techniques to planning problems in Meade County were presented at the Symposium on Remote Sensing Applications to North American Land Use Oct. 26-30, 1975 in Phoenix, Arizona. The meeting was sponsored by the American Society of Photography. The first publication, "Hierarchical Resource Analysis for Land Use Planning Through Remote Sensing" describes how

remote sensing can be used to provide regional and detailed site specific inventories of land use and soil resource limitations and/or capabilities for land use planning. The second publication, "Integration of Remotely Sensed Land Use Data with Soil Interpretations for Resource Planning" illustrates how other required planning information, interpretations of soil limitations or suitability in this case, can be integrated with remotely sensed land use interpretations for resource planning. The paper discusses data processing techniques which can greatly enhance the use of remotely sensed data by allowing various interpretations, regardless of scale, to be integrated with other data (e.g., soil interpretations) for planning purposes.

SUMMARY AND CONCLUSIONS

Remote sensing technology was effectively used to provide land use and soil survey information for comprehensive county wide and detailed land use planning and zoning in Meade County. The types of data collected by remote sensing techniques was determined by consultation with the planners responsible for development of the land use plan. The following data have been provided to the action groups and are being used for county-wide and detailed planning in the Black Hills area:

1. Level I land use data at scales of 1:63,350 and 1:250,000 for entire county.
2. Detailed land use data at scales of 1:24,000 and 1:7,920 for Black Hills Area of county.
3. General soils map at scales of 1:63,350 and 1:250,000 for entire county.
4. Limitations to development and resource opportunities were interpreted from the county-wide general soils map and provided to the planning personnel.
5. General maps of floodplain areas and water resources were provided to planners.
6. Computer maps of soil interpretations of SCS soils data were provided at the scale of detailed land use data on a photographic background for planning and zoning purposes.

In addition, the utility of using photographs as base maps for plotting data has been illustrated to the land use planners in Meade County.

PENNINGTON COUNTY FOLLOW-UP ACTIVITIES

The objective of this NASA sponsored activity was to develop technology for using remote sensing imagery to rapidly develop general soils and land use inventories for implementing operational programs in Pennington County. The project utilized LANDSAT-1 satellite and high altitude RB-57 imagery to produce land use maps and a general soil survey for the agricultural portion of the county.

Pennington County and State of South Dakota officials were involved in the planning and decision-making processes. The Director of Equalization, the County Commissioners Sixth District Council of Local Governments personnel and the State Department of Revenue were actively involved, and the Black Hills Conservancy Subdistrict and other groups to a lesser extent.

Substantial follow-up work has been underway in Pennington County during the 1974-75 fiscal year. The county commissioners have called upon RSI personnel several times to meet with groups to discuss the land use, soils and land evaluation products. As a result of the project, commissioners purchased a set of large scale (1:24,000) RB-57 imagery from RSI for detailed studies by county planners. They are presently drafting overlays of section boundaries, present land use and zoning delineations on these enlargement prints.

A publication, "Use of ERTS-1 Imagery for Land Evaluation in Pennington County, South Dakota," described the methodology for arriving at a soilscape map, a land value map, and describes the practical application of the soilscape map. The soilscape map was interpreted for limitations for urban development and the soils for resource opportunities for agricultural production. The land value assessment and the interpretations were published in a popular publication entitled, "Soilscapes Interpreted from LANDSAT Imagery, Pennington County, South Dakota" Another popular publication, "Land Use Data Interpreted from ERTS-1 Imagery" describes the techniques used to delineate various land use classes.

The soils data from LANDSAT I imagery has been used in tax equalization of agricultural land in Pennington County. The data were transferred to large scale black and white photography and furnished to a consultant for reassessment of agricultural land in the county. The use and value of these data for land evaluation in Pennington County are expressed in a letter from Lillian Juran, Director of Equalization (Appendix A). An earlier letter from M.T. Norton, Area Appraiser for the Department of Revenue, gives his appraisal of the value of the project in easing his responsibilities is also enclosed in (Appendix A).

Although it is difficult to estimate the dollar savings or returns resulting from these remote sensing efforts, it is easy to visualize the value of the NASA-RSI program in Pennington County. Remote sensing technology has furnished planners with a general soils map, land use and land use potential maps, and other resource maps. Without this project, Pennington County would not have had this information for many years. Also, procedures were established whereby other counties can be provided with similar data products and information in a timely manner.

NASA PROJECTS AND FEEDBACK TO RSI

In addition to personal letters responding to certain projects sponsored by NASA Office of University Affairs Grants, other feedback concerning the application of remote sensing technology to current problems or requests for communicating the technology involved have been common. For example, recent work in Pennington County and ongoing work in Potter County on soil surveys for tax equalization has resulted in several requests to RSI personnel to describe the techniques used and their applications. Requests were made for and talks were presented at the Spring Seminar for South Dakota Assessing Officers and at the Sixteenth Annual Conference of the Midwestern States Association of Tax Administrators. Program information and requests are in Appendix A. A presentation was also given to the Rotary club in Gettysburg, Potter County where work is currently underway. Other interest in ag-land evaluation for tax purposes through remotely sensed soil surveys are exemplified by requests from Leroy Mullerleile of the Minnesota Dept. of Revenue, Pearl Bringelson (Douglas County Director of Equalization), and several phone calls from

the Clark County Director of Equalization, Darlene Hurlbut. Ziebach County, South Dakota has also expressed an interest.

Requests for cost estimates for land use maps of varying detail via remote sensing techniques, have recently been received from Hughes County and for several Western S.D. counties by the Sixth District Council of Local Governments located in Rapid City, South Dakota.

OTHER PROJECTS SUPPORTED IN PART BY NASA OFFICE OF UNIVERSITY AFFAIRS

AIR BORNE THERMOGRAPHY OF TEMPERATURE PATTERNS IN SUGAR BEET PILES

Spoilage of sugar beets in storage piles can cause substantial financial loss to the processor and grower. Spoilage results in the generation of heat within the pile which is normally expressed as a temperature anomaly at or near the surface of the pile. Airborne thermal-infrared scanner imagery (thermography) was evaluated as a technique to locate spoilage areas and aid in scheduling the processing of sugar beet piles. The use of this technique to detect spoilage areas in sugar beet storage piles appears to have promise. A paper entitled "Evaluation of Thermography as an Aid to Scheduling the Harvest of Sugarbeet Storage Piles to Minimize Spoilage Losses" provides the operational details. The investigation was reported at the Tenth International Symposium on Remote Sensing of Environment held Oct. 6-10, 1975 at the University of Michigan, Ann Arbor, Michigan. The American Crystal Sugar Company (Moorhead, Minn.) has contracted with RSI for three thermal scanning missions over sugar beet storage piles in the Red River Valley during 1975-1976 storage season.

DETECTION OF APPARENT ROOFTOP TEMPERATURES BY THERMOGRAPHY

Present energy situations dictate the necessity for energy conservation and the rectification of present energy-loss problems. One area receiving considerable attention is home insulation. The Remote Sensing Institute has evaluated and made operational a procedure using an aerial thermal scanner system to survey entire communities for apparent rooftop temperatures. These scanner data are processed to form thermograms or pictures of the temperature patterns among rooftops which can be used to infer

heat losses due to poor insulation. Details of the procedure and its use by CENGAS, a division of Central Telephone and Utilities Company, were reported recently at the Tenth International Symposium on Remote Sensing of the Environment held Oct. 6-10, 1975 at the University of Michigan, Ann Arbor, Michigan. Numerous news releases over all media (radio, TV, newspapers, etc.) have been made concerning this technique and its applicability. Additional thermal surveys of rooftops have been scheduled for completion during the 1975-1976 winter season.

THE INFLUENCE OF SOILS UPON LANDSAT SPECTRAL SIGNATURES

This study was undertaken during the 1974 growing season to determine the influence of soils and vegetation on LANDSAT spectral signatures. Spectral differences among six important glacial soil associations were investigated through the use of multi-temporal Exotech radiometric data and computer compatible tapes of two LANDSAT scenes.

Soil-plant interrelationships were evident among radiometer data collected from wheat grown on different soil associations.

From the analysis of April 19, 1974 LANDSAT data, soil differences had a more pronounced influence on the spectral properties of grassland than on bare soil.

The influence of soils upon the spectral properties of corn and oats data were investigated using June 30, 1974 LANDSAT data. The most pronounced soil differences were found among the corn data where soil associations could be identified correctly within the corn data 70 percent of the time.

Results of this study emphasize that soils influence the spectral properties of vegetation and should be considered when inventorying vegetation on a regional basis using LANDSAT data.

The investigation was conducted by Mr. Gary Lemme and Dr. Fred Westin, graduate student and Professor in Plant Sciences Department, respectively. Work was supported primarily by the Agricultural Experiment Station and partially by the NASA Office of University Affairs Grant to the Remote Sensing Institute. This work is being drafted in thesis form and a copy will be located in the RSI Library.

BICENTENNIAL ACTIVITIES

SIOUX FALLS BICENTENNIAL PARKWAY

The single most important Bicentennial project with which RSI personnel have worked is the Sioux Falls Bicentennial Parkway. It is sponsored by the Sioux Falls Park and Recreation Department. The City Commission budgeted over $300,000 of revenue-sharing funds for land acquisition, chiefly of river-front property along the Big Sioux River. Land acquisition is taking longer than expected and the Sioux Falls Park and Recreation Department has had to proceed with detailed planning of one phase of the Parkway. This and personnel changes have hampered progress and most of the planning over the past year dealt with concept planning utilizing very large scale maps and air photos. Progress, however, was made along the following avenues:

1. Education and familiarization of park and recreation personnel with basic remote sensing technique, capabilities, applications and limitations.
2. Ascertainment of local needs. An image quality and interpretability summary was supplied to the planners. A summary which reflects the specific needs of park and recreation planning is being developed.
3. Several RSI techniques of using photographic bases for display of data have been suggested and are being actively investigated.
4. Recent NASA U-2 coverage (May 1975) of the proposed parkway was supplied to the Parks and Recreation Dept. for the conceptual planning effort. The potential uses of the color infrared photography, which was enlarged to a scale of 1:5000 was discussed with Parks and Recreation Personnel.

It is expected that further consultation on the use of these steps and other remote sensing technology will accompany the remaining efforts on the Bicentennial Parkway.

The LANDSAT mosaic of the state with principal agricultural areas, transportation routes, and notes of interest is in preparation with support being solicited from interested groups by the SDSU Gamma Sigma Delta organization. The map is to be distributed during the Bicentennial

Affair to acquaint interested groups as tourists with South Dakota agricultural areas, resources, and points of interest as viewed from major transportation arteries in the state.

NEWS RELEASES-NASA PROJECTS

MEADE COUNTY PROJECT

The role of remote sensing technology as a source of land use and soil data for Meade County was discussed in an article entitled "Land Use Planning Progresses" in the Sunday, February 16, 1975 issue of the Rapid City Journal. The article is in Appendix B. The gaps filled by operational remote sensing technology are discussed in the context of "tools" provided for planning and zoning.

THERMAL SCANNING FOR APPARENT ROOFTOP TEMPERATURES

The Remote Sensing Institute at South Dakota State University has developed, tested, and is utilizing a thermal scanner system to survey apparent rooftop temperatures for entire communities. The technique, developed under partial NASA funding, has been conducted for CENGAS (the GAS ENERGY DIVISION OF CENTRAL TELEPHONE AND UTILITIES) for several communities. The applications have been described in numerous recent news releases. One, which appeared in PARADE(Sunday News Supplement) was simply entitled "AERIAL SURVEY" and discussed the NASA-supported technique. Another entitled "WHEN THERE'S FIRE IN THE FURNACE, IS THERE SNOW ON THE ROOF?" was in the Sept, 1975 issue of Electro-Optical Systems Design (Vol 7, No. 9) and also discussed the operational program. Both articles are in Appendix B. More than 50 articles explaining the projecthave been published.

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Anderson, J.R., E.E. Hardy, and J.T. Roach. 1971. A Land-Use Classification System for Use with Remote-Sensor Data. Geological Survey Circular 671.

Benson, Lawrence A., Charles J. Frazee, and V.I. Myers, "Land Classification of the Lake Dakota Plain in South Dakota with Remote Sensing Methods." Interim Technical Report, SDSU-RSI-73-13, August, 1973.

Brink, A.B.A., J.A. Mabbutt, R. Webster, and P.H.T. Beckett. 1966. "Report of the Working Group on Land Classification and Data Storage. Mil. Eng. Expt. Estab. Christchurch, England. Mexe Report 940.

Christian, C.S., and G.A. Stewart. 1968. "Methodology of Integrated Surveys." Proc. Toulouse Conference. UNESCO, Paris. P. 233-280.

Frazee, C.J., V.I. Myers, and F.C. Westin. 1972. "Density Slicing Techniques for Soil Survey." Soil Sci. Soc. Amer. Proc. 36:693-695.

Frazee, C.J., P.H. Rahn, F.C. Westin, and V.I. Myers. 1974. "Use of ERTS-1 Imagery for Land Evaluation in Pennington County, South Dakota," Proceedings, Ninth International Symposium on Remote Sensing of Environment, Ann Arbor, Michigan. pp 549-568.

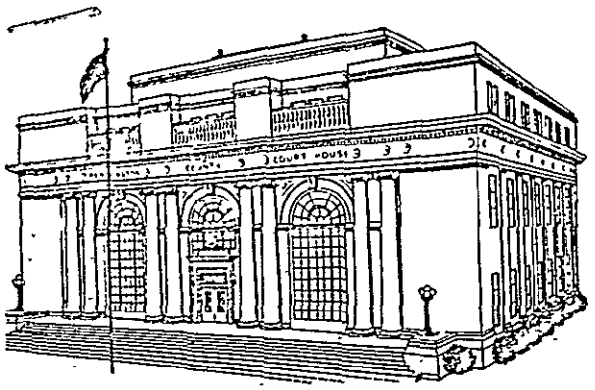
Webster, R. and R.H.T. Beckett. 1970. "Terrain Classification and Evaluation Using Air Photography: A Review of Recent Work at Oxford." Photogrammetria 26: 51-75.

Publications List

The following is a list of popular and published articles supported by NASA Office of University Affairs Grant No. NGL.42-003-007 during the period July 1, 1974 to June 30, 1975

1. Frazee, C.J., P.H. Rahn, F.C. WEstin and V.I. Myers, 1974. Use of ERTS-1 Imagery for Land Evaluation in Pennington County, South Dakota, Proceedings, Ninth International Symposium on Remote Sensing of Environment, Ann Arbor, Michigan. pp. 549-668.
2. Byrnes, B.H., C.J. Frazee and T.L. Cox. 1975. Hierarchical Resource Analysis for Land Use Planning Through Remote Sensing. Proceedings American Society of Photogrammetry (Symposium on Remote Sensing Applications to North American Land Use Including Resource Management in Arid Environments, ASP-ACSM Fall Convention), Oct 26-31, Phoenix, Arizona.
3. Cox,T.L. and B.H. Byrnes. 1975. Integration of Remotely Sensed Land Use Data with Soil Interpretations for Resource Planning. proceedings American Society of Photogrammetry (Symposium on Remote Sensing Applications to North American Land Use Including Resource Management in Arid Environments, ASP-ACSM Fall Convention). Oct 26-31, Phoenix, Arizona.
4. Bjorklund, J., F.A. Schmer and R.E. Isakson. 1975. A report on the Use of Thermal Scanner Data in an Operational Program for Monitoring Apparent Rooftop Temperatures. Proceedings, Tenth International Symposium on Remote Sensing of Environment, Ann Arbor, Michigan.
5. Moore, D.G., S. Bichsel and R. Best. 1975. Evaluation of Thermography as an Aid to Scheduling the Harvest of Sugarbeet Storage Piles to Minimize Spoilage Losses. Proceedings, Tenth International Symposium on Remote Sensing of the Environment, Ann Arbor, Michigan.
6. Bateman, A.J. and C.J. Frazee. 1975. Developing a Land Use Planning Process: The Meade County Story. Extension Bulletin (In preparation)
7. Land Use Data Interpreted from ERTS-1 Imagery, Pennington County. AES Info Series No. 10, Feb. 1975. SDSU RSI 75-01, South Dakota State University, Brookings, South Dakota 57006.

8. Soilscapes Interpreted from LANDSAT Imagery. SDSU RSI 75-05 and AES Info Series No. 12, South Dakota State University, Brookings, South Dakota 57006.



Pennington County

OFFICE OF DIRECTOR OF EQUALIZATION

RAPID CITY, SOUTH DAKOTA 57701

Sept. 15, 1975

Remote Sending Institute
South Dakota State University
University Station
Brookings, S. D. 57006

Dear Sirs:

I have received the copies of the popular publication on the work done in Pennington County by Dr. Frazee, and I like the way the booklet was put together, with map and explanation.

The data of the soilscape maps was used in our recent reappraisal, In most areas the soil classes are correct. Some areas are being checked for review as to soil class.

Over all we found the information and data very useful, and truly a guideline to use in land values.

Sincerely,

Lillian Juran

Lillian Juran
Director of Equalization

Hot Springs, S. Dak.
20 Sept 74

Mr. Victor I. Myers
Remote Sensing Institute
Brookings, South Dakota

Dear Mr. Myers:

I have had the pleasure of working with Dr. Chas. Frazee over the past several months on the reappraisal of Pennington County using Remote Sensing Material.

To me it is fantastic as to the accuracy of these highlevel photos, and the use that can be made of them, in the appraisal of rural land.

With the information that your institute can provide, and the cost estimates being what they are, I can see no reason why other counties should not be taking advantage of this service for valuing land for assessment, in compliance with the 1970 Ag valuation law, rather than waiting several years for a soil survey to be made.

As a member of the field staff of the Department of Revenue, I would personally recommend that other counties, especially here in the West River Area, look into the use of Remote Sensing for the evaluation of land for Assessment purposes.

I hope that I will be able to spend much more time in this field in the months to come.

Sincerely yours

Melvin T. Norton
Area Appraiser
Dept. of Revenue
Hot Springs, S. Dak.

STATE OF MINNESOTA
DEPARTMENT OF REVENUE
CENTENNIAL OFFICE BUILDING
SAINT PAUL MINNESOTA 55145

July 29, 1975

Mr. Bernie Byrnes
Assistant Research Soil Scientist
Remote Sensing Institute
South Dakota State University
Brookings, South Dakota 57006

Dear Mr. Byrnes:

On behalf of the Minnesota Department of Revenue, I express thanks and appreciation for your response to my request for information about your use of satellite imagery in property tax assessment. The three publications were very interesting and informative. I have passed them on to Bill Slavin of our Property Equalization Division and chairman of the committee I referred to in my letter to Paul Schmidt.

I was also interested in an article on RSI's involvement in measuring heat losses from roofs that appeared in last Sunday's Minneapolis Tribune. This appears to be a very worthwhile project that should interest anyone paying the monthly heating bill.

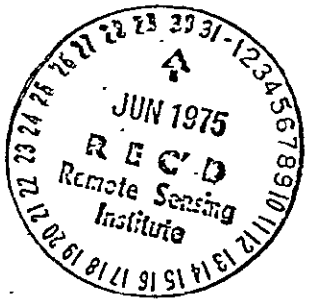
Thanks again for the information and your quick response. I will inform you if we decide to utilize this technique in conducting future property tax assessment activities in Minnesota.

Sincerely,

Leroy Mullerleile, Supervisor
Systems Office

/js

DIRECTOR OF EQUALIZATION
DOUGLAS COUNTY
ARMOUR, SOUTH DAKOTA 57313
June 25, 1975



Bernard H. Byrnes
Ass't. Research Soil Scientist
South Dakota State University
Brookings, South Dakota 57006

Dear Sir;

The Douglas County Commissioners have asked me to write for more information in regard to the RSI maps.

1. What would the cost be to map Douglas County?

2. What is the approximate length of time it would take to prepare such a map, for use in the County?

3. How would this type of a map compare to the regular Soil Survey map?

4. Douglas County has contracted for a soil survey which is thought it would be completed in approximately three and one-half years, would the additional cost of a RSI map benefit the County?

5. Douglas County has a Soil Survey map that was researched in 1923, would this be of any value now? Could this be updated according to the new classifications? If so what would the cost be?

Please include any additional information that would ne helpful.

Thank you.

Sincerely yours,

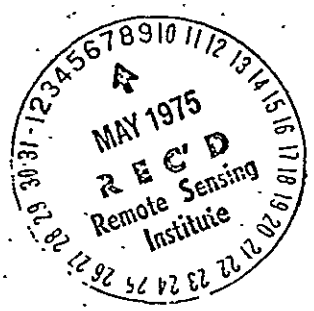
Pearl L. Bringelson
Director of Equalization

--TENTATIVE PROGRAM--

SPRING SEMINAR FOR SOUTH DAKOTA ASSESSING OFFICERS
(All meetings to be held in the Hall of States room - Guest House)

May 15-16, 1975

Guest House
101 North Broadway
Watertown, South Dakota



May 14 -- Wednesday.

3:00 P.M. - Tour of Big Stone Power Plant.
Those attending meet at Main Gate at 2:45 p.m.
(From Big Stone City follow signs on Highway 15Y)
8:00 P.M. - Executive Board Meeting of SDAAO, also publications committee at Guest House.

May 15 -- Thursday. - Anker Dybdahl, CSDA - presiding

8:00 A.M. - Registration by SDAAO (tentative fee $6.00, Banquet included)
9:30 A.M. - Coffee
10:00 A.M. - Opening of Program - Secretary of Revenue, Lyle Wendell
10:30 A.M. - Appeal Procedure - Ralph Mernaugh, Chairman of State Board of Equalization.
11:00 A.M. - Assessors Certification Program - George Winckler, CAE, CSDA.

12:00 NOON - Lunch hour.

1:15 P.M. - Varied Subject Matters - Property Tax Division
2:15 P.M. - Ag-land classification by remote sensing - Bernie Byrnes, Staff Specialist-Soils and Dr. Tracy Cox, Research Environmental Scientist.
2:50 P.M. - Coffee
3:20 P.M. - New Legislation - John Dewell, Ass't Attorney General.
3:45 P.M. - HB-744 Livestock - Paul E. Schmitt, CSDA
6:30 P.M. - BANQUET at Elks Club

May 16 -- Friday

8:00 A.M. - HB-744 Livestock (continued)
9:00 A.M. - (to be determined)
9:45 A.M. - Coffee
10:15 A.M. - SDAAO Meeting

Note: Bring your copy of HB-744.

May 19, 1975

Mr. Victor Myers
Director of Remote Sensing Institute
Harding Hall
South Dakota State University
Brookings, South Dakota 57006

Dear Mr. Myers:

The Midwestern States Association of Tax Administrators are having a conference at the Curtis Hotel in Minneapolis August 10-12, 1975. Several of the states have shown an interest in the progress made in regard to Ag-land Classification by Remote Sensing.

We have been contacted by Mr. Gene Eik, Deputy Director of Property Tax for Iowa who is also chairman of the property tax program for M.S.A.T.A. for the conference. He has asked us to contact the Remote Sensing Institute for a 30 to 45 minute program on August 12th.

We talked to Bernie Byrnes about this and he suggest we contact you for your approval.

There are 13 states in this group: North Dakota, Nebraska, Oklahoma, Kansas, South Dakota, Missouri, Iowa, Minnesota, Wisconsin, Illinois, Indiana, Ohio and Michigan.

We ask for your approval of furnishing this program.

Sincerely,

Paul E. Schmitt
Director of Property Tax

PES:jeb

cc: Bernie Byrnes
Gene Eik

Monday P.M.

A Property Tax Program for Billion Dollar Energy Plants
Byron Dorgan, Commissioner
North Dakota

Review of Major Innovations and New Legislation
W. D. Gibson, Utility Analyst
Indiana

Tuesday A.M.

Land Evaluation Through Remote Sensing
Tracy L. Cox, Research Environmental Scientist
Remote Sensing Institute
South Dakota

State Certification of Local Assessors
Vernon L. Anderson, Chairman
Minnesota State Board of Assessors

Computer Assistance in Assessment Procedures
Frank Frost, Asst. Administrator
Nebraska

PARADE'S SPECIAL

INTELLIGENCE REPORT

by LLOYD SHEARER

BECAUSE OF VOLUME OF MAIL RECEIVED, PARADE REGRETS IT CANNOT ANSWER QUERIES ABOUT THIS COLUMN.

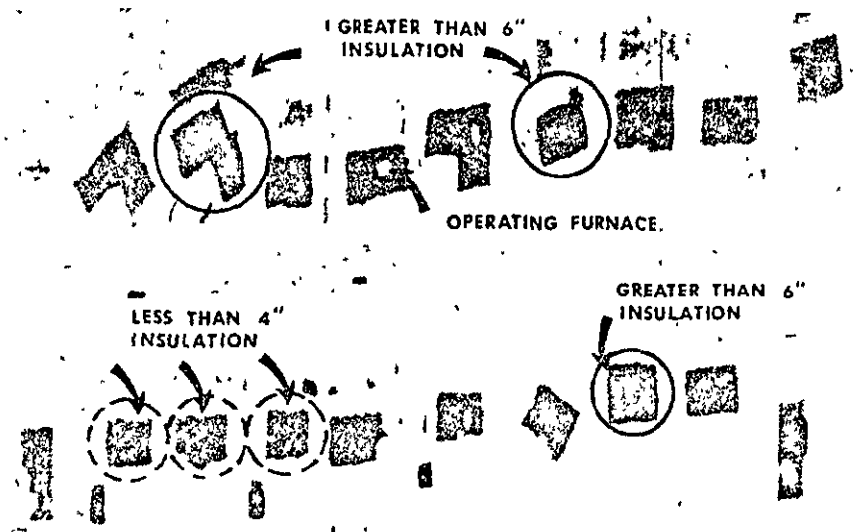
PARADE 9/14/75

AERIAL SURVEY It's no secret that the world's major military powers use aerial surveillance to spy on other nations' missile bases and on other intelligence targets--but the National Aeronautics and Space Administration now has found a civilian application for that technique, and it could reduce heating bills next winter.

NASA showed a utility company last winter how to conduct an aerial survey of Sioux Falls, S.D., and of four communities in Nebraska--Lincoln, Beatrice, Columbus and Norfolk--to identify homes, stores and offices that waste fuel through heat loss from poor insulation.

The key is a sophisticated tape-and-film process that produces photographs showing warm roofs in light tones--indicating heat leakage--and cool roofs in darker tones.

The utility company, Cengas, paid all costs of the survey and now is inviting its customers to examine the aerial photographs of their buildings to determine whether they should install insulation before the cold weather returns.



IN THIS AERIAL PHOTO, WARM ROOFS—INDICATING POOR INSULATION—SHOW UP LIGHTER THAN DO COOL ROOFS.

NEWS (continued)

DIGITAL DISPLAY REPORT

New York, NY — The market research firm of Frost & Sullivan, Inc. has compiled a 154-page analysis of the major supplier segments of the optoelectronics industry and the major product areas using optoelectronic devices.

There was a time when the market growth curves ran upward to never-ending heights. That changed somewhat, the firm reports. While liquid crystals will go from a $3.2 million base in 1974 to $230 million by 1982, gas-discharge devices, pegged at $34 million in 1974 will peak out at $62 million by 1978 and drop to $29 million by 1982. LEDs will more than double, from $103 million in '74 to $261 million in '82. Electronic watch displays will triple by 1975 and peak out by 1977, even though the digital electronic watch market will continue to expand.

Frost & Sullivan cite the dynamic factors at work as cost-cutting technology and the vertical integration of heretofore "supplier-only" companies. □

WHEN THERE'S FIRE IN THE FURNACE, IS THERE SNOW ON THE ROOF?

Brookings, SD — Cengas, the natural-gas distributing division of Central Telephone and Utilities Corp., conducted an aerial survey of rooftops in five midwestern communities last winter. The purpose of the survey was to determine whether home owners were wasting fuel due to inadequate insulation. During several cold, clear nights, an airplane made successive low altitude passes over the cities, using a thermal infrared scanner to map the radiated thermal energy. Each pass covered a strip about three city blocks wide. Roof surface temperatures were recorded on magnetic tape and then converted into data on strips of film by the Remote Sensing Institute at South Dakota State University. The data were then printed on photographic paper.

In the resulting imagery, called thermograms, silhouettes of individual buildings are easily seen. Warm roofs appear in light tones and cool roofs darker. Cengas officials estimate that at least 60,000 buildings in the five communities surveyed are losing excessive amounts of heat. Cengas customers have been invited to examine the survey results and judge whether they could save fuel by installing better insulation.

The aerial survey technique was developed by the Remote Sensing Institute with support by the State of South Dakota and NASA's Office of University Affairs. The operational surveys were paid for by the utility company. □

LASER-FUSION CONTRACT AWARDED

Ann Arbor, MI—KMS Fusion, Inc. has been awarded a $2,920,000 cost-type letter contract by the Energy Research and Development Administration for theoretical, experimental and analytical research activities in support of the national laser-fusion program. The primary objective of the contract is to help define the conditions necessary for achieving significant thermonuclear burn (about 1 trillion neutrons per pellet implosion) and laser light-pellet energy breakeven