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RESEARCH APPLICATIONS PROGRAMS

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KARS

Kansas Applied Remote Sensing Program

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THE APPLICATION OF REMOTE SENSING TO RESOURCE MANAGEMENT AND ENVIRONMENTAL QUALITY PROGRAMS IN KANSAS

December 1983

THE APPLICATION OF REMOTE SENSING TO RESOURCE MANAGEMENT AND ENVIRONMENTAL QUALITY PROGRAMS IN KANSAS

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ABSTRACT

Activities of the Kansas Applied Remote Sensing (KARS) Program are designed to establish interactions on cooperative projects with decision-makers in Kansas agencies in the development and application of remote sensing and GIS procedures. This report describes the activities of the KARS Program in pursuit of its objectives during the period April 1, 1982 through March 31, 1983.

The projects conducted during this year comprised a mix of short-term projects in which agencies have identified critical areas of immediate data needs and longer-term projects that have been continued from previous years because of their importance or a renewed interest on the part of the agency involved.

The most important work revolved around the Kansas Interagency Task Force on Applied Remote Sensing and its efforts to establish an operational service-oriented remote sensing program in Kansas state government. Concomitant with this work was the upgrading of KARS capabilities to process data for state agencies through the vehicle of a low-cost digital data processing system.

As an agricultural state, Kansas is particularly receptive to technological advances that relate to agriculture. The KARS Program has continued to take an active role in irrigation mapping stemming from the original mapping effort that was begun in 1973. KARS is now integrating data acquired through analysis of Landsat into geographic information systems designed for evaluating groundwater resources.

Management and conservation of land-related resources is another area of key concern in the state. One project is concerned with management practices in rangeland areas. Another deals with construction of a digital soils data base for use in planning, tax appraisal and natural resource management. Other projects are concerned with preserving existing environments, one with those which are necessary as habitats for wildlife, and another with conservation of soils through assessment of fallow lands.

KARS also continues to work at the national level on projects of broad scope, such as the national inventory of state natural resources information systems to be completed in late 1983.

I. THE KANSAS APPLIED REMOTE SENSING PROGRAM

THE KANSAS APPLIED REMOTE SENSING PROGRAM

INTRODUCTION

The unique contemporary problems facing officials at all levels of government and within private industry have created a need for objective data gathering to supplement or in some cases replace traditional methodologies. The need for objective data gathering has been further emphasized by the increasing pressures from social, environmental and economic considerations.

The University of Kansas Applied Remote Sensing (KARS) Program has established a continuing program of activities to evaluate and demonstrate the utility of remote sensing technology in data gathering for decision-makers in state, regional and local agencies. Now in its eleventh year, the KARS Program is developing the concepts and methodologies to utilize remote sensing procedures and related spatial data analysis technologies in dealing with significant problems in Kansas related to changing urbanization patterns, rapid irrigation growth, changing agricultural needs and environmental quality. This activity has been accomplished primarily through cooperative projects undertaken with governmental agencies in Kansas on problems of immediate concern.

This report outlines the activities and accomplishments of the KARS Program during the period April 1, 1982 through March 31, 1983 in pursuit of its key objectives:

- <u>Research and develop</u> new modes of analyzing Thematic Mapper, Multispectral Scanner, Aerial Camera, Thermal Scanner, and Radar data, singly or in concert, in order that more effective use can be made of such systems.
- <u>Merge</u> data derived from remote sensing with data derived from conventional sources in geographic information systems to facilitate better environmental planning and resources management.
- <u>Stimulate</u> the application of the products of remote sensing systems to significant problems of resource management and environmental quality now being addressed in NASA's Global Habitability directive.
- <u>Apply</u> remote sensing techniques and analysis and geographic information systems technology to the solution of significant concerns of state and local officials and private industry.

- Participate cooperatively on remote sensing projects with public agencies and private firms.
- Effect the transfer of applicable remote sensing technology to governmental agencies and private firms at all levels as a by-product of projects conducted in the KARS Program.
- Assist personnel within public agencies and industry in the evaluation of the capabilities of the rapidly changing remote sensing systems and the benefits which might be achieved through their utilization.
- Guide, assist and stimulate faculty, staff and students in the utilization of information from the Earth Resources Satellite (Landsat) and Aircraft Programs of NASA in research, education and public service activities carried out at the University of Kansas.

THE KANSAS APPLIED REMOTE SENSING (KARS) PROGRAM

The Kansas Applied Remote Sensing (KARS) Program was established by the National Aeronautics and Space Administration (NASA) in 1972 to conduct applied research on techniques which will enable public agencies and private industry to better utilize available satellite and airborne remote sensing systems. The KARS Program is an applied research program of the University of Kansas Space Technology Center administered through the University of Kansas Center for Research, Inc. The Program draws upon the remote sensing expertise and facilities of the University of Kansas accumulated as a result of over 18 years of research in remote sensing conducted at the University. The applied and basic research programs of the KARS Program and the KU Remote Sensing Laboratory, respectively, have received national recognition.

The Space Technology Center (STC) was founded in 1972 by the National Aeronautics and Space Administration (NASA) and the State of Kansas to enhance research and education in space-related science and technology through multidisciplinary research efforts. STC was established as part of a NASA plan to set up a network of advanced facilities across the nation. Recognizing that important University research is sometimes impeded because specialized researchers do not have the facilities to work together, NASA sought to build centers where such interaction not only would be possible, but would be encouraged.

The goal of the Space Technology Center is to enhance research and education in space science and technology and contribute to the economic growth of the nation. To achieve this goal, the Center fosters multidisciplinary research in the sciences, humanities, engineering and business and transfers the results to the public.

The KU Space Technology Center is the last of twenty-seven interdisciplinary centers that were built across the nation as part of NASA's $44 million investment program. Its 77,000 square-foot design is planned to encourage communication between researchers and to adapt easily to the growing interests of faculty and students and the changing priorities of the space program. More than 30 KU faculty and 105 staff and students, representing every school of the University, work at the Center to explore areas that are related to the space program.

The KARS Program provides a full range of remote sensing, mapping, geographic information system, and related services (Table 1). Projects undertaken by the KARS Program with public agencies or private clients are designed to identify and facilitate the manner in which remote sensing/geographic information systems technology can be employed to aid in decision-making, policy formulation, planning and in meeting other responsibilities and objectives. The KARS Program has provided assistance and services to more than forty agencies and firms in Kansas, Missouri and other states in the Great Plains/Rocky Mountain region. Contractual applied remote sensing projects have been carried out for the National Aeronautics and Space Administration, U. S. Fish and Wildlife Service, U. S. Office of Surface Mining, USDA/Soil Conservation Service, U. S. Environmental Protection Agency, U. S. National Park Service, Missouri River Basin Commission, Kansas Fish and Game Commission, Mid-America Regional Council and Farmland Industries, Inc. (Appendix I). Projects have involved land use/land cover inventory, monitoring land use change, wildlife habitat evaluation, mapping of irrigated lands, surface mined lands inventory, recreational area planning, soil conservation needs assessment, aquatic vegetation mapping, rangeland condition evaluation, urban area analysis, and education and training (Table 2). In addition, KARS staff have provided remote sensing consulting services to the Government of India under the auspices of UNESCO, the State of Wyoming, the State of Tennessee, and the State of Chihuahua, Mexico.

Table 1. SERVICES OF THE KARS PROGRAM

The KARS Program provides the following services:

- Interpretation of remote sensing data in support of land use/land cover, environmental, planning, agricultural and natural resources inventories and analyses;

- Research in the analysis of remote sensing data and in applications of remote sensing/geographic information systems technologies;

- Geocoding, geographic information system design and production; statistical analysis, design of sampling surveys, areal statistical data summaries;

- Analysis of trends, projections, spatial modeling, monitoring of change on a seasonal (e.g., range burning, harvesting) or annual basis (e.g., land use, wildlife habitat);

- Map production using state-of-the-art cartographic techniques including negative scribing, color separation and computer graphics;

- Field investigation either in support of remote sensing data collection or independently designed to meet specific agency or client requirements;

- Aerial photography in support of KARS research and applications projects;

- Location and acquisition of remote sensing data; flight mission design;

- Instruction in remote sensing techniques, interpretation and applications; short courses, workshops, seminars; technology transfer.

Table 2. MAJOR KARS PROGRAM RESEARCH AND APPLICATIONS AREAS

Land use/land cover inventory, change detection and mapping

Irrigated lands inventories

Water resources management

Wildlife habitat evaluation

Strip mined lands assessment

Crop and rangeland resource inventory and evaluation

Integrated natural resources inventories

Geographic information system design, construction, and application

Thematic mapping

Technology transfer/remote sensing education

One measure of the KARS Program's success in working with state agencies and other users in Kansas is the unanimity of support for the Kansas Interagency Task Force on Applied Remote Sensing. The Task Force, comprised of representatives of all state agencies that have utilized Landsat or other remote sensing data, is actively engaged in examining alternatives for making greater operational use of the KARS Program to serve Kansas State government. The Kansas Legislature, in 1982, endorsed a resolution in support of the KARS Program and the Task Force, awarded the KARS Program funds to work more operationally with Kansas agencies and established a fee fund to facilitate such work.

During 1983 the Task Force has supported KARS' successful efforts to retain baseline funding from the State of Kansas. In addition, the Task Force has drafted legislation to (1) create a permanent state commission on remote sensing and (2) inventory all surface water resources in Kansas. These bills will be considered by the Kansas Legislature in 1984. The Office of Kansas Governor John Carlin has been very supportive of the Task Force. Governor Carlin, the Task Force and the KARS Program will hold, in November 1983, a Governor's Conference on Applied Remote Sensing, Geographic Data Analysis and Mapping in Kansas.

The KARS Program has published the quarterly KARS Newsletter since 1972 (Appendix II). The newsletter is designed to foster the application of remote sensing data and to provide a forum for communication on remote sensing related matters. Current circulation is approximately 2,000. Readers include employees of local, state, regional, and federal agencies, research centers, colleges and universities, and private firms. Most readers reside in the Midwest and Western U. S., but Newsletters are mailed throughout the United States, and to several other nations. Many new projects have developed from this medium.

As a means of facilitating KARS's responses to continual requests for information about the Program, a descriptive brochure has been designed, printed and distributed to all recipients of the KARS Newsletter. The brochure (Figure 1) details the facilities, equipment and staff of the Program and describes the capabilities and services of the KARS Program. The brochure has proved to be an invaluable introduction to the Program that provides an attractive "calling card" for distribution at meetings, workshops, agency visits and use in answering phone and mail queries.

Figure 1. The KARS Program Brochure

There continues to be substantial demand for the Kansas Landsat Mosaic, Kansas Land Use Patterns Map published in 1974, the Guide to Aerial Photography and Space Imagery and Center Pivot Irrigation Maps for Southwest Kansas. These have greatly increased the visibility of the KARS Program across Kansas.

The KARS Program has sponsored over twenty-five workshops, conferences, short courses and seminars on applied remote sensing (Appendix III). Since 1972, the KARS Program has provided training for over 700 agency personnel and other users from throughout the U. S. Training, briefings and technology transfer activities have been conducted both in Lawrence and at other locations. KARS staff have provided briefings, workshops, and seminars for legislators, public agencies, professional organizations, industry and other users in Kansas, Wyoming, Tennessee, Mexico, and India.

CONTACTS WITH AGENCIES

During the last year regular personal visits to Kansas agencies have been continued and KARS personnel have routinely attended various interagency meetings such as the Kansas Groundwater Management District Association meetings and the annual Kansas Soil Survey Work Planning Conference. Frequent meetings of the Kansas Interagency Task Force on Applied Remote Sensing have enhanced agency-KARS interaction significantly and are serving to establish the KARS Program as a key state geographic information center. These interactions are facilitating communications between the KARS Program and agency personnel. Agencies with which contacts have been established are listed in Table 3. Contacts are maintained with all of these agencies and additional contacts are actively pursued.

While projects usually develop through individual contacts between agency and KARS personnel, communications also result from more general information dissemination efforts aimed at promoting widespread interest in remote sensing applications. These activities in the past year have included (1) publication of the KARS Newsletter, (2) numerous talks and presentations to public and professional organizations throughout Kansas, (3) publication and dissemination of a new KARS Program brochure, and (4) continued distribution of several KARS publications (Appendix IV).

Table 3. AGENCIES WITH WHICH CONTACTS ARE MAINTAINED BY THE KANSAS APPLIED REMOTE SENSING PROGRAM

Municipal:

CONCORDIA, KANSAS, CHAMBER OF COMMERCE
KANSAS CITY, KANSAS, CITY COMMISSION
KANSAS CITY, KANSAS, DEPARTMENT OF PLANNING AND DEVELOPMENT
KANSAS CITY, KANSAS, MAYOR'S OFFICE
LAWRENCE, KANSAS, CITY ENGINEER
LAWRENCE, KANSAS, CITY COMMISSION
LAWRENCE, KANSAS, PLANNING DEPARTMENT
Salina, Kansas, Planning Department
OTTAWA, KANSAS, PLANNING DEPARTMENT
Overland Park, Kansas, Department of Community Development

County:

ATCHISON COUNTY, KANSAS. COMMISSIONERS
CHEROKEE COUNTY, KANSAS, BOARD OF COMMISSIONERS
CLOUD COUNTY, KANSAS, COMMISSIONERS
DOUGLAS COUNTY, KANSAS, EXTENSION AGENT
DOUGLAS COUNTY, KANSAS, PLANNING DEPARTMENT
FRANKLIN COUNTY, KANSAS, PLANNING COMMISSIONERS
Harvey County, Kansas, Planning Department
JACKSON COUNTY, KANSAS, DISTRICT CONSERVATIONIST
JOHNSON COUNTY, KANSAS, UNIFIED SEWER DISTRICT
Johnson County, Kansas, Community Development Office
NEMAHA COUNTY, KANSAS, DISTRICT CONSERVATIONIST
RILEY COUNTY, KANSAS, ENGINEER
SALINE COUNTY, KANSAS, DEPARTMENT OF PLANNING AND ZONING
SUMNER COUNTY, KANSAS, COMMISSIONERS
Wichita-Sedgwick County Metropolitan Area Planning Department, Kansas

State:

Kansas Agricultural Extension Service
KANSAS ATTORNEY GENERAL'S OFFICE
KANSAS CORPORATION COMMISSION
KANSAS STATE BOARD OF AGRICULTURE
KANSAS DEPARTMENT OF ECONOMIC DEVELOPMENT
KANSAS DEPARTMENT OF HEALTH AND ENVIRONMENT
KANSAS DEPARTMENT OF REVENUE
KANSAS DEPARTMENT OF STATE PLANNING AND RESEARCH
Kansas Department of Transportation
Kansas Department of Energy
KANSAS ADJUTANT GENERAL, DIVISION OF EMERGENCY PREPAREDNESS
Kansas State Biological Survey
Kansas Groundwater Management Districts Association
KANSAS BUREAU OF AIR QUALITY AND OCCUPATIONAL HEALTH
KANSAS STATE HISTORICAL SOCIETY
KANSAS STATE CONSERVATION COMMISSION
KANSAS FISH AND GAME COMMISSION
KANSAS GEOLOGICAL SURVEY
KANSAS GOVERNOR'S OFFICE
KANSAS LEGISLATIVE RESEARCH DEPARTMENT
Kansas Mined Land Conservation and Reclamation Board
KANSAS PARK AND RESOURCES AUTHORITY
KANSAS WATER OFFICE
MISSOURI WATER BOARD
MISSOURI DEPARTMENT OF NATURAL RESOURCES
MISSOURI GOVERNOR'S OFFICE
WYOMING WATER DEVELOPMENT COMMISSION

Regional:

Big Lakes Regional Planning Commission (Pottawatomie, Riley, Geary Counties, Kansas)
CHIKASKIA-INDIAN HILLS REGIONAL PLANNING COMMISSION (SUMNER, HARPER, KINGMAN COUNTIES, KANSAS)
Flint Hills Resource Conservation and Development Project (Morris, Chase, Marion and Lyon Counties, Kansas)
FOUR RIVERS RESOURCE CONSERVATION AND DEVELOPMENT DISTRICT (JEWELL, REPUBLIC, MITCHELL, CLOUD, OTTAWA, LINCOLN, ELLSWORTH AND SALINE COUNTIES, KANSAS)
GREATER SOUTHWEST REGIONAL PLANNING COMMISSION
Kansas Groundwater Management Districts 5
Ozark Regional Commission
SOLDIER CREEK WATERSHED BOARD OF DIRECTORS
MID-AMERICA REGIONAL COUNCIL
Northwest Kansas Planning and Dev. Commission (Cheyenne, Sherman, Wallace, Rawlins, Thomas, Logan, Decatur, Sheridan, Gove, Norton Graham, Trego, Phillips, Rooks Ellis, Smith, Osborne, and Russell Counties, Kansas)
SUNFLOWER RESOURCE CONSERVATION AND DEVELOPMENT DISTRICT (SUMNER, HARPER, KINGMAN, BARBER, COMANCHE AND KIOWA COUNTIES, KANSAS)
TAUY CREEK WATERSHED PLANNING DISTRICT BOARD OF DIRECTORS
National Conference of State Legislatures
National Governors' Association
Wakarusa Rural Clean Water Program

Federal:

MISSOURI RIVER BASIN COMMISSION
U.S. ARMY CORPS OF ENGINEERS, KANSAS CITY AND ALBUQUERQUE OFFICES
U.S. DEPARTMENT OF AGRICULTURE, AGRICULTURAL STABILIZATION AND CONSERVATION SERVICE (ASCS)
U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE (SCS)
U.S. DEPARTMENT OF AGRICULTURE, FOREST SERVICE
U.S. Geological Survey, Denver and Moffett Field, California
U.S. Geological Survey, Reston, Virginia
U.S.G.S. WATER RESOURCES DIVISION - LAWRENCE/GARDEN CITY, KANSAS
U.S. Bureau of Reclamation Denver and Topeka Offices
U.S. ENVIRONMENTAL PROTECTION AGENCY KANSAS CITY AND WASHINGTON, D.C. OFFICES
U.S. FISH AND WILDLIFE SERVICE, KANSAS CITY, DENVER, AND WASHINGTON, D.C. OFFICES
U.S. BUREAU OF INDIAN AFFAIRS, HORTON, KANSAS AGENCY
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA) HEADQUARTERS, NATIONAL SPACE TECHNOLOGY LABORATORIES/ EARTH RESOURCES LABORATORY, AMES RESEARCH CENTER, Goddard Space Flight Center
National Oceanic and Atmospheric Administration (NOAA)
U.S. DEPARTMENT OF THE INTERIOR, OFFICE OF SURFACE MINING, KANSAS CITY REGIONAL OFFICE

Private Firms:

FARMLAND INDUSTRIES, INC.
Dow Chemical Corporation
E. I. duPont deNemours and Company, Inc.
Basin Electric Power Cooperative
Sunflower Electric Power Cooperative
October Oil, Inc.
Mobay Chemical Co., Inc.
Satlab, Inc.
Earth Satellite Corporation
ERDAS, Inc.
Could/SEL, Inc.

*All agencies that are capitalized represent demonstration projects that have been completed or are being developed.

The Kansas Interagency Task Force on Applied Remote Sensing, comprised of representatives of all state agencies that have worked with the KARS Program, was established to identify and evaluate mechanisms for institutionalizing the KARS Program as an operational state remote sensing program. The Task Force has been formally recognized by the Kansas Legislature, and provided a formal mandate, reporting procedure and funding.

Presentations were made to numerous Kansas public and professional organizations including, among others, the Kansas Ground Water Management District Association, Kansas Academy of Science, Leadership Kansas, Kansas Soil Survey Planning Workshop, Kansas Association of Professional Soils Classifiers, and the Kansas Association of Watersheds. KARS staff authored professional papers and publications as well (Appendix IV).

NATURE OF PROJECTS

Table 4 indicates the range of projects in progress during 1982-83.

PRINCIPAL KARS PROGRAM PERSONNEL

The KARS Program has assembled a unique staff of individuals who have over forty years combined experience, broad contacts, and specialized expertise in applied remote sensing, mapping, and natural resources. The KARS Program is administered by Professor B. G. Barr, Director of the Space Technology Center, and Dr. Edward A. Martinko, KARS Program Associate Director. Mr. James Merchant, Ms. Loyola Caron, Mr. Christopher Gunn, and Dr. Lee Williams complete the senior personnel of the Program. The KARS staff is comprised of specialists having expertise in ecology, forestry, wildlife biology, geography, computer science, environmental studies and natural resources management. Three of the principals have worked for state government and, therefore, have first-hand knowledge of the needs and problems experienced by such agencies. One has extensive experience with private industry. Vitas are contained in Appendix V.

Professor B. G. Barr, Director of the University of Kansas Space Technology Center and Professor of Mechanical Engineering, is Director of the KARS Program. Professor Barr has been engaged in interdisciplinary and applied remote sensing research with various NASA Programs for twenty years. He founded the KARS Program in 1972 and has been Director since its inception. He holds a B.S. in Mechanical Engineering from the University of

Table 4
KARS PROGRAM IN-PROGRESS PROJECTS
April 1982 - March 1983

PROJECT:	RANGELAND MANAGEMENT IN CIMARRON NATIONAL GRASSLAND
COUNTY INVOLVED:	Morton
COOPERATING AGENCIES:	U. S. Forest Service - Elkhart, Kansas; U. S. Department of Agriculture - Agricultural Stabilization and Conservation Service - Elkhart, Kansas
PROJECT:	WALNUT CREEK WATERSHED GROUNDWATER MODEL - IRRIGATED LANDS AND CROP INVENTORY
COUNTIES INVOLVED:	Ness, Rush, Barton
COOPERATING AGENCY:	Kansas Geological Survey
PROJECT:	USING LANDSAT TO EVALUATE PRONGHORN ANTELOPE HABITAT IN KANSAS
COUNTIES INVOLVED:	Gove, Sherman, Trego, Wallace
COOPERATING AGENCY:	Kansas Fish and Game Commission
PROJECT:	KANSAS INTERAGENCY TASK FORCE ON APPLIED REMOTE SENSING
COUNTIES INVOLVED:	Statewide
COOPERATING AGENCIES:	Kansas Governor's Office; Kansas Senate; Kansas House of Representatives; Kansas Water Office; Kansas Geological Survey; Kansas Department of Revenue; State Board of Agriculture; Kansas Department of Health and Environment; Kansas Park and Resources Authority; Kansas Fish and Game Commission; Kansas Department of Economic Development; Kansas Corporation Commission; Kansas Association of Counties; Kansas Association of Groundwater Management Districts; Kansas Department of Administration - Division of Budget; Kansas Legislative Research Department
PROJECT:	CONSTRUCTION OF A DIGITAL SOILS DATA BASE FOR HARVEY COUNTY, KANSAS
COUNTY INVOLVED:	Harvey
COOPERATING AGENCIES:	USDA/Soil Conservation Service; Harvey County Planning Commission; Kansas Department of Revenue
PROJECT:	CHARACTERIZATION OF FALLOW LANDS USING LANDSAT
COUNTIES INVOLVED:	Scott, Lane
COOPERATING AGENCY:	USDA/Soil Conservation Service
PROJECT:	AN INVENTORY OF STATE NATURAL RESOURCES INFORMATION SYSTEMS
AREA:	United States
COOPERATING AGENCIES:	NASA/Ames Research Center; USDA Soil Conservation Service

Kansas. His graduate work concentrated on several case study investigations of the technical, financial and social factors involved in implementing new technologies in industry. He was employed in private industry in technical and operating management positions for fifteen years before joining the faculty of the University of Kansas in 1962. Since then he has taught project management, engineering design, engineering economics and thermodynamics. He has also managed a number of complex interdisicplinary projects, including the University's BETA Program for industrial technology transfer. This program has dealt extensively with the development and application of computerized data bases to provide technology transfer and information services to industry.

The Associate Director of the KARS Program is Dr. Edward A. Martinko. Dr. Martinko is an Assistant Scientist in the Space Technology Center and is also Director and Assistant Professor of Environmental Studies at the University of Kansas. He has over 15 years' experience in the areas of ecology and remote sensing of biological resources. He holds a B.A. in Chemistry and Biology from the College of Emporia, an M.A. in Biology from the University of Colorado and a Ph.D. in Entomology from the University of Kansas. He has been a staff biologist with the Kansas Biological Survey and is a co-founder of the Kansas Interagency Task Force on Applied Remote Sensing. He has first-hand familiarity with the functions and needs of state government and industry, and has been a consultant to the government of Chihuahua, Mexico. Dr. Martinko's recent work has focused on remote sensing applications in integrated pest management, noxious weed inventory and wildlife habitat assessment.

James W. Merchant, Senior Remote Sensing Applications Specialist with the KARS Program, has been engaged in basic and applied research in remote sensing since 1971, nine years of which he has been associated with the KARS Program. He has also served as a Natural Resources Planner with the Baltimore (Maryland) Regional Planning Council and Research Assistant in microwave remote sensing with the University of Kansas' Remote Sensing Laboratory. He holds a B.A. in Geography from Towson State University, Towson, Maryland, an M.A. in Geography from the University of Kansas, and is presently a Ph.D. candidate in the Department of Geography, University of Kansas. He is currently working with Kansas and federal agencies on projects involving the application of remote sensing and geographic information systems to resources problems in the areas of water resources management, rangeland inventory and evaluation and land use analysis. He is a co-founder of the Kansas Interagency Task Force on Applied Remote Sensing. Mr. Merchant is personally acquainted with users and remote sensing specialists throughout the U. S. He has participated in the National Conference of State Legislatures' Natural Resource Information Systems (NCSL/NRIS) Task Force meetings and NCSL briefings for state government officials in Kansas, Wyoming and Tennessee, and has been a consultant to the government of Chihuahua, Mexico.

Loyola M. Caron, Remote Sensing Specialist with the KARS Program, has a unique background in natural resource information systems (NRIS) technology, remote sensing, wildlife management and forestry. She holds a B.S. in Wildlife Biology and an M.S. in Forestry, with emphasis on remote sensing of natural resources, from the University of Minnesota. Prior to joining the KARS Program staff, she was Staff Associate with the National Conference of State Legislatures' Natural Resource Information Systems Project in Denver. This program provided technical assistance to state legislators on Landsat and NRIS technology. During her two years with the Conference, she participated in state legislative committee briefings throughout the U. S. designed to inform legislators about Landsat and NRIS capabilities and limitations; represented state needs in the national "Five Agency" effort to develop a national land classification system for vegetation, landforms, soils and water; assisted in a performance audit for the Arizona Resource Information System, with special emphasis on examining state agency information needs; and was responsible for preparation of a bi-monthly newsletter and various other publications about Landsat/NRIS technologies and their use by state legislators and agencies. She has also worked for North Dakota's Regional Environmental Assessment Program (REAP), an experimental effort by the State of North Dakota to implement NRIS technology in an attempt to better plan for and manage development of its resources. In this capacity she served as the earth sciences research coordinator responsible for collecting natural science data for a statewide automated data base. Ms. Caron also acted as liaison between state agencies and REAP computer personnel to determine optimum strategies for meeting agency needs.

Dr. T. H. Lee Williams serves as consultant to the KARS Program on training, software development and applied remote sensing. Dr. Williams received his Ph.D. in Geography with emphasis on remote sensing from Bristol University, England. He is Associate Professor of Geography at the University of Kansas. He has nearly ten years of experience in applied remote sensing, five years of which he has been affiliated with the KARS Program. Dr. Williams teaches a full curriculum of undergraduate and graduate courses in remote sensing/GIS technology at the University of Kansas. He has designed and taught four short courses in applied digital processing of remote sensing data offered through the KARS Program. He has special expertise in project design, software development, digital image processing, and training. Dr. Williams has been a consultant to the government of India.

Christopher W. Gunn, Computer Applications Specialist with the KARS Program, is completing an M.S. degree in computer science at the University of Kansas. His research emphasis is in the area of natural language research and computational semantics. A secondary emphasis has been on operating systems and data communications. His practical background includes extensive experience with eight- and 16-bit microcomputers, development and conversion of image processing software on microcomputers and mainframes, and system integration.

Projects requiring specialized scientific expertise are staffed primarily by graduate students from the specific academic disciplines involved, assisted by faculty advisors when appropriate. Personnel from the various firms and agencies are involved in their own projects at no cost to NASA.

FACILITIES

KARS Program offices and laboratories are located in the University of Kansas Space Technology Center. The program has complete facilities for processing and interpretation of remote sensing data in both image and digital formats, state-of-the-art cartographic production, statistical analysis, and geographic data base production. Graphic arts, photographic processing and support services are provided within the Space Technology Center.

The KARS Program's Image Interpretation Laboratory is furnished with a complete range of equipment for viewing and analyzing imagery, and for transferring image data to base maps of various scales. Included are a Bausch and Lomb Zoom Transfer Scope, an Itek Color Additive Viewer, a

Variscan Rear Projection Viewer, five Richards Light Tables with Bausch and Lomb Zoom 240 stereoscopes, a Saltzman Reducing/Enlarging Projector, a MacBeth Color Spot Densitometer, an Interpretation Systems Incorporated (ISI) VP-8 Color Video Image Analyzer, an Old Delft Scanning Stereoscope, and a complete assemblage of other manual image interpretation aids.

Aerial photography in support of KARS projects is acquired from a Cessna 180 Skywagon accessible to KARS staff. Both a multispectral cluster of four Hasselblad 500EL 70mm-format cameras and a Fairchild nine-inch format cartographic camera are available for photographic missions.

Custom designed cartographic and graphic products are prepared by KARS staff using negative scribing and photo-mechanical techniques. Production of color graphics and color separations are standard procedures. Printing services are available. KARS staff also have access to Tektronix computer graphics systems, computer mapping software, and both flatbed and drum plotters.

A current file of Landsat, Skylab and aerial imagery is maintained by the KARS Program for the use of project personnel and user agencies. The Landsat file contains a combination of selected black and white and FCC imagery for various dates since the earliest Landsat in mid-1972. Over 130 prints and 1,100 transparencies are included in the file. The imagery is catalogued by path and row and date and includes complete coverage of Kansas. Aerial photography holdings include over 170 rolls of film.

An extensive map collection is maintained by the KARS Program. This collection contains a variety of maps of Kansas and surrounding areas. Included are state base maps, topographic sheets, county maps, general regional maps, thematic maps and image mosaics.

The KARS Program also maintains a substantial reference library for both in-house and agency use. This material includes reports, articles, periodicals, manuals and textbooks pertinent to remote sensing and selected applications areas.

Analysis of digital remote sensing data, digitizing and other computer-assisted data processing operations are supported by facilities of the KARS Digital Data Analysis Laboratory (Appendix IV). The KARS stand-alone

Digital Image Processing System provides KARS with a full range of capabilities in computer enhancement and classification of digital Landsat data, as well as other remotely sensed data. The system also supports computer graphics, geographic information system, statistical, cartographic, and integrated natural resources analysis.

The Digital Data Analysis Laboratory is, in addition, equipped with five remote terminals or microcomputer terminal-emulators interfaced to the University of Kansas Honeywell Level 66 DPS-3E Computer System, which provides KARS staff with access to additional interactive digital image processing and classification, statistical analysis, and computer mapping software. One terminal (Decwriter IV) is available for field use in short courses and/or on-site data processing at remote locations.

The KARS Program is continuing the development of a low-cost, microcomputer-based system for Landsat data analysis, image processing and geographic information storage, manipulation, and retrieval. This system will augment and enhance KARS' current capabilities in the area of digital processing and will culminate efforts to provide an affordable user-oriented system. The system has been designed to overcome several of the shortcomings that have impaired the availability of computer systems addressing this problem area.

The hardware foundation of the KARS system is a DEC 11/23, an advanced microprocessor that emulates an 11/34. (An 11/23 operates at roughly two-thirds the speed of an 11/34, according to most estimates.) The KARS system has 256K bytes of random-access memory.

Mass storage is provided by an 80-megabyte Control Data Corporation Model 9762 disc drive with an Emulex SC01A2 controller. The controller has the capacity to support one additional drive. A Kennedy 9100 10.5-inch reel-to-reel tape drive with an Emulex TC01P controller provides magnetic tape input and output at a tape speed of 75 inches per second. A Sky Computers SKYMNK arithmetic processor is in place to accelerate numeric processing. A Versatec 8222-F 22-inch electrostatic printer/plotter with 200 points-per-inch resolution provides hard-copy graphics output.

Color video display and other functions are provided by a Terak 8510/a-8600HDX microcomputer. The 8510/a includes an 11/2 microprocessor, 64K bytes RAM, an eight-inch dual density floppy disc drive, keyboard and a monochrome CRT display with graphics capability at a 320-by-240 pixel resolution. The 8600HDX display integrated with the 8510/a includes an intel 8086 microprocessor, a 19-inch high-resolution RGB color monitor, and video refresh memory and display circuitry capable of 640 by 480 pixels with six bits (64 simultaneous colors) per pixel resolution. Other peripherals include an Altek AC90SM intelligent digitizer with 60 x 42 inch backlit tablet and various terminals and printers.

II. GENERAL KARS ACTIVITIES

KANSAS INTERAGENCY TASK FORCE ON APPLIED REMOTE SENSING

The University of Kansas Applied Remote Sensing (KARS) Program has received base funding from the National Aeronautics and Space Administration (NASA) since 1972 to conduct applied research on techniques which will enable public agencies to better utilize available satellite and airborne remote sensing systems. Kansas agencies are now beginning to integrate remote sensing techniques into their conventional data collection and analysis programs on an operational basis.

In order to facilitate institutionalization of the KARS Program as an operational arm of state government, the KARS Program and Kansas agencies have organized the Kansas Interagency Task Force on Applied Remote Sensing (Table 5). The Task Force first met in May 1981.

The Task Force works with the KARS Program to:

- Provide policy direction for the KARS Program;
- Define project goals and priorities;
- Enhance interagency communication, coordination and cooperation on remote sensing and utilization of geographic information systems;
- Provide feedback to the KARS Program regarding agency data needs and concerns;
- Evaluate the Program's performance and requirements; and
- Assess alternatives for greater and more operational utilization of remote sensing/geographic information system (GIS) technology on a statewide basis.

During the initial meetings, Task Force members considered a number of issues pertaining to the role of remote sensing and geographic information system technology in meeting agency data needs. They acknowledged that agencies often have common requirements for similar data (e.g., land use/land cover), and that it would therefore be advantageous to coordinate data collection efforts. The agency representatives also agreed to investigate alternatives for enhancing access to, and applications of, remote sensing/GIS technology.

TABLE 5

KANSAS INTERAGENCY TASK FORCE ON APPLIED REMOTE SENSING

1982 - 1983

Members

Kansas Applied Remote Sensing Program

Kansas Association of Counties

Kansas Corporation Commission

Kansas Department of Health and Environment

Kansas Department of Revenue

Kansas Fish and Game Commission

Kansas Geological Survey

Kansas Governor's Office

Kansas Groundwater Management Districts

Kansas Park and Resources Authority

Kansas State Board of Agriculture

Kansas Water Office

Kansas Senate

Kansas House of Representatives

Kansas Department of Economic Development

Other Participating Agencies

U. S. Bureau of Reclamation

U. S. Geological Survey

U.S.D.A. Soil Conservation Service

Kansas Bureau of Investigation

Kansas Legislative Research Department

Kansas Department of Administration -
Division of Budget

In mid-1982 the Kansas Interagency Task Force on Applied Remote Sensing received formal recognition and direction from the Kansas Legislature. Senate Concurrent Resolution No. 1644, introduced by Senators Fred A. Kerr and Jane M. Eldredge in January 1982, was endorsed by both the Kansas Senate and House of Representatives in April.

Resolution 1644 states, in part, "That it is in the interest of the people of the state that a task force on applied remote sensing be created to evaluate the ways the Kansas Applied Remote Sensing Program can be most efficiently and effectively maintained . . ." The Task Force will be comprised of "a person designated by the governor, a person designated by the president of the senate, a person designated by the speaker of the house, a person designated by the director of the Kansas water office, a person designated by the director of the Kansas geological survey, a person designated by the secretary of the department of revenue, a person designated by the secretary of the state board of agriculture, a person designated by the secretary of health and environment, a person designated by the director of the Kansas park and resources authority, a person designated by the director of the Kansas fish and game commission, a person designated by the Kansas department of economic development, a person designated by the state corporation commission, a representative of local governments designated by the state association of counties, a person designated by the director of the Kansas Applied Remote Sensing Program, a person designated by the president of the Kansas association of groundwater management districts and a person designated by the chancellor of the University of Kansas."

The Legislature directed that "the task force shall exist until December 31, 1983, and shall report its progress, findings and recommendations to the governor and the legislature on or before December 31, 1982, and December 31, 1983."

Highlights of the Task Force's April 1982 - March 1983 accomplishments are reviewed below.

The resolution was the primary topic of discussion by the Task Force at its April 7, 1982 meeting held at the State Capitol in Topeka. Other issues addressed at the meeting included:

- Fee fund for the KARS Program -- As recommended by Governor John Carlin in his 1983 budget, a fee fund account was established for the KARS Program. This fund will facilitate transfer of funds from user agencies to the KARS Program.
- Landsat-D status and data price increases -- Landsat-D's multispectral scanner and a thematic mapper were discussed. NOAA will raise prices of Landsat data by about 2.5 times the present prices on October 1, 1982. Agencies were encouraged to identify data needs and place orders prior to that date.
- Proposals for new projects -- A number of new projects dealing with tax appraisal, wildlife habitat inventory, noxious weed inventory and land use planning were discussed.
- ASCS 35mm aerial photography -- The KARS Program will petition the USDA Agricultural Stabilization and Conservation Service (ASCS) on behalf of the Task Force, to archive its annual 35mm aerial photography of Kansas counties at the KARS Program after the photography is no longer of use to ASCS offices. The KARS Program would then file and index the photography and make it available for use by Kansas agencies and local units of government.

At its May meeting the Task Force dealt principally with administrative and operational matters. Edward Martinko, KARS Program, was elected Chairperson and Robert Walters, Kansas Department of Revenue, Vice Chairperson. The Task Force reviewed and endorsed an eighteen-month work plan designed to fulfill its mandate under Resolution 1644. Agency representatives were also briefed on the disposition of KARS baseline funds appropriated by the Kansas Legislature for FY 83, and on the procedures for using a fee fund established by the Legislature for the KARS Program in the 1982 budget of the University of Kansas.

On other issues, the Task Force:

- Discussed a proposal by the Kansas Fish and Game Commission for a cooperative interagency study of alternatives for conducting a statewide land use/land cover inventory;

- Endorsed a letter to Dr. James M. Beggs, Administrator of NASA, expressing the Task Force's concerns regarding continued development, testing, evaluation and transfer of remote sensing technology; and
- Received notification from Mr. Frank Mosier, Kansas State Executive Director, USDA/Agricultural Stabilization and Conservation Service, that ASCS will fully support the Task Force in efforts to archive obsolescent ASCS 35mm aerial photography with the KARS Program.

The July 1982 meeting of the Task Force focused upon the issue of baseline funding for the KARS Program. Edward Martinko, KARS Associate Director, presented a review of the history of NASA funding of the KARS Program, the services which these funds have provided Kansas agencies, and the need for continued baseline support for such services. A committee of the Task Force, chaired by Robert Walters, Kansas Department of Revenue, was commissioned to study the issue in greater detail. The committee was requested to determine whether there is a need for baseline funding and, if so, what services baseline funds should provide, and what the level and source of such funding should be.

The Task Force also reviewed a number of proposed projects. Particular attention was given to a proposed interagency study of alternative means for inventorying land use and land cover statewide. The Task Force requested that the KARS Program prepare a proposal to investigate costs of, and alternative techniques for, meeting specific needs of state agencies. Special consideration should be devoted to change detection.

Other issues discussed at the July meeting included:

- NOAA's proposed Landsat-D MSS Basic Data Set -- The Task Force endorsed a letter to NOAA expressing the position of the Task Force in regard to the proposed frequency of collection of Landsat-D multispectral scanner (MSS) data;
- NOAA's Land Remote Sensing Satellite Advisory Committee -- The Task Force was briefed on the purpose and composition of the Committee; points of contact were identified; and
- ASCS 35mm aerial photography -- Agency representatives were provided a listing of all ASCS aerial photos received, to date, by the KARS Program.

The major topic on the agenda at the September 1982 meeting of the Task Force was a report by the Committee on Baseline Funding. The Committee was commissioned by the Task Force to study requirements and alternatives for baseline support of the KARS Program. Robert Walters, Kansas Department of Revenue, Vice Chairperson of the Task Force and Chairperson of the Committee, reported the Committee's conclusions. It was recommended that the Task Force consider two different, though not mutually exclusive, avenues for implementation and funding of an operational remote sensing/geographic data processing facility.

The Committee proposed that the ultimate objective of the Task Force should be the establishment of a Kansas Environmental/Natural Resources Information Center. The Center would have some characteristics of the Texas Natural Resources Information System and some of the features of the Minnesota Land Management Information System. In the context of such a center, the KARS Program would provide all of its current services in the areas of remote sensing, mapping and geographic data analysis, but would also become a statewide clearinghouse for natural resources and environmental information. The clearinghouse would provide rapid access to data held by federal, state, regional and local agencies and private firms. Alternative budgets and funding mechanisms were presented.

The feasibility of establishing such a center at the present time was questioned by several Task Force members. The Committee, in recognition of this circumstance, offered a second interim alternative -- that the Task Force recommend that the Governor and Legislature provide continued baseline funding for the KARS Program in line with projected costs of maintaining KARS' services at their current level. The Task Force endorsed a resolution to that effect.

Other issues addressed at the September meeting included:

- Statewide land use/land cover inventory -- The Task Force endorsed a resolution urging all agencies to identify funds in their FY 84 budgets to define a methodology and classification for, and initiate work on, a comprehensive digital land use/land cover data base for Kansas;
- Status of other projects -- The Task Force reviewed proposed new projects including (1) construction of an integrated digital data base for Harvey County and (2) an assessment of erosion/sedimentation hazard in the Upper Neosho River watershed;

- Landsat 4 -- The Task Force was briefed on the successful launch of Landsat 4, characteristics of the sensors, and availability of data;
- ASCS 35mm aerial photography -- Task Force members received an updated listing of coverage received from 54 Kansas counties.

The Kansas Interagency Task Force on Applied Remote Sensing met twice during the last quarter of 1982. At its October 26, 1982 meeting, held at the State Capitol in Topeka, the Task Force focused on review of a draft interim report on its 1982 activities and recommendations, which was to be submitted to the Governor and the Kansas Legislature prior to December 31, 1982 (see Appendix VII, "Highlights of the Interim Report of the Kansas Interagency Task Force on Applied Remote Sensing").

The draft report summarized the accomplishments of the Task Force during its first year of formal operation, and discussed various alternatives under consideration for providing greater utilization of remote sensing/geographic information systems technology on a statewide basis. One alternative called for a maintenance budget for the KARS Program; a second alternative described a proposal for establishing a Kansas Environmental/Natural Resources Information Center.

It was the consensus of the Task Force that the report should emphasize that, to date, this second alternative is viewed by the Task Force as the best approach for institutionalizing a remote sensing/geographic data processing and information clearinghouse in Kansas. The first was proposed as an interim, hold-the-line position which will enable KARS to continue serving the State until such time as the Task Force makes its final recommendations, and the Governor and Legislature consider action on those recommendations.

The Task Force concluded that the concept of an Information Center should be identified as an option favored by its members. Other options will be considered at future meetings. In addition, a FY 84 "caretaker" baseline budget should be recommended in the report as an interim measure. It was suggested that this would be a realistic strategy in view of the current state fiscal situation.

Other issues discussed at the October meeting of the Task Force included:

- The status of a proposed study of alternatives for conducting a statewide land use/land cover inventory; specific note was made of the manner in which funds would be utilized;
- A new KARS project which has been funded by the U. S. Soil Conservation Service (Washington, D. C.) through NASA. The KARS Program will conduct an inventory of state natural resources data bases throughout the U. S.;
- A new KARS project funded by the Kansas state office of the U. S. Soil Conservation Service (Salina). The KARS Program will develop a digital soils data base for Harvey County, Kansas. The work will be a prototype for other digital data bases of a similar nature; and
- The Task Force endorsed a letter to the U. S. Bureau of the Census requesting consideration of Kansas agencies' needs in construction of new digitized map products for Kansas; this is in support of a proposed project of the Kansas Department of Economic Development and the KARS Program to digitize Kansas townships' boundaries. Such a digital georeferencing system could be a foundation for a statewide data base.

At its November 30, 1982 meeting the Task Force took final action on the Interim Report to the Governor and the Kansas Legislature. A number of both substantive and editorial suggestions had been received from Task Force representatives and had been incorporated into the report. These were reviewed by Edward Martinko, Chairman of the Task Force.

Martinko also called to the attention of the Task Force a recent report by the Kansas Department of Economic Development entitled <u>Strategy for the Eighties: High Technology Industrial Development</u>. This report discusses the prospects for attracting more high technology industry to Kansas. Governor Carlin has taken a special interest in this area. Discussion revolved around the roles that remote sensing and the KARS Program might play in promoting high technology in Kansas.

The Task Force noted that the KARS Program is recognized as a user and purveyor of high technology. The Task Force, therefore, recommended that reference to this topic be included in the Interim Report.

James Merchant, KARS Program, reviewed the Work Plan for 1983. During 1982, the Task Force has (1) identified and proposed specific projects of high priority to be accomplished during the next 2-3 years (e.g., the pilot land use/land cover inventory for Kansas), (2) identified and evaluated alternative mechanisms for funding of the KARS Program, although this process will continue during the next year, and (3) begun to review the experiences of other states (Texas and Minnesota) for institutionalizing state remote sensing/geographic information systems capabilities.

Task Force members concurred that the following items comprised important new work remaining to be accomplished in 1983:

- Update and augment the August 1981 User Needs Study; assess data needs of agencies and firms not represented on the Task Force (e.g., federal, state, local government and industry);
- Hold a statewide conference on remote sensing and geographic information system applications; and
- Identify and evaluate alternative mechanisms for institutionalizing and funding of the KARS Program.

Martinko then proposed the formation of two study committees to investigate special areas of concern to the Task Force. The first of these, to be chaired by Ray Menendez, Department of Revenue, was asked to review user/agency support of the KARS Program. This committee was to evaluate:

- Role of users in supporting the KARS Program;
- Interests and needs of other state, federal, local agencies and private firms;
- Future of the Task Force (need, composition, duties);
- Budgeting problems and possible solutions;
- Recommendations.

A second study committee, to be headed by Don Kostecki, Kansas Water Office, was to consider the option of establishing an information center or other alternatives within the KARS Program. Attention focused on:

- Services and mode of operation;
- Administration/institutionalization;
- Funding - amount and sources.

The chairpersons were authorized to solicit other members of the Task Force to serve. KARS Program staff were available to assist each committee. The study committees were asked to present an interim report of their progress at the next Task Force meeting.

James Merchant (KARS Program) then presented a proposal for a conference on applied remote sensing, geographic data analysis and mapping in Kansas. The objectives of this conference would be to provide an overview of the state-of-the-art of applied remote sensing, geographic data analysis and mapping in Kansas; define new applications for these technologies; identify research and development needs; disseminate information on the Kansas Interagency Task Force on Applied Remote Sensing and its recommendations regarding the future of these technologies; and provide technical introductions to new techniques via half-day workshops.

Although Task Force members endorsed the concept and need for such a conference, several members felt that the proposed schedule of sessions and workshops needed to be focused more directly toward the end-user. Merchant was asked to chair a committee to develop a detailed plan for presentation and discussion at the next meeting.

The February 1982 meeting of the Task Force focused on the concurrent session of the Kansas Legislature. Edward Martinko, Task Force Chairman, reported that Governor Carlin recommended FY 84 support for the KARS Program at the same level as provided in FY 83. It was also noted that the Legislature apparently will approve funding for KARS projects contained within the budget proposal of the Kansas Fish and Game Commission.

KARS' 1983-84 research proposal submitted to NASA in January was discussed. KARS' research will focus on evaluation of Landsat Thematic Mapper (TM) data, and development of geographic information systems technologies. NASA funds for application of research findings will not be available.

The Task Force received a report from its Committee on KARS Program Options. This committee, established at the November 1982 meeting, is charged with examination of KARS services and mode of operation; administration/institutionalization; and funding for the KARS Program. Discussions of this committee have concentrated on the proposed services of a Kansas resources information center, services the KARS Program currently provides, and services that might be provided if a resources information center was established. Specific examples of KARS Program capabilities were requested, to assist the Committee in identifying major issues affecting the resources of the state, and the manner in which the KARS Program might address those issues.

James Merchant, KARS Program, then presented the Task Force with a revised proposal for a statewide conference on remote sensing and geographic information systems. It was requested that a decision regarding the need for holding the conference be made at the next Task Force meeting.

Other items discussed at the February meeting included:

- The Task Force requested that KARS Program staff prepare a briefing on remote sensing and geographic information systems technology, applications and recent developments for presentation at the next Task Force meeting.
- Edward Martinko reported that members of the Kansas House Committee on Communications, Computers and Technology, chaired by Representative Mike Meacham, had toured the KARS Program facilities in January. The KARS Program was included in the Committee's tour of various facilities at the University of Kansas related to their goal of promoting and enhancing high technology ventures in the State of Kansas. Committee members were briefed on the KARS Program, remote sensing and the Kansas Interagency Task Force on Applied Remote Sensing.
- The most recent issue of the Landsat Data Users Notes was distributed to those present. Of special interest to the Task Force were (1) a two-page display comparing Thematic Mapper (TM) images with those of other Landsat sensors and high altitude aerial photography; (2) availability of Landsat data on floppy disks, allowing users to acquire data for small areas at a substantial reduction in cost; and (3) the constitution of the MSS Basic Data Set, providing for repetitive 16-day coverage for agricultural areas during the growing season.
- The Task Force was briefed about a series of upcoming Landsat meetings being held by NOAA, one of which would be hosted by the KARS Program on April 21.

- The KARS Program has acquired additional ASCS 35mm color aerial slides. Fifty-eight counties have contributed their slides to the Program; several counties have provided slides for more than one year.

At the March 21, 1983, Task Force meeting, members reviewed the status of the proposed statewide conference on applied remote sensing, geographic data analysis and mapping. It was agreed that the KARS Program should proceed with plans for holding the statewide conference in late October or early November 1983. Authority was provided the KARS Program to plan the conference, and to contact the Governor's Office to arrange coordination and participation, as feasible.

Loyola Caron, KARS Program, reported on the status of the Natural Resources Information Systems (NRIS) Inventory Project. This Project is being conducted by the KARS Program for NASA/Ames Research Center, under a grant from the USDA Soil Conservation Service in Washington, D. C. The purpose of the project is to locate and inventory automated state and sub-state data bases/repositories throughout the United States.

Other agenda items were as follows:

- Recent aerial photography of Topeka, Kansas, acquired through the National High-Altitude Photography (NHAP) Program was displayed. Both black-and-white and color infrared coverage are nearly complete for Kansas.
- James Merchant briefed Task Force members on current developments in remote sensing and geographic information systems technologies. Merchant gave a slide presentation reviewing the basic principles of remote sensing. He also discussed the design of geographic information systems and presented examples of how this technology can be used to analyze various complex issues.

During the forthcoming year the KARS Program will continue to work closely with Kansas agencies to broaden and enhance the operational utilization of remote sensing/GIS technology in Kansas. The Kansas Interagency Task Force on Applied Remote Sensing has already made significant progress toward that objective. The KARS Program, the Task Force and the Office of Governor John Carlin will co-host the Governor's Conference on Applied

Remote Sensing, Geographic Data Analysis and Mapping in Kansas on November 7-8, 1983. In December 1983 the Task Force will present its final report and recommendations regarding the KARS Program and the utilization of remote sensing/GIS technologies in Kansas to Governor Carlin and the Kansas Legislature.

KARS DIGITAL IMAGE PROCESSING SYSTEM

The KARS Program is continuing the development of a low-cost, microcomputer-based system for Landsat data analysis, image processing and geographic information storage, manipulation and retrieval. This system will augment and enhance KARS' current capabilities in the area of digital processing and will culminate efforts to create an affordable, user-oriented system. The system has been designed to overcome several of the shortcomings that have impaired the availability of computer systems addressing this problem area.

The system represents a major upgrade of KARS's capacity for digital image analysis and information processing. Until recently, KARS was limited to the use of the University's central computer system and a small desktop personal computer. The central system, a Honeywell Information Systems Level 66 DPS-3E, serves the entire University instruction and research users' community. More than 100 users of the time-sharing system may be signed on simultaneously. Such an environment proved unsuitable for image processing applications.

Other institutions that have used large centralized mainframe computers for Landsat analysis successfully have generally had available a large computer dedicated for image processing applications. A dedicated computer usually is necessary because image processing makes such heavy demands on computer resources that it is seldom compatible with the many-user, time-sharing environment that large central computers usually support.

Alternatively, the majority of satellite image processing systems have been built around large mini-computers. Such computer systems, with the storage devices and display peripherals necessary for the processing of Landsat data, cost from $200,000 to $500,000 and up.

Both high-end mini-computers and mainframe computers have the following disadvantages for the sort of Landsat and spatial data analysis conducted by the KARS Program:

- They are expensive to acquire and expensive to maintain and operate.
- Their general-purpose central processing units are best suited for multi-user time-sharing applications such as commercial data entry, program development or instruction. They are not "tuned" for heavy mathematical processing or massive, high-speed input/output, such as that required for Landsat processing or image display.

KARS' strategy, therefore, has been to use advanced microcomputer technology to develop a system optimized in terms of cost-effectiveness and suitability for Landsat-oriented computing. KARS has been particularly interested in the software package ELAS (Earth Resources Laboratory Applications Software) written at NASA's Earth Resources Laboratory at Bay St. Louis, Mississippi. ELAS was developed to be a portable software system (in contrast to many other image analysis packages, which have extensive built-in hardware and software dependencies) and had been implemented on computers as small as a (DEC) PDP 11/34. One of KARS' goals is to facilitate the migration of ELAS to the microcomputer realm.

The hardware foundation of the KARS system is a DEC 11/23, an advanced microprocessor that emulates an 11/34. (An 11/23 operates at roughly two-thirds the speed of an 11/34, according to most estimates.) The KARS system has 256K bytes of random-access memory (Figure 2).

Mass storage is provided by an 80-megabyte Control Data Corporation Model 9762 disc drive with an Emulex SC01A2 controller. The controller has the capacity to support one additional drive. A Kennedy 9100 10.5-inch reel-to-reel tape drive with an Emulex TC01P controller provides magnetic tape input and output at a tape speed of 75 inches per second. A Sky Computers SKYMNK arithmetic processor is in place to accelerate numeric processing. A Versatec 8222-F 22-inch electrostatic printer/plotter with 200 points-per-inch resolution provides hard-copy graphics output.

Color video display and other functions are provided by a Terak 8510/a-8600HDX microcomputer. The 8510/a includes an 11/2 microprocessor, 64K bytes RAM, an eight-inch dual density floppy disc drive, keyboard and a monochrome CRT display with graphics capability at a 320-by-240 pixel resolution. The 8600HDX display integrated with the 8510/a includes an Intel

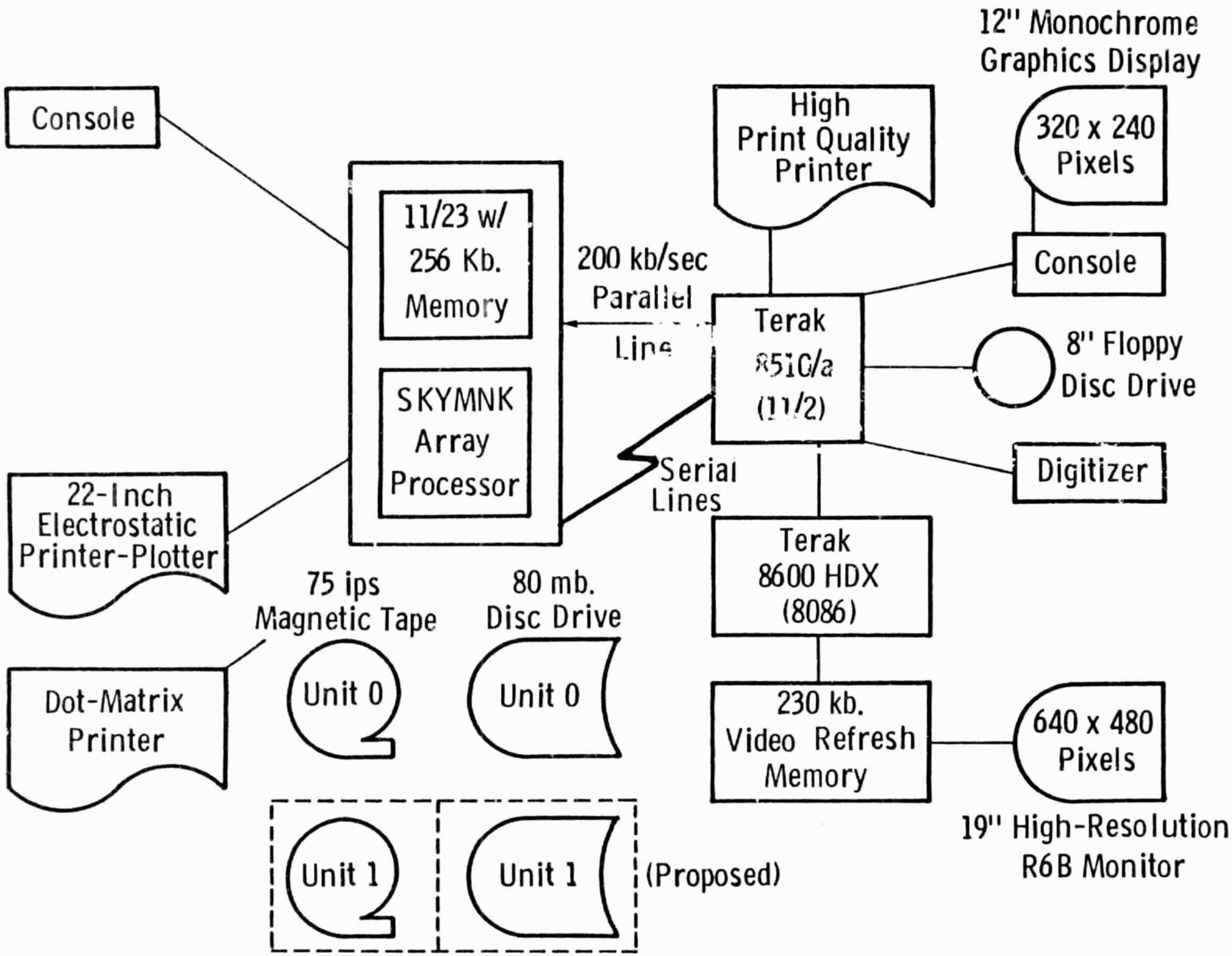

Figure 2. The KARS Program Low-Cost Stand-Alone Image Processing and Geographic Information System

8086 microprocessor, a 19-inch high-resolution RGB color monitor, and video refresh memory and display circuitry capable of 640 by 480 pixels with six bits (64 simultaneous colors) per pixel resolution.

Originally, the Terak (with an 11/23 CPU) was to be the heart of the entire system. However, several hardware incompatibilities developed between the Terak display hardware and several of the other system peripherals. Now, the Terak (with an 11/2 CPU) will serve initially as a display subsystem. Eventually, additional functions will be assigned to the Terak to take full advantage of the dual-processor configuration. Initially, the two computers will communicate by DLV-11 serial ports for control purposes, with two DRV-11 16-bit parallel boards serving for medium-speed (about 200,000 bytes per second) transfers of image data. Eventually, a bus-rate interprocessor link capable of about 1 million bytes per second may be installed.

The ELAS implementation on the PDP 11/34 mentioned above was accomplished using the RSX-11M operating system. Unfortunately, RSX-11M is a true time-sharing system with two serious shortcomings for image analysis. First, as a time-sharing system, RSX-11M incurs substantial overhead in order to handle multiple users. Second, RSX-11M restricts individual programs to no more than 56K bytes of memory in most circumstances.

KARS' goal of a microprocessor-based "unrestricted" ELAS may be attempted using the DEC single-user RT-11 operating system, or a variant of the portable operating system UNIX. There is no current timetable for either of these developments. However, they should allow ELAS to regain some of the capacity that was deleted from RSX-11M ELAS because of the space limitations.

The KARS system will never have the raw CPU power to perform very large analysis tasks--such as multi-frame, multi-date Landsat classification--at speeds suitable for real-time interactive display and analysis. Jobs of such a size might very well take days of real time, and would essentially be done in a batch, rather than interactive, mode. However, the KARS system is highly efficient with respect to computer resources. Display functions will be performed by the Terak's 8086 CPU; image modification and enhancement will be performed by the Terak's 11/2 CPU; intensive numeric operations will be performed by the TRW pipeline CPU in the SKYMNK arithmetic unit; data transfers will be performed by intelligent device controllers that use direct memory access (DMA) techniques. The 11/23 CPU will perform control and supervisory functions but will not, in the mature system, do much computing. Thus, the need for a fast and expensive general-purpose CPU is avoided.

The estimated total cost of the KARS system, including KARS Altek AC90SM 42 x 60 inch back-lighted digitizer that was already on site, is slightly more than $100,000.

During the forthcoming year the KARS Program will pursue several recently initiated efforts to establish cooperative, and mutually beneficial, hardware/software research and development programs with private industry. KARS will focus particular developmental efforts upon enhancement of software for analysis of Landsat-4 Thematic Mapper data and for GIS research and applications.

III. KARS PROJECT ACTIVITIES

April 1, 1982 - March 31, 1983

A PROTOTYPE LANDSAT-BASED RANGELAND RESOURCE INFORMATION SYSTEM FOR THE CIMARRON NATIONAL GRASSLAND

The Earth's grassland environments are being subjected to increasing pressures and demands. Contemporary rangeland resource managers must deal with a host of issues including commercial livestock grazing, petroleum and mineral exploitation, conversion of rangeland to cropland, soil erosion, water quality, recreational use and wildlife sustenance. Yet, there are currently relatively few trained range professionals available to manage the vast expanses of grassland which exist throughout the world.

Not only must range managers frequently contend with very large areas, but they also must consider the interplay of a great many disparate factors when making decisions regarding resource utilization. Decisions concerning establishment of stocking rates, for example, must be based upon evaluation of a spectrum of institutional, political, economic, geographic and biotic data. There is a direct relationship between the quality of decision-making and the quality of data and analytical tools available to the decision-maker.

Remote sensing has been shown to be an effective means for enhancing the quality of range resources data (Aldrich, 1979; Tueller, 1982). Geographic information systems (GIS) will aid rangeland resource managers in analyzing and evaluating data derived both from remote sensing and from other sources in order to make more effective resource management decisions. The project summarized below represents one attempt to foster the utilization of both remote sensing and GIS technology by the range manager working at the local level.

The primary objective of this project is to identify and demonstrate the manner in which a rangeland resource information system founded upon Landsat MSS data may be employed by local level range managers. The study focuses on the Cimarron National Grassland of southwestern Kansas.

Background

Tueller (1982) notes that:

"Remote sensing for range management will be accomplished in a systems context. A system that uses remote sensing on rangelands must include the gathering of data concerned with a specific problem and then data analysis, followed by the generation of information that may be employed in the solution of the problem. The system must be complete before remote sensing is useful. Remote sensing is just one step, but a powerful and hopefully cost-effective step, in the series of procedures leading to the solution of the problem."

He also observes that:

"It is relatively easy to suggest an approach and draw a diagrammatic illustration of [a range resources information] system. But it is very difficult to know all the requirements and define the most cost-effective package with which to match up management requirements, ground information requirements, sensors, specialists, interpretation, training, and an applications approach for any given rangeland remote sensing requirement at any given time."

Our research addresses the information system design and applications issues raised by Tueller. Because rangeland resource management requires analysis of numerous spatially varying and spatially referenced phenomena, it is proposed that range resource information systems will usually be established as geographic information systems.

Such a proposal is certainly not unique to this study. Maxwell (1976), for example, described a possible remote rangeland analysis system based upon data acquired via computer processing of Landsat MSS digital data. Boyd and his colleagues (1978, 1980, 1981) have extensively studied range management information needs and the extent to which such needs might be met via a microcomputer-based Landsat range resource information system. Other investigators are pursuing similar ideas (e.g., Graetz, et al., 1982; Haas, 1982; Tueller, 1982).

Our work in the Cimarron National Grassland draws extensively upon and synthesizes the results of the investigations cited heretofore. It is our interest not only to involve the local level range resource manager in design of a rangeland management information system, but also to provide access to such a system in order that he can gain experience in its utilization in routine decision-making. We believe that the feedback stemming from such an experience will aid us in "fine-tuning" the system design, in more accurately establishing cost-benefit relationships and in better defining applications. In addition, we believe that technology transfer will be fostered as the range managers involved in our work pass on their experiences to others having similar needs and interests.

The Cimarron National Grassland

Cimarron National Grassland (CNG) encompasses approximately 107,140 acres in the extreme southwestern corner of Kansas. Most of CNG lies along the Cimarron River in Morton County, Kansas, though isolated tracts are scattered throughout Morton and neighboring Stevens counties. The grassland lies in an area of level to gently rolling high plains topography at elevations from 3,150 feet to 3,700 feet above sea level. CNG has a continental semiarid climate characterized by an extreme annual temperature range (105 to -25 F) and erratic, though usually scant, precipitation (averaging 16-18 inches annually) (Dickey, et al., 1963; Fox, 1968; Mecklenburg, 1975).

The soils of Morton County are broadly classified as either sandy or "hardlands." Most CNG soils are sandy and are subject to wind erosion when not covered with adequate vegetation. During the late nineteenth and early twentieth centuries cultivation, wind erosion, overgrazing and drought destroyed or altered much of the original native grassland vegetation and associated riparian communities. The area, in the heart of what was the "Dust Bowl," was acquired by the federal government in the 1930's and is now managed by the USDA Forest Service (Dickey, et al., 1963; Mecklenburg, 1975).

The Forest Service has made substantial progress in re-establishing grassland and riparian vegetation. In general, well-managed hardland soils support short-grass prairie, while sandy soils are covered with mid-to-tall grasses and forbs. Open stands of cottonwood, willow and tamarisk occur along the Cimarron River. Sand sagebrush (*Artemesia filifolia*), yucca (*Yucca glauca*) and other, less numerous, weed and brush species continue to dominate the landscape in many areas, a relic of the abusive manner in which the land was managed prior to 1935. There is continual effort exerted to decrease the distribution of plants such as sage and yucca and to increase the distribution and coverage of grasses which provide both excellent ground cover and forage for grazing (Mecklenburg, 1975, 1979).

CNG is managed for multiple uses. These include extraction of oil, gas and gravel, grazing of cattle and recreation (hunting, camping). Grazing is a particularly important land use and has a substantial impact on the local economy. All but about 650 acres of CNG are employed for summer grazing. Nearly 80% of the 5,800-6,000 cattle grazed in a given year are grazed under permit to the Morton County Grazing Association; other cattle are stocked under permits allotted to individuals. Present stocking rates average 3.0 acres per animal unit month. Range management is conducted jointly by permit recipients and the Forest Service. It is believed that higher stocking rates could be allowed in the future if range improvements, revegetation and more intensive management were undertaken (Mecklenburg 1975, 1979).

The short grass prairie and riparian woodland which comprise most of CNG are fragile ecosystems and require careful management if problems such as those that occurred during the 1930's are to be averted in the future. It is important that the Forest Service has accurate, current information regarding the distribution and condition of land cover, range quality, success or failure of reseeding and weed control efforts and related phenomena. At present, management of the entire CNG, much of which is fragmented in parcels scattered over a 540-square mile area, is administered by a single Forest Service ranger and his assistant. Conventional field data collection and analysis techniques are time-consuming and costly and often provide insufficient information to optimally manage CNG (Mecklenburg, 1979).

<u>A Prototype Range Resource Information System</u>

The Kansas Applied Remote Sensing (KARS) Program is investigating, with CNG/Forest Service cooperation, the capability of remote sensing, especially the Landsat multispectral scanner (MSS), to provide data concerning the distribution of CNG plant communities (e.g., grasses, sagebrush, yucca), the distribution of other cover types and the condition of cover types (e.g., ground cover and vegetative biomass) (Merchant and Roth, 1981). Our initial results, and those of other investigators, have demonstrated that Landsat MSS data can be effectively employed in inventorying and monitoring range vegetation (see, for example, Maxwell, 1976; Harlan, 1979a, 1979b). The multispectral, multitemporal data and large areal coverage afforded by Landsat make it a valuable complement to aerial photography and to other conventional sources of data regarding rangeland environments.

Range managers involved in our initial work defined for us a set of particularly pressing range management information needs which might be addressed via remote sensing (Table 6). These echo results compiled by other investigators (e.g., Boyd, et al., 1978, 1981; Tueller, 1982).

Range managers who evaluated the results of our CNG Landsat work identified specific management decisions which would be facilitated by information such as that we extracted from Landsat MSS data (Table 7) (Merchant and Roth, 1982). It is clear, however, that such decisions also require consideration of information other than that which can be obtained via remote sensing (Mecklenburg, 1981).

Until recently the establishment of a geographic information system was an expensive and time-consuming proposition beyond the reach of most local level resource managers (e.g., national grasslands managers, wildlife refuge managers, county planners, large ranchers). It is our contention, however, that there are now available hardware and software having sufficient capabilities at low enough cost ($13,000-$40,000) to be viable for such applications (see also Reed, 1982). Examples include ERDAS (Faust, et al., 1981; Killpack, 1983), GRIDAPPLE (Killpack, 1983), and MAPS (Tomlin, 1980). Without question these systems/software will get better and their cost-capability ratio will improve. Other microcomputer-based systems will be developed and marketed. We believe, however, that existing systems can be employed to benefit at present, and that active utilization of such systems will provide feedback that will promote design of hardware and software which better addresses user needs. In addition, such utilization will enable resource managers to define mechanisms and methods for employing GIS capabilities in management activities.

Range resource managers representing the USDA Forest Service, USDA Soil Conservation Service, and Kansas Fish and Game Commission were asked to assist KARS staff in identifying the desirable components of a prototype rangeland resource information system (Table 8). Range professionals have also been asked to aid in the design of strategies, models and algorithms for analyzing data.

TABLE 6. RANGELAND MANAGEMENT INFORMATION NEEDS

- INVENTORY AND CLASSIFICATION OF RANGELAND VEGETATION
- ESTIMATION OF CARRYING CAPACITY AND SITE (FORAGE) PRODUCTION
- CONDITION CLASSIFICATION AND TREND MONITORING
- EVALUATION OF RANGE UTILIZATION
- MONITORING OF RANGE FIRE HAZARD
- WATERSHED PROTECTION, EROSION HAZARD ASSESSMENT
- WILDLIFE AND WILDLIFE HABITAT EVALUATION
- RANGE IMPROVEMENT POTENTIAL
- GRAZING SUITABILITY EVALUATION

TABLE 7. MANAGEMENT DECISIONS WHICH WOULD BE AIDED BY IMPROVED RANGE RESOURCE INFORMATION

- ESTABLISHMENT OF PERMISSIBLE STOCKING RATES AND GRAZING ROTATIONS
- ALLOTMENT OF GRAZING PERMITS
- IDENTIFICATION OF AREAS REQUIRING SAGEBRUSH AND YUCCA CONTROL
- IDENTIFICATION OF AREAS REQUIRING RESEEDING
- ASSESSMENT OF REQUIREMENTS FOR WILDLIFE HABITAT IMPROVEMENT
- EVALUATION OF SUCCESS OF RESEEDING AND WEED CONTROL PROGRAMS
- ALLOCATION OF RESOURCES (FUNDING, MANPOWER) AND PRIORITIES FOR ALL RESOURCE MANAGEMENT ISSUES
- DESIGN OF LONG TERM MANAGEMENT PLANS

Table 8.
PROTOTYPE RANGELAND RESOURCE INFORMATION SYSTEM

Data Type (Derived Data)	Data Source
• Land Cover/Land Use	Landsat MSS CCTs Aerial Photography Field Sampling
• Biomass/Cover	Landsat MSS CCTs Field Sampling
• Land Treatment, Management History	U. S. Forest Service
• Soils (Range Site, Erodibility, Suitability)	USDA/SCS Morton County Soil Survey
• Elevation (Slope, Aspect)	USGS Topographic Maps Digital Terrain Tapes
• Ownership, Management Units, Administrative Boundaries	Land Ownership Maps
• Grazing History (Intensity, Spatial Distribution, Rotations, Leasing)	Grazing Records (U. S. Forest Service, Morton County Grazing Association)
• Wildlife	Kansas Fish and Game Commission U. S. Forest Service
• Weather and Climate	NOAA Climatic Records Kansas State Agricultural Experiment Station, Meteorological Data
• Petroleum, Gas, Minerals	Kansas Geological Survey U. S. Forest Service

The GIS design was structured so as to capitalize on existing available GIS software and capabilities of the KARS Program. Most data, for example, are digitized and analyzed in raster format, though some (e.g., soils) are digitized in polygonal mode and converted to raster mode for certain analytical purposes (Figure 3).

Developmental work has been accomplished on KARS' DEC PDP 11/23-based digital data analysis system. Support equipment includes an 80-megabyte Control Data Corporation disc drive, a Kennedy 9100 tape drive, a Sky Computers SKYMNK array processor, and a Versatec 8222-F 22-inch electrostatic printer-plotter. Color video display functions are provided by a Terak 8510/a-8600HDX microcomputer having a 19-inch RGB monitor capable of 640 x 480 pixel resolution. Digitizing is accomplished with an Altek AC90SM microprocessor-controlled digitizer having a 42 x 60-inch back-lighted digitizing tablet.

Software currently utilized for the CNG work includes digitizing and image processing packages generated by KARS staff and the very portable MAPS software developed at Yale University (Tomlin, 1980). The MAPS software has been modified to operate on larger data arrays than provided for in the original, teaching-oriented, version, and to provide new data input and map output options.

Future Objectives

In recent years there have been dramatic advances in the technology of computer-assisted spatial data processing. Great strides have been made in the development of hardware and software designed for digitizing, storing, manipulating, integrating, analyzing and displaying geographically referenced data. Equally significant progress has been made in the analysis of remotely sensed data, particularly Landsat Multispectral Scanner (MSS) digital data. The Thematic Mapper (TM) opens the door to a host of new possible applications.

To a large extent, however, neither sophisticated geographic information systems nor remote sensing techniques have filtered down to the local level user (e.g., range manager, county planner, soil conservationist). Equipment costs and software characteristics have, among other things, made adoption of such techniques impractical at the local level. It is essential, however, that if such technology is to be employed

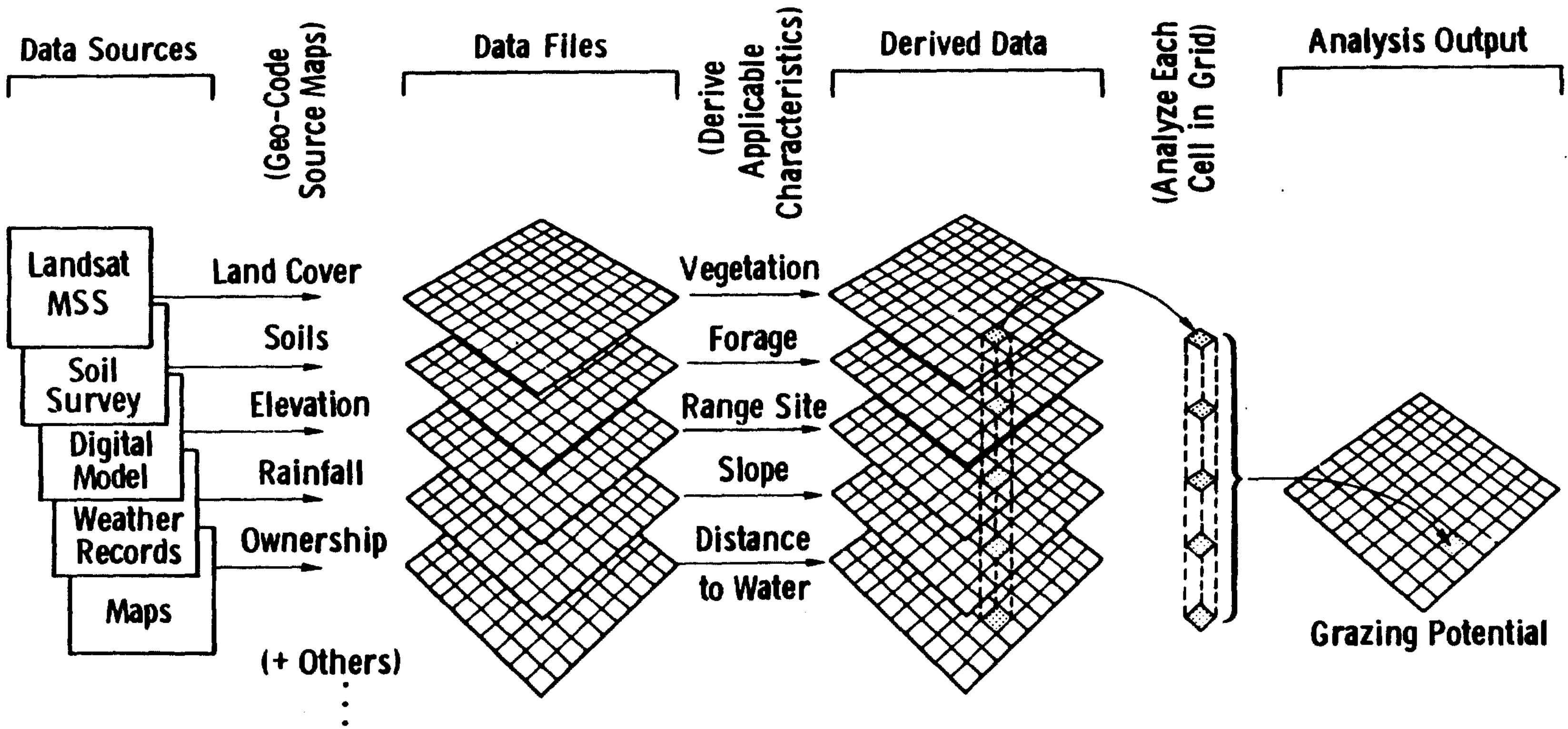

Figure 3. Prototype Rangeland Resource Information System

effectively in site specific planning or resource management, potential users must have the opportunity to use and evaluate the technology on a day to day basis.

Microcomputer technology now offers the possibility to accomplish this task. The objectives of this research are to:

1. Construct a Landsat-based integrated digital rangeland resource information system for a portion of the Cimarron National Grassland;
2. Define with resource managers, planners and other potential users the information content, applications, resolution, costs and benefits of the data base;
3. Identify software in the public domain (e.g., ELAS, MOSS) which could be adapted to hardware costing $15,000 - $30,000 and which could provide upward compatibility with existing state and federal systems;
4. Define and evaluate the specific role of Landsat MSS data (and TM data) as available in range resource management at the local level;
5. Refine currently used KARS MSS digital analysis strategies to incorporate soils, slope and aspect data and to make use of appropriate data transformations;
6. Initiate examination and evaluation of change detection algorithms;
7. Examine and evaluate institutional alternatives for facilitating data transfer between federal, state and local levels.

While the work will focus specifically on the development of a system for management of renewable resources (e.g., range, forest, wildlife), every effort will be made to make the system as comprehensive as possible so that the needs of other local level users (e.g., planners, tax assessors, soils conservationists, wildlife managers) can be addressed.

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REMOTE SENSING/GEOGRAPHIC INFORMATION SYSTEMS APPLICATIONS IN GROUNDWATER MODELING: THE WALNUT CREEK VALLEY, KANSAS

Concern over declining groundwater levels in recent years has led the Kansas Geological Survey (KGS) to initiate a geohydrologic study of the alluvial aquifer underlying the Walnut Creek Valley in central Kansas (Figure 4). The objective of the study is to develop a predictive groundwater model that will allow mathematical simulation of geohydrologic processes within the aquifer in order to determine future groundwater availability under various conditions of withdrawal and recharge.

Since irrigated cropland is the heaviest user of groundwater in the valley, data regarding irrigated acreage and its precise location within the watershed would provide a starting point for estimating water usage effectively. Based on techniques developed in previous irrigation mapping projects (Williams and Poracsky, 1979a, 1979b), the Kansas Applied Remote Sensing (KARS) Program undertook, in the spring of 1980, a cooperative study with KGS to provide remote sensing data as input to the geohydrologic model. The model will combine information on aquifer characteristics, crop phenologies and water requirements, and precipitation records to aid in the design of a groundwater management plan for the Walnut Creek area.

Project Scope

The KARS Program, in cooperation with KGS, agreed to investigate the utility of remote sensing in the development of a geohydrologic model for the Walnut Creek Valley. The model would address three major factors: the amount of groundwater currently in the aquifer, the amount of annual natural recharge, and the amount of groundwater withdrawn by pumping. The remote sensing component of the model called for a multidate assessment of irrigated lands in the watershed, via the interpretation of Landsat multispectral scanner (MSS) imagery, to identify irrigated crops. Combined with crop phenologies and water use requirements, the remote sensing technique would generate water use estimates that can be compared with well permits and usage reports (the current methods for monitoring withdrawals) to more accurately determine rates of groundwater withdrawal.

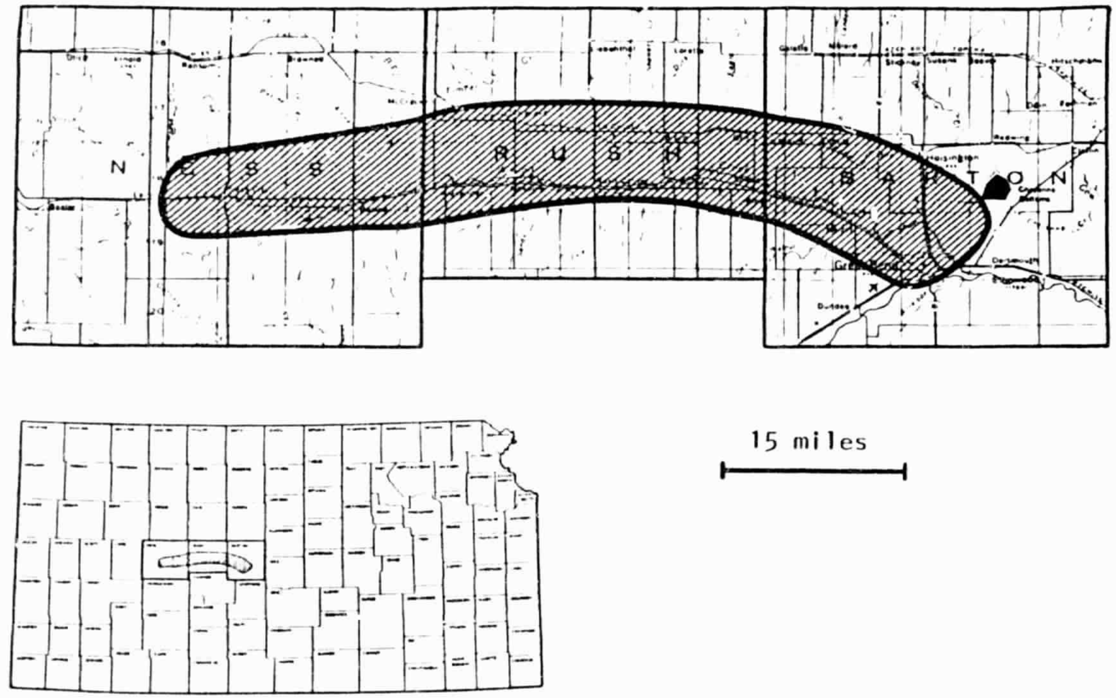


Figure 4. Walnut Creek Valley, Central Kansas

The Study Area

The Walnut Creek Valley in central Kansas is approximately 70 miles long, comprises approximately 300 square miles, and varies in width from about one mile in the upper reaches to about six miles in the lower reaches. Extending eastward from Ness City in Ness County, through Rush County and into Barton County, it joins the Arkansas River near Great Bend. The Valley receives approximately 21 inches of precipitation per year, most of which occurs during the growing season in spring and summer (Gillespie and Slagle, 1972).

The study area lies outside of the Ogallala Formation, the primary aquifer of western Kansas and the Great Plains, and is underlain instead by the Dakota Formation. Water from the Dakota has a high level of dissolved solids and is considered to be only marginally acceptable as irrigation water throughout much of the Valley (Jenkins and Pabst, 1977). Nonetheless, the aquifer is heavily drawn upon for irrigation of crops. Major crops grown in the area are winter wheat, corn, sorghum, and alfalfa.

Water levels in the Valley generally decline during the irrigation season (May to September), then gradually rise until pumping begins the following season (Jenkins and Pabst, 1977). Although some overall long-term declines have been observed, the area is considered to be rechargeable. Natural recharge comes almost entirely from percolation of streamflow through the channels of Walnut Creek and its tributaries. Infiltration of precipitation and deep percolation of irrigation waters have minimal input to total recharge (Gillespie and Slagle, 1972).

Concern has centered around the question of whether the aquifer has reached, or perhaps already exceeded, the saturation point in terms of irrigation development and pumpage rates. If continued pumping seems likely to result in further depletion of the aquifer, additional well development in the watershed may be prohibited or strictly controlled.

Groundwater Modeling Process

In general, the development of any groundwater model requires that three factors be addressed (Jenkins and Pabst, 1977). First, the physical characteristics of the aquifer (e.g., available pore space, pore size, and rate of water movement through the pores) must be determined. Second, the quantitative inputs of water to the aquifer, or recharge, must be evaluated. Recharge may come from precipitation falling on the land surface and percolating down to the aquifer, or from percolation from stream channels or from some other subsurface source. Third, withdrawal of water from the aquifer must be quantified. This would include, most importantly, the amount of water withdrawn through wells, although other possible withdrawals, such as springs and seeps, may be of local significance.

By relating these three factors quantitatively in a mathematical formula, it is possible to derive an estimate of drawdown over a certain period of time. This relationship is exemplified by the following simple equation:

$$\text{Drawdown} = \text{Storage} + \text{Recharge} - \text{Withdrawal}$$

Information regarding drawdown and aquifer storage can be readily obtained through analysis of aquifer geology and regular monitoring of observation wells distributed throughout the Valley (Gillespie and Slagle, 1972). Recharge can be estimated relatively accurately by analysis of soils (percolation, infiltration properties), surface hydrology and precipitation characteristics (Gillespie and Slagle, 1972; Doorenbos and Pruitt, 1977).

Difficulty has been encountered in the acquisition of accurate data concerning withdrawals from the aquifer. At present, data describing withdrawals is available in the form of well permits and usage reports from the Division of Water Resources, Kansas State Board of Agriculture. However, both of these sources have associated problems that limit their reliability. Well permits tell only what the irrigator is legally allowed to pump, not what was actually pumped. There may be much less water pumped than the legal total if there is above average precipitation or if a crop such as winter wheat (which requires relatively little irrigation) is grown rather than corn or alfalfa (which are heavy users of irrigation water).

The other source of data, yearly water usage reports, could provide very good information if the data were objectively collected by a well meter. However, because reports are based on the subjective estimates of irrigators, they may vary in reliability from individual to individual. Furthermore, these reports are incomplete. In any one year only about 60-80% of the irrigators in the Valley actually turn in reports.

Remote Sensing Input

It is in this critical area of withdrawals that remote sensing technology was deemed capable of making a significant contribution by providing spatial information concerning irrigated cropland and crop types on that land. It was anticipated that such data could be employed to make more consistent, accurate estimates of water usage based on specific crop water requirements.

A methodology founded on techniques developed by the KARS Program in an earlier study of irrigated lands for the Kansas Legislative Research Department was adapted for this work (Williams and Poracsky, 1979b). The previous work by KARS involved identification of both flood and center-pivot irrigation systems on Landsat MSS imagery. This work revealed that irrigated fields in western Kansas generally have a more vigorous crop cover than similar unirrigated fields. This difference in crop vigor was reflected in the tonal characteristics of the irrigated and non-irrigated fields, especially in the red spectral band (Band 5) of Landsat MSS imagery, which is sensitive to the low red reflectance of healthy vegetation. Crop calendars of the major crops were used to select dates on which maximum segregation could be expected (Williams and Poracsky, 1979).

Field Work

Prior to image interpretation, KARS personnel conducted fieldwork in the Walnut Creek study area during May and August of 1980. Transects through the study area were driven to obtain familiarity with the region and to observe different cropping patterns present. Field notes were recorded on acetate overlays of 1:24,000-scale 7.5 minute U.S. Geological Survey topographic maps of the area.

Interpretation Procedures

The geographic location of the Walnut Creek study area warranted the acquisition of two adjacent Landsat scenes: Path 31, Row 33, and Path 32, Row 33. Three years of Landsat data were analyzed for the KGS study - 1973, 1976, and 1979 (Table 9). For each year interpretations of irrigated land were performed at three widely-spaced dates throughout the growing season. The dates included an early season image (April/May), a mid-season image (July/August), and a late season image (September/October). This scheme was necessary in order to observe each of the dominant irrigated crops, identified by dark tones on the imagery, in its most vigorous growing stage.

Visual interpretation of Band 5 Landsat imagery was performed on 1:125,000-scale enlarged prints of the Walnut Creek Valley. A grid cell network was constructed and drawn on the imagery, with each cell representing four square sections (Figure 3). The interpretations for all three

Table 9

Landsat Imagery Utilized in Walnut Creek Study

(All Band 5)

Path: 31 Row: 33	Path: 32 Row: 33
30 May 1973	13 May 1973
10 August 1973	6 July 1973
4 October 1973	21 October 1973
14 May 1976	6 May 1976
16 July 1976	14 May 1976
21 August 1976	8 July 1976
26 May 1979	4 August 1976
11 September 1979	22 August 1976
	25 March 1979
	2 July 1979
	25 August 1979
	3 September 1979

Figure 5. Grid cell network imposed upon 1:250,000 Landsat enlargement. Each cell represents four square miles. (Walnut Creek Valley located in center of image.)

parts of the growing season were recorded on a single acetate overlay. This overlay was prepared with the same grid system that had been imposed on the Landsat prints. Each cell in the grid system on both the overlay and the print was assigned a number to aid in the process of location and registration. Some difficulty was encountered in the precise registration of acetate to image, due mainly to the distortion which resulted during the enlargement of the original Landsat 1:1,000,000 scene. Even though each image was interpreted at 1:125,000 scale, the resolution presented difficulty in identifying precise locations (e.g., individual fields).

On the interpreted overlays, each area identified as irrigated was color-coded to indicate the date or combination of dates on which it appeared. Based on the combinations and a knowledge of crop calendars it was then possible to identify the type of irrigated crop growing in each field. Tables 10 and 11 show the combinations that were used to identify each crop type and the color-coding strategy employed. Any crop which appeared irrigated on only an early season image was identified as winter wheat. Any crop which appeared irrigated on only a mid-season image was identified as either corn or sorghum. Late season imagery was used as a check to identify irrigated alfalfa. Whenever a field appeared irrigated in any two or all three parts of this season, it was identified as alfalfa, because alfalfa has multiple harvests and thus multiple high-vigor irrigation periods throughout the growing season.

Digitization Procedures

Following a check of the interpretation, each year's compilation was digitized and a separate data file created for each irrigation date pattern, as coded by color. A computer plot of field boundaries for each color was then prepared and overlaid on the original compilation to provide a visual check on the accuracy of the digitizing (Figure 6).

Boundaries of the irrigated areas were digitized using the KARS Program's Altek AC90SM Digitizer operating in grid cell mode. A grid system was imposed on the entire study area that was equivalent to a 16 by 16 grid for each section; that is, each section was divided into 256 cells. This meant the boundaries were digitized to an accuracy of about 1/32 of an inch, which exceeded the accuracy of the freehand-drawn interpretations. However,

Table 10
DATE COMBINATIONS FOR IDENTIFYING EACH IRRIGATED CROP

Irrigated Crop	Date of Imagery Which Indicates Presence of Irrigation		
	Early Season	Mid-Season	Late Season
Winter Wheat	X		
Alfalfa	X	X	
Alfalfa	X		X
Corn or Sorghum		X	
Alfalfa	X	X	
Alfalfa		X	X
Alfalfa	X	X	X

Table 11

COLOR-CODING STRATEGY

Color	Identified Crop
Yellow	Winter Wheat
Red	Corn or Sorghum
Blue	Alfalfa
Purple	Alfalfa
Green	Alfalfa
Brown	Alfalfa
Gray	Alfalfa

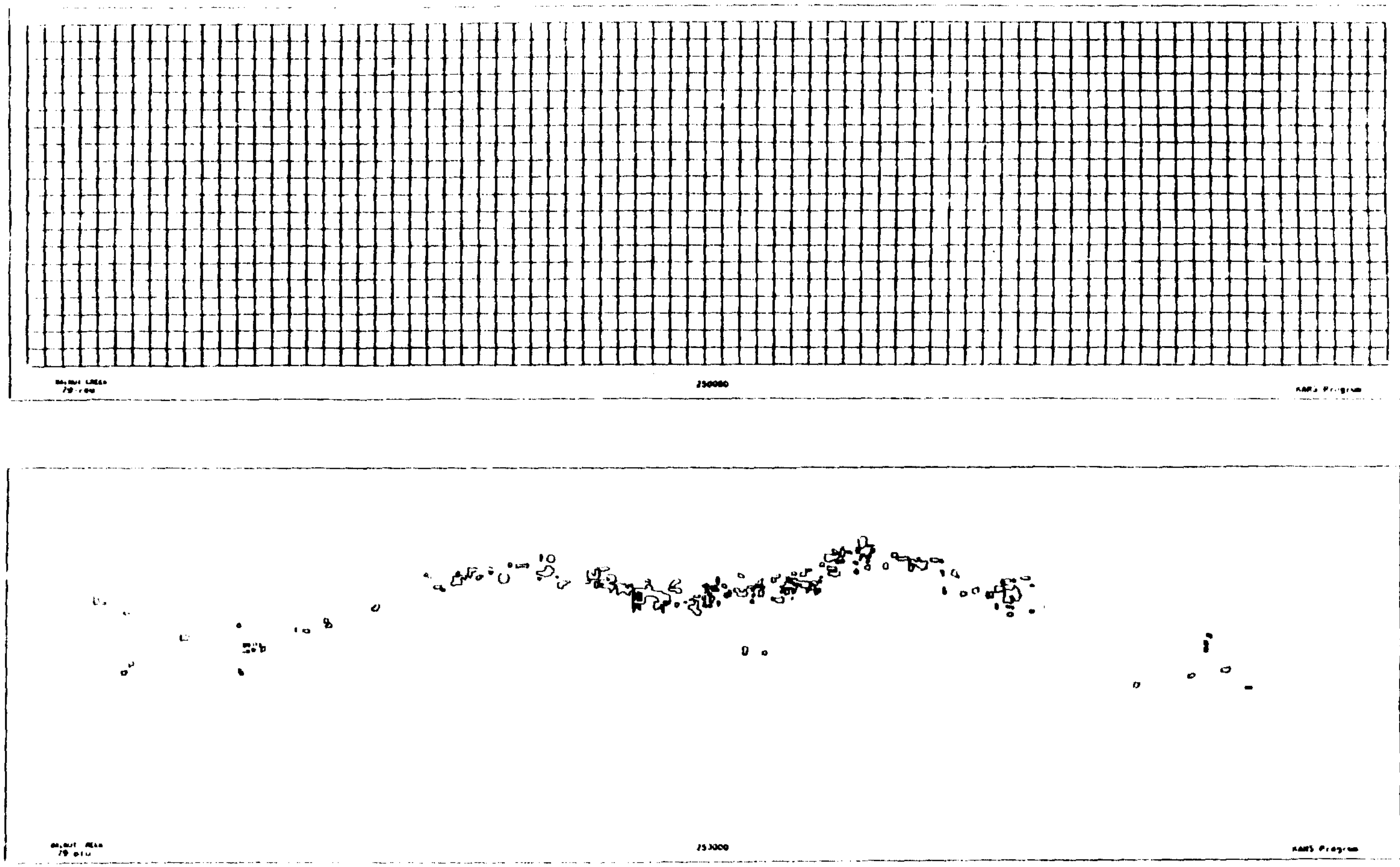


Figure 6. Two of the computer plots used to verify the digitized data with the original compilations. The upper plot represents the one-square-mile section line grid of the study area; the lower plot is the area identified as being irrigated in the middle part of the growing season (July/August) and represents the irrigated corn and sorghum in the Valley.

the number of data points necessary to represent a given field was in most cases less than would have been required for point-polygon-type boundary representations.

Two programs, written in the language C for the KARS Intertec Super-Brain microcomputer, were prepared to process the field data. Program EDITPTS (edit points) verified polygon closure and eliminated duplicate polygons. Program AREAGRID filled the interiors of the polygon boundaries, imposed on them a larger grid system corresponding to the quarter-section lines of the township/range system, and computed the areas within each quarter section that were irrigated.

The irrigated acreage data were transmitted to the University of Kansas central computer system, a Honeywell Level 66DPS-3E, and made available to KGS. The areal statistics have since been transferred to the new KGS computer, a Data General Eclipse MV8000.

A third program - PLOTMAP - was used to derive output such as was illustrated in Figure 6. This program was written in Fortran to be used with the Calcomp 1038 plotter at the University of Kansas to produce maps of irrigated lands in the study area.

Estimation of Pumpage

The interpretation of the Landsat imagery yielded information regarding a particular crop's acreage on a per quarter section basis. Once a crop was identified, the U.S. Soil Conservation Service Kansas Irrigation Guide was consulted to determine the amount of water required for normal, healthy growth. The crop's net irrigation requirement was then computed by subtracting annual precipitation figures from the total water requirement of the crop. Thus, the end result of this calculation represented the amount of irrigation water required by that particular crop.

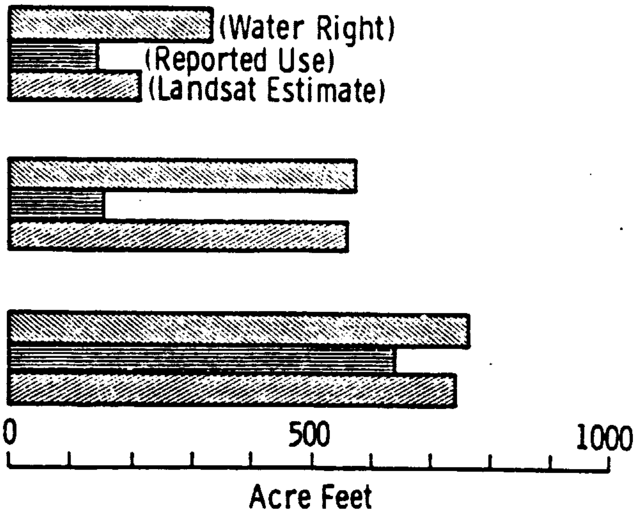
It may be noted that while a crop's net irrigation requirement dictated a specified amount of water to be pumped, the amount actually pumped was probably higher. This extra irrigation was necessary to offset the moisture lost from runoff, evaporation, or rapid percolation through the soil.

Conclusion

Using this Landsat-based technique, it is possible to derive an estimate of the amount of water being pumped for irrigation. Preliminary data for several sample sections indicate that the technique is providing results that appear reasonable and consistent. A comparison of the Landsat-based estimates and the other two sources (well permits and usage reports) for the sample sections reveal the Landsat pumpage data to be consistently lower than the legal water right for the section and higher than the reported use (Figure 7). Because the water use reports are based on incomplete records, this is precisely what would be expected.

At this point it appears that the Landsat-based technique can provide an objective means for determining pumpage rates of groundwater supplies. Final evaluation of the results must await further data analysis by KGS and, ultimately, the completion of the groundwater model. KGS has approved funding to complete work on the model in FY84. With the development of a reliable groundwater model, there will be a better understanding of the course of action that should be followed in future groundwater development in the Walnut Creek Valley and in other critical water management areas as well.

Figure 7. Pumpage Data for Three Sample Sections



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MODELING CHANGES IN PRONGHORN ANTELOPE HABITAT IN WESTERN KANSAS

Kansas represents the extreme eastern edge of pronghorn antelope range. Historically, great numbers of pronghorns inhabited the western part of the state, but by the early 1960's only a handful remained in Sherman and Wallace counties, located at the Kansas-Colorado border. The decline of antelope in the state has been attributed to destruction of native prairie and unregulated hunting.

In the early 1960's, the Kansas Forestry, Fish and Game Commission (now the Kansas Fish and Game Commission) made plans to try to reestablish antelope herds in western Kansas. Antelope trapped in Montana were released in Sherman and Wallace counties in 1964. More antelope were trapped in Colorado and released in 1966 and 1967 in other counties, but these latter efforts were largely unsuccessful. The population in Sherman and Wallace counties, however, grew from 37 in 1962 to approximately 1,100 in 1981.

In selecting potential release sites for additional pronghorn transplants, Kansas Fish and Game personnel looked for areas featuring large tracts of uninterrupted rangeland. These areas can then be subjected to additional evaluation on the premise that areas where conversion of rangeland to cropland is occurring rapidly would be undesirable release sites. The use of remotely sensed data was felt to be ideal for performing the required analyses of land cover over time.

Previous Work

In 1977, the Kansas Fish and Game Commission contacted the Kansas Applied Remote Sensing (KARS) Program to evaluate five areas in Kansas for pronghorn antelope habitat suitability. Landsat imagery was used to evaluate the extent of agricultural encroachment onto rangeland for each area for the years 1972 through 1976. On the basis of this study, the Flint Hills region in Chase County and the Clark County area were selected as release sites by the Kansas Fish and Game Commission. The three remaining sites in Morton, Gove, and Ellsworth counties were rejected.

Of particular importance were the data on the Gove County area. Based upon its location and land use the Kansas Fish and Game Commission had anticipated that this area would be selected as a release site. An analysis of Landsat images by the KARS Program, however, showed that the Gove County area had experienced a 37% decline in rangeland over the five-year period between 1972 and 1976.

Since completion of the antelope project in 1978, the Kansas Fish and Game Commission has continued to release pronghorn antelope in a number of areas. Motivated by a desire to increase the herd size and expand the range of antelope in the still successful Sherman/Wallace area, antelope were released in the nearby Gove County area in 1979, despite the trend of a decline in rangeland demonstrated by KARS' analysis of 1972-76 Landsat images.

Although there has not yet been an official aerial survey to estimate the population of this herd, reported sightings of the herd are favorable. This is a seeming anomaly. If conversion of rangeland to cropland is indeed a critical factor in the successful establishment of antelope, why then are herds doing so well in the Gove County area? Perhaps rangeland conversion is of only secondary importance.

The success of pronghorn antelope in the Gove County area and in neighboring Trego County prompted KARS Program staff to reassess habitat parameters critical to the success of pronghorns. Previous work had been based on the premise that the size of the range available was one of the most important factors bearing on the success of pronghorns. However, recent studies have brought forth the importance of winter wheat in the diet of Kansas pronghorns.

Sexson (1979) reported in his study of pronghorns in Sherman/Wallace counties that winter wheat comprised almost 80% of their diet during the 1977-78 winter months. Alfalfa comprised more than 10% of their diet at certain other times of the year. Because winter wheat is a major part of the antelope diet during the winter, the KARS Program and Kansas Fish and Game Commission decided to investigate not only the relative abundance, but also the interspersion and juxtaposition of this crop in both the Sherman/Wallace and Gove/Trego areas.

<u>Objectives</u>

In view of the success of pronghorns in the Gove/Trego area, the KARS Program initiated a study to compare the relative abundance of winter wheat--an important component of the Kansas pronghorn diet--in prime antelope habitat (Sherman/Wallace area) with that of the Gove/Trego area (see Figure 8). This study was conducted for 1973 and 1980, and considered

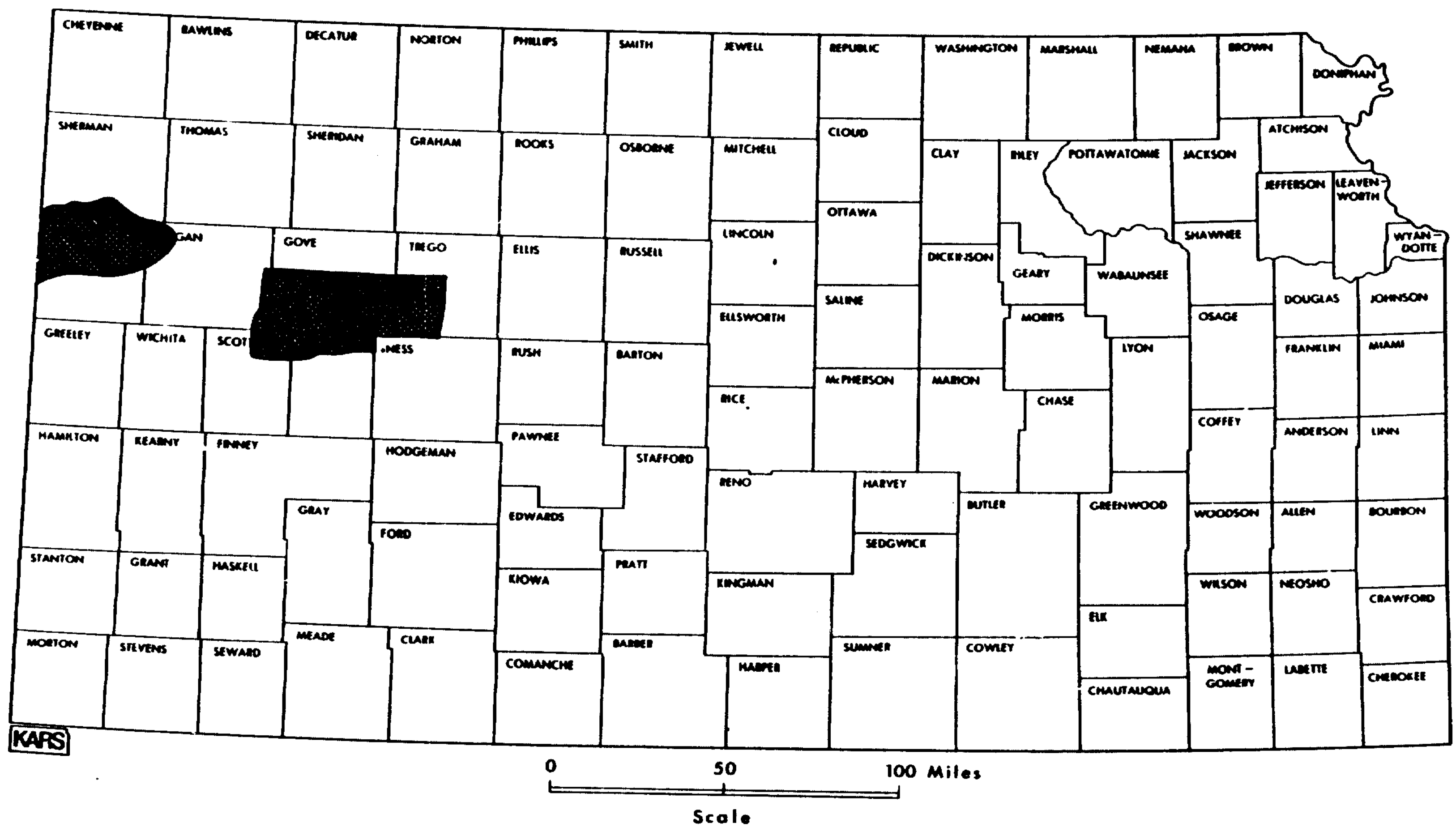

Figure 8. Pronghorn Antelope Study Areas

the interspersion and juxtaposition of winter wheat, other cropland and rangeland. The two study areas were compared to each other over the eight-year interval.

Methodology

The study was executed in two phases. The first phase was to map land cover in the Sherman/Wallace and Gove/Trego study areas in both 1973 and 1980. Land cover was classified as rangeland, winter wheat and other cropland. Once this process was completed, a model developed by Mead, et al. (1981), and later tested by Heinen and Mead (1982) and Cross and Heinen (1982), was applied to measure the interspersion and juxtaposition of winter wheat, other cropland and rangeland.

Land cover was mapped from Band 5 Landsat multispectral scanner (MSS) imagery, enlarged to a scale of 1:250,000. Interpretation at this scale facilitated registration of land cover types to 1:250,000 U.S. Geological Survey topographic quadrangles. In one instance, National High Altitude Aerial Photography was used instead of Landsat imagery because imagery for the required season contained unacceptable amounts of cloud cover.

The types of imagery utilized for each study area for 1973 and 1980, as well as dates and available ground truth information, are summarized below:

- Sherman/Wallace (1973) - Landsat MSS imagery, Band 5: May 14, 1973, July 7, 1973 and August 12, 1973
  - U.S. Air Force black and white oblique photography (1:30,000): May 22, 1974
- Sherman/Wallace (1980) - National High Altitude Aerial Photography, black and white (1:80,000): August 20-September 21, 1980
  - ASCS 35mm aerial photography (1:120,000): Fall 1980 and July 1981
- Gove/Trego (1973) - Landsat MSS imagery, Band 5: May 31, 1973 and August 29, 1973

- Gove/Trego (1980) - ASCS photo-index sheets (1:63,360): September 5 - October 4, 1980
  - Landsat MSS imagery, Band 5:
    May 30, 1980 - eastern half
    May 13, 1980 - western half
    August 1, 1980

The substantial use of aerial photography for the 1980 seasons undoubtedly resulted in increased accuracy of rangeland and cropland delineation for that season. However, Landsat imagery or some other ancillary data (ASCS 35mm color slides) were required in order to identify parcels of winter wheat.

Both spring and late summer Landsat imagery were utilized, when available, to interpret winter wheat. Winter wheat and alfalfa are actively growing in the spring of the year, and hence appear as dark gray-to-black n the spring imagery. Other crops have not yet been planted or have not yet emerged. They appear as light gray-to-white parcels, because a spectral response is essentially recorded for soil (not growing vegetation).

In the late summer imagery, winter wheat has been harvested and lies fallow, whereas alfalfa may be actively growing. Therefore, this imagery can be used to eliminate parcels of alfalfa classified as winter wheat on the spring imagery. Of course, some of the alfalfa on the late summer imagery may have been recently harvested, resulting in possible confusion of the harvested alfalfa with fallow areas. However, this error is considered negligible because alfalfa is a relatively minor crop in western Kansas, compared to winter wheat; and alfalfa is also occasionally grazed by antelope, so this crop is certainly not without some value.

Once the land cover was delineated and classified, it was registered to 1:250,000 U.S. Geological Survey topographic base maps. A grid (160-acres/cell) was superimposed over the study area to determine the approximate frequency of rangeland and cropland.

According to Cross and Heinen (1982), the cell size selected should ideally be made on the basis of biological factors such as home range size and patchiness of the landscape. Because large herbivores utilize relatively homogeneous landscapes, their habitat may be analyzed with larger cell sizes than habitat for small game species.

Whenever winter wheat was present in a 160-acre cell (no matter how little), the cell was recorded as winter wheat. The predominance rule for type mapping is not applied for this land cover; rather, winter wheat is assigned to an independent category, thus reflecting its importance to the pronghorn diet. Each cover type is then expressed by the frequency of occurrence within the study area on a cellular basis.

<u>Habitat Evaluation</u>

Once the land cover has been recorded on a cell-by-cell basis, a technique developed by Mead, et al., (1981) to measure interspersion and juxtaposition was utilized. Interspersion is defined by Giles (1978) as a measurement of the spatial intermixing of habitat types; and juxtaposition refers to some measure of the proximity of different habitat types.

<u>Interspersion</u>. According to Mead's criteria (1981), interspersion is calculated by counting the total number of cells surrounding a centroid cell which contain a different cover type category than the centroid cell. There are eight possible cover type changes surrounding any cell in the grid superimposed over the 1:250,000-scale cover type map. The interspersion value for any given cell is thus expressed as the ratio of total cover type changes over total possible number of cover type changes (8). Index values for interspersion thus range from 0 to 1 (see Figure 9).

Heinen and Mead (1982) divided this range from 0 to 1 into three intervals representing areas of low (0.00 - 0.33), medium (0.34 - 0.67), and high (0.68 - 1.00) values for interspersion, and then assigned an integer value (1 = low, 2 = medium, and 3 = high) to represent degrees of interspersion on a final map output. Hence, the final calculated interspersion index for a particular area would range from 1 to 3.

In this study, interspersion was not represented in map form because only three cover types were classified in this study and because of the relative homogeneity of cover types in the study areas; and integer values were therefore not assigned to represent intervals of interspersion. Instead, a single interspersion value was derived for each study area for each year (1973 and 1980) by adding the total cover type changes for all cells and dividing by the total possible number of cover type changes for all cells. This index value thus falls between 0 and 1 for the area as a

	Actual Cover Type Changes	Possible Cover Type Changes	Interspersion Value (Range 0 - 1.0)
W R R R R R R R R	1	8	1/8 = 0.125
W C C C R C W W R	7	8	7/8 = 0.875
Total for Two Centroid Cells	8	16	8/16 = 0.50

Figure 9. Measuring for Interspersion

whole. Because the goal of this study is to compare and contrast different areas over time, derivation of a single interspersion value for each area in this way was considered appropriate.

Juxtaposition. Juxtaposition indices (fine edge relationships and are developed by first assigning relative weighting factors representing the importance of different community junctions.

Edge weighting factors used in the calculation of juxtaposition were assigned based on relative importance of various edges to pronghorn antelope (see Table 12). Though the values assigned may be subject to debate, nonetheless they serve the ultimate purpose of comparing two study areas--one known to contain high quality antelope habitat--over an eight-year time period. Cross and Heinen (1982) postulate that, although the adjacency of two cells containing the same cover type does not represent a true edge, it may be given a weighting factor for the juxtaposition index if large stands of that type are important for the species under consideration. In this study, large tracts of open rangeland are certainly a desirable habitat feature for this particular ungulate.

The index values derived for each centroid cell in relation to its edges were then divided into three intervals representing areas of low (0.00 - 0.17), medium (0.18 - 0.34) and high (0.35 - 0.50) values for juxtaposition. These ranges thus represent degrees of habitat quality, and can be portrayed in map format. The mean interval juxtaposition value was derived by assigning an integer value to each interval (1 - low, 2 - medium, and 3 = high), and summarizing for the study area as a whole. This total value is then divided by the total juxtaposition value possible, which accounts for a maximum edge value of 12 for each centroid cell. The resulting juxtaposition index thus ranges from 1 to 3.

Results

The results of implementing Mead's model for the Sherman/Wallace and Gove/Trego study areas are summarized in Figure 10 and in Tables 13-14. Figure 10 summarizes the frequency of occurrence of various cover types in 160-acre parcels for each study area. Because the predominance rule for type mapping was not used for winter wheat, this particular category is greatly overexaggerated. However, for game species having large home ranges

Table 12.

Edge Weighting Factors Assigned for the Calculation of Juxtaposition

COVER TYPE	Rangeland	Cropland	Winter Wheat
Rangeland	0.5	0.05	0.4
Cropland		0	0
Winter Wheat			0.05

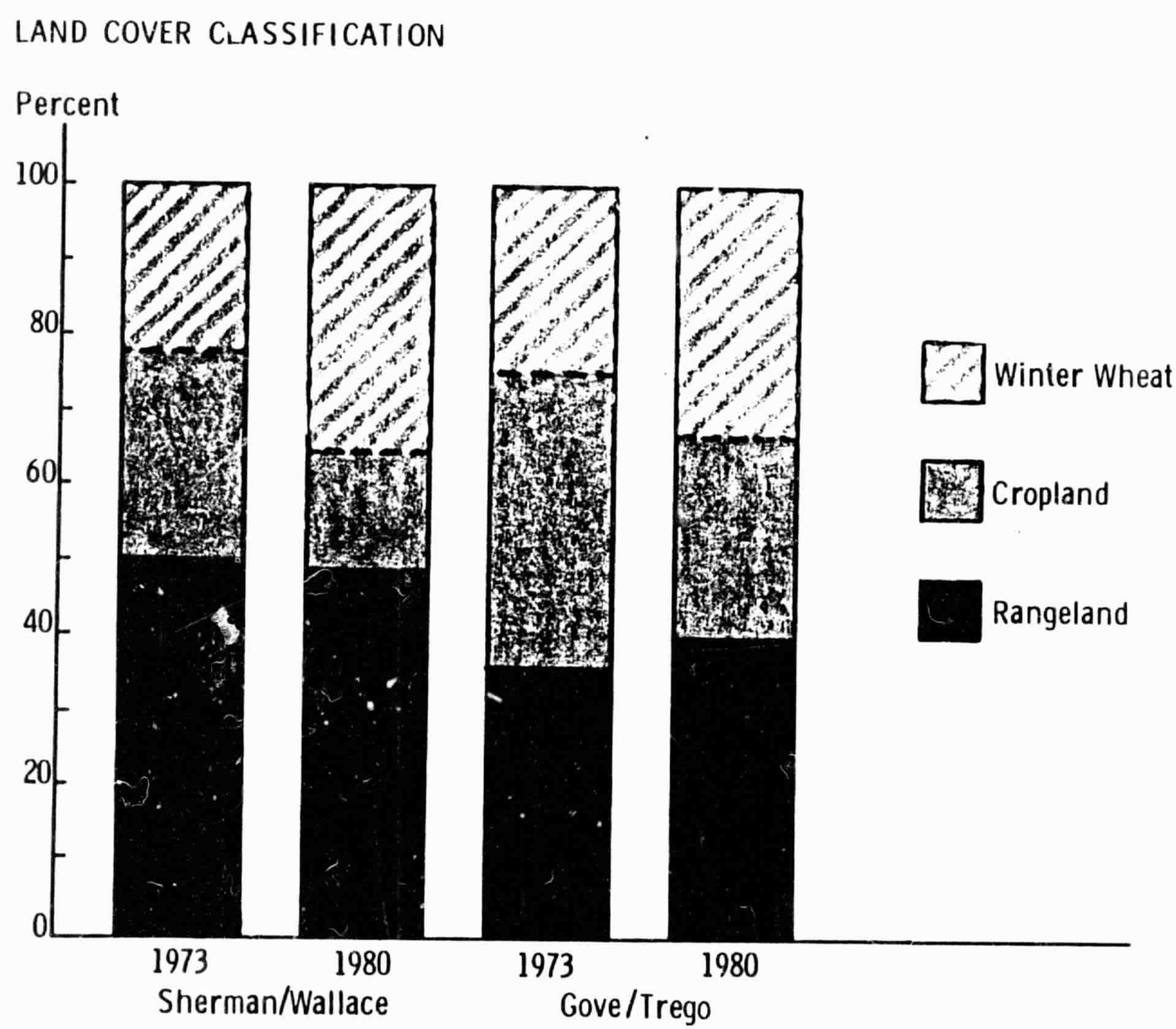

Figure 10. Frequency of occurrence of winter wheat, cropland and rangeland for each study area (1973 and 1980)

	Sherman/Wallace		Gove/Trego	
	1973	1980	1973	1980
Actual Cover Type Changes	7123	7193	15445	18033
Possible Cover Type Changes	18754	18754	36246	36246
Interspersion Index	0.38	0.38	0.43	0.50

Table 13. Average Interspersion Values

	Sherman/Wallace		Gove/Trego	
	1973	1980	1973	1980
Low (0.00 - 0.17)	47.2%	43.7%	61.0%	55.1%
Medium (0.18 - 0.34)	11.0	12.7	13.6	17.4
High (0.35 - 0.50)	41.8	43.6	25.4	27.5
	100%	100%	100%	100%

Table 14. Frequency of Occurrence for Areas of Low, Medium, and High Juxtaposition (Percent)

(i.e., pronghorns), it is reasonable to assume that any cell containing winter wheat could easily be reached, provided it is juxtaposed to its predominant habitat, rangeland.

The results of calculating the interspersion for the two study areas for 1973 and 1980 are contained in Table 13.

The juxtaposition indices derived for the two study areas for 1973 and 1980 are summarized in Tables 14 and 15. Figures D-G present the spatial distribution of habitat quality based on the results of the model.

The results of this study provide new insight into the relative importance of winter wheat/alfalfa availability and spatial distribution in relation to the size of the rangeland. This perspective may influence future management decisions made by Kansas Fish and Game regarding their efforts to increase pronghorn antelope populations in Kansas.

	Sherman/Wallace		Gove/Trego	
	1973	1980	1973	1980
Average Value	1.95	2.00	1.64	1.72

Table 15. Average Interval Value of Juxtaposition

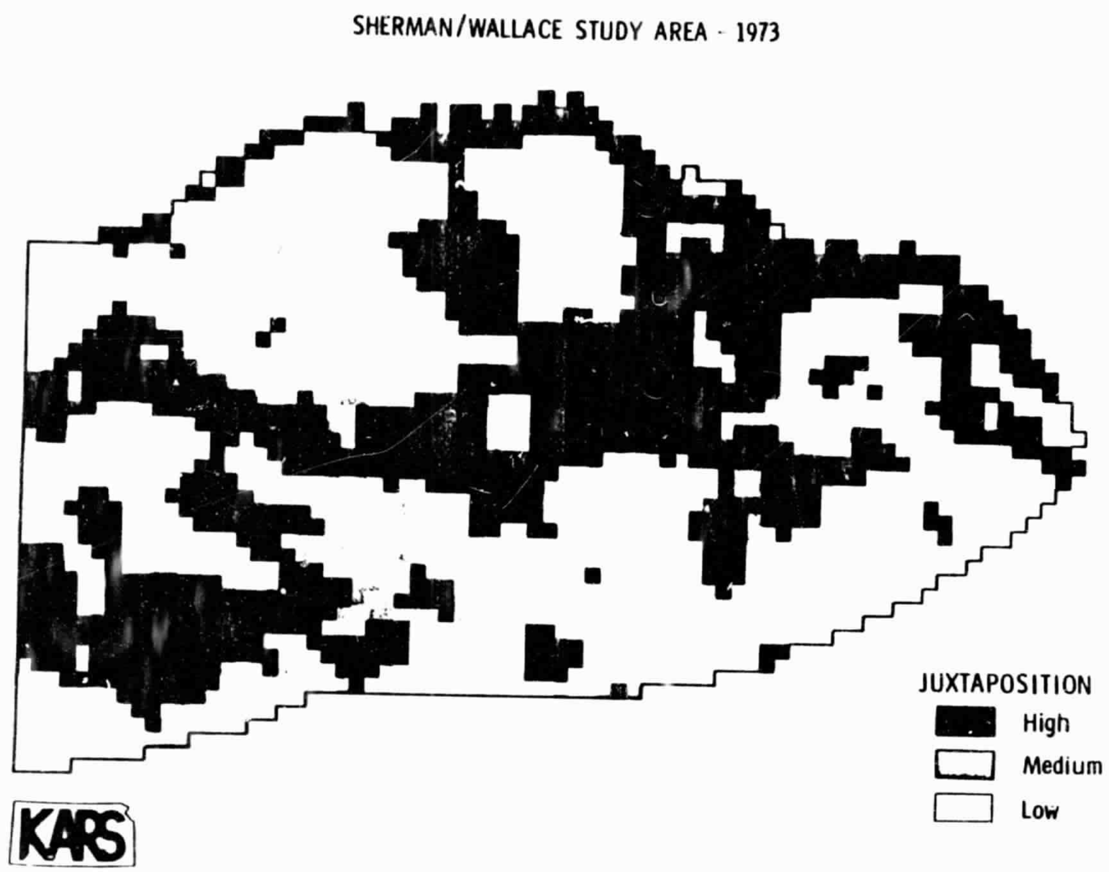

Figure 11. Spatial Distribution of Areas of Low, Medium and High Juxtaposition in the Sherman/Wallace Study Area - 1973

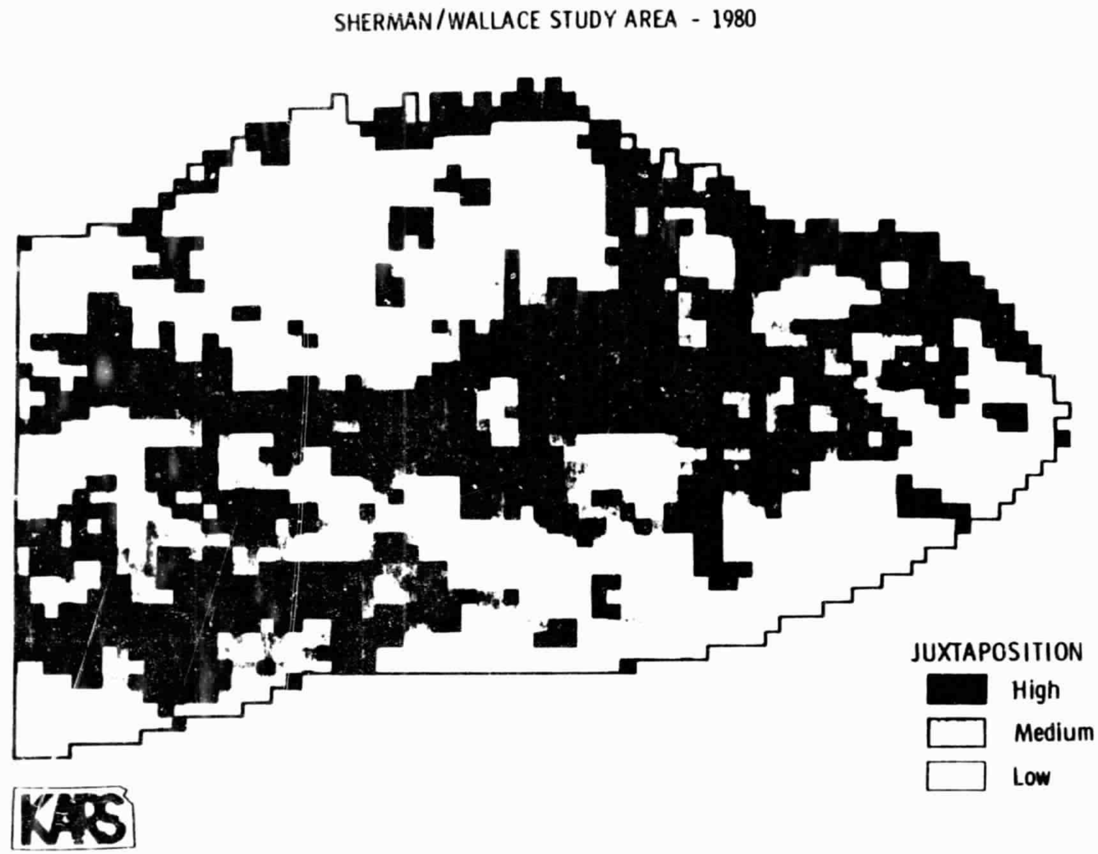

Figure 12. Spatial Distribution of Low, Medium and High Juxtaposition in the Sherman/Wallace Study Area - 1980

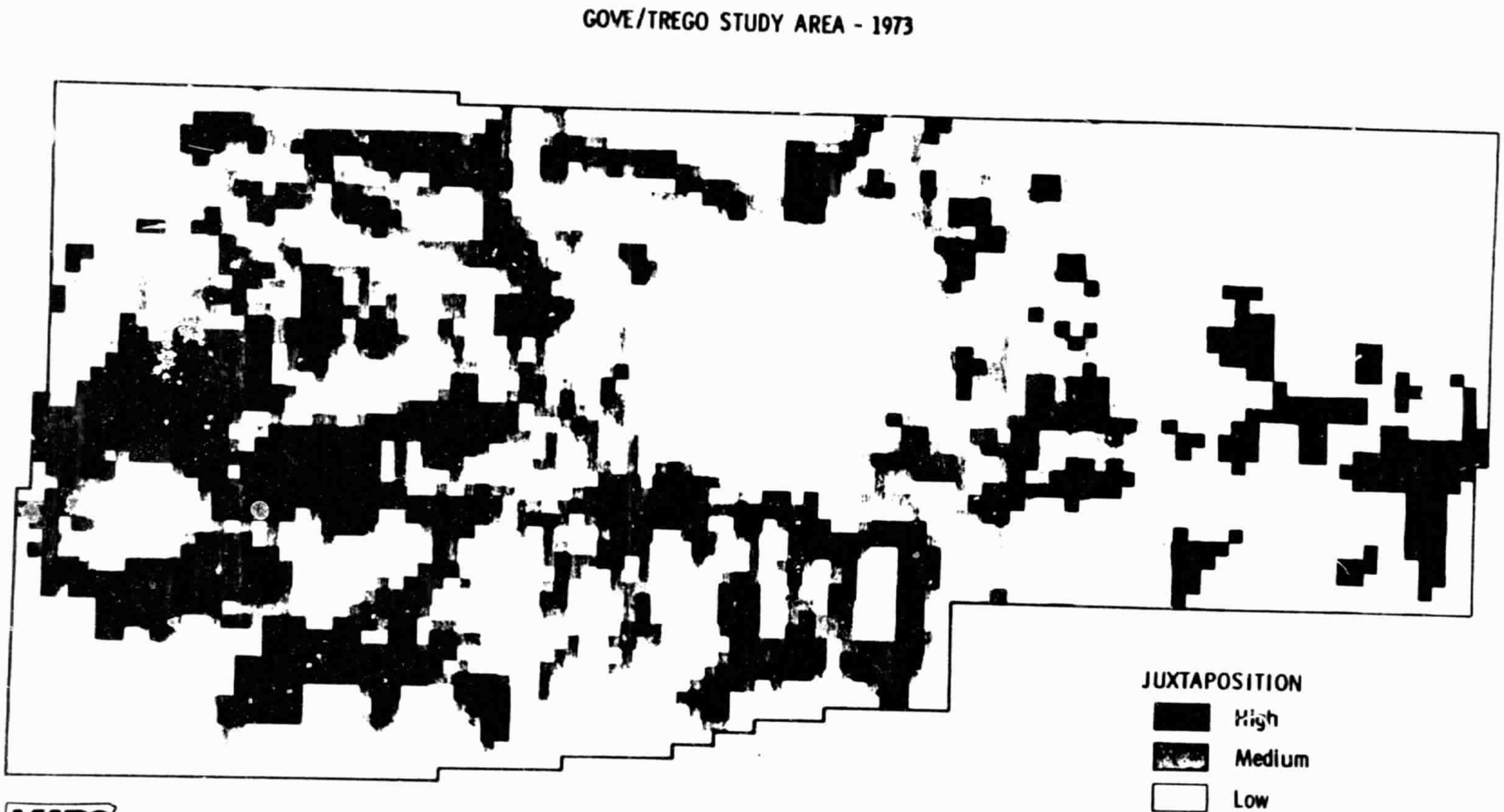

Figure 13. Spatial Distribution of Areas of Low, Medium and High Juxtaposition in the Gove/Trego Study Area - 1973

GOVE/TREGO STUDY AREA - 1980

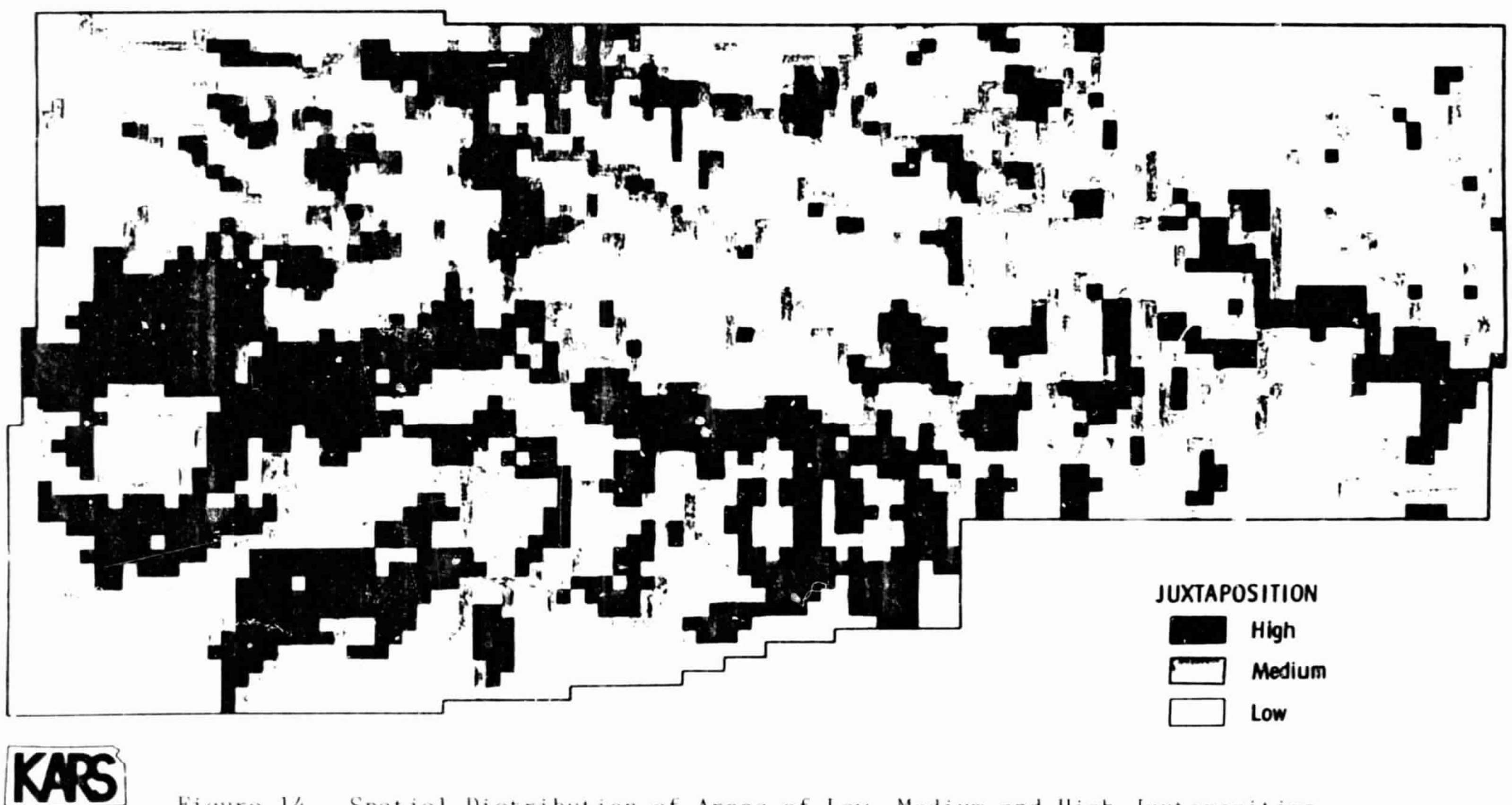

Figure 14. Spatial Distribution of Areas of Low, Medium and High Juxtaposition in the Gove/Trego Study Area - 1980

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CONSTRUCTION OF A DIGITAL SOILS DATA BASE FOR HARVEY COUNTY, KANSAS

In recent years there have been dramatic advances in the technology of computer-assisted spatial data processing. Great strides have been made in the development of hardware and software designed for digitizing, storing, manipulating, integrating, analyzing and displaying geographically referenced data.

Data regarding soils are one of the most constant and fundamental types of geographic data required in community and regional planning, natural resources management, and agriculture. Techniques for digitizing soils maps and for using such digital data have been widely tested. Operational use of digital soils data is growing. In Kansas, however, there has been no utilization of either digital soils data or other geographically referenced data except in a small number of demonstration projects undertaken by the Kansas Applied Remote Sensing (KARS) Program. An appreciation of the potential value and the broad applications of digital spatial data by public agencies requires that such agencies have experience working with a fully operational data base. In September 1982 the KARS Program initiated a project funded by the USDA/Soil Conservation Service (SCS) Kansas State Office which will result in the construction and application of a soils data base for Harvey County, Kansas.

Objectives

The specific objectives of this project are:

1. To digitize the USDA/Soil Conservation Service modern soil survey maps of Harvey County, Kansas;
2. To create a digital data base in which soils boundaries, soils identifications, suitability ratings, productivity ratings, capability classifications and related information will be stored;
3. To prepare sample maps having various scales, formats, soils interpretations, and accompanying statistical data;
4. To evaluate the potential applicability of such digital data for use in the USDA/SCS Land Evaluation and Site Assessment System;
5. To provide SCS staff and other users with the opportunity to use, apply and evaluate an operational digital soils data base; and

6. To provide the foundation for a future integrated geographic information system for Harvey County to be used in county planning, tax assessment, agricultural development and natural resources management.

Project Location

Harvey County, Kansas, having some 540 square miles, is one of the smallest counties in the State and, consequently, one of the least costly for which to create a geographic data base. It also, however, possesses a number of other attributes which make it a desirable location in which to carry out such a project. These include:

1. substantial differences in soils types and capabilities;
2. a progressive county planner committed to using the data base in comprehensive planning and zoning and in the implementation of the SCS Land Evaluation and Site Assessment System (LESA), and actively pursuing the possible upgrading of the soils data base to include other geographically-referenced data in an integrated information system;
3. a high likelihood that the SCS District Conservationist and the Harvey County Assessor will make substantial use of the data base; and
4. high visibility resulting from the county's proximity to Wichita, the interaction that the county planner has with other planning personnel in Kansas, and the likelihood that other county public agency staff will also make known their application of the data base.

Methodology

All soils data are being digitized using hardware and software capabilities of the Kansas Applied Remote Sensing (KARS) Program. Soils maps are being digitized in a polygonal mode at the resolution of the modern soil survey for Harvey County. All polygons are identified by soils series, and soils are assigned appropriate capability, suitability, productivity and other ratings.

Products

KARS will provide SCS and staff of Harvey County public agencies with an opportunity to prepare maps for various applications, in various scales and formats, and having a variety of soils interpretations. There will be a capability to prepare maps at a scale of 1:24,000 registered to U.S. Geological Survey 7.5 minute topographic quadrangles covering Harvey County. KARS staff will provide technology transfer, training and assistance to data base users. Users from other agencies and private firms will be encouraged to employ the data base. Initial use will be free. Subsequent use by non-SCS and non-Harvey County users will be at the cost of KARS personnel time and materials for map preparation or other services rendered.

Project Implications

The KARS Program has, for more than a decade, provided technical assistance, training and services to Kansas agencies on matters pertaining to spatial data analysis and remote sensing. The KARS Program, a non-profit applied research arm of the University of Kansas Space Technology Center, is the founding and the pivotal agency in the Kansas Interagency Task Force on Applied Remote Sensing, a body on which some thirteen state and local agencies are represented and which solicits participation from federal agencies and others interested in the application of new technologies for spatial data analysis. The Task Force has been charged by the Kansas Legislature with evaluating such technologies and promoting interagency cooperation in the development and application of appropriate spatial data analysis techniques.

An operational digital soils data base would contribute greatly to the efforts of the Task Force. Harvey County would provide an essential "testing-ground" for agencies to learn the value and great flexibility of digital data bases. Furthermore, it would provide SCS with a mechanism for educating personnel from other agencies on the many valuable ways in which soils data may be interpreted and applied. The KARS Program would use every opportunity (including its quarterly KARS Newsletter) to disseminate information on the project. Every effort will be made to provide "hands on" experience with the data base and to provide assistance to Harvey County personnel, in particular, in making planning, zoning, tax assessment and other decisions.

Until such a digital data base is available and is tested, evaluated and used by Kansas agencies, it is unlikely that the mission of the Task Force will be fully realized. It is also unlikely that agencies will, on their own, delve into this new technology. A data base in Harvey County, however, would facilitate greatly the dissemination of a new and valuable tool and would also aid in providing agencies with a much greater appreciation of the broad applicability and value of soils data.

In addition, preparation of a digital soils data base would provide a foundation upon which to build an operational, comprehensive, integrated geographic information system for Harvey County. Harvey County and the Kansas Department of Revenue have both indicated interest in augmenting the soils data base with other data regarding such factors as land use, zoning, hydrology, topography, transportation, land ownership, and geology. Funds are being solicited from these agencies to finance construction of these data bases. The preparation of a soils data base would provide impetus to this effort.

Should there be success in securing local, state and federal cost-sharing to prepare a comprehensive geographic information system for the County, this would be especially significant to the Task Force, for one of its primary objectives is to promote interagency cooperation, coordination, and costs-savings. A cooperative project in Harvey County would demonstrate that this can be accomplished, and that costs can be saved by creating a data base that serves local, state, and federal interests simultaneously.

Project Status

In addition to meeting the six objectives of the Harvey County soils project outlined above, KARS has identified three additional goals related to the digitization process itself. These are:

1. To set up the physical data sets to be used for the project in maximum conformity with the procedures used by the SCS National Headquarters' Cartography and Remote Sensing (CRS) staff, and to segment the data sets in a similar compatible manner;
2. To provide as one of the final output products a digital tape conforming to the standards of Part 502 of the SCS National Cartographic Manual;(U.S. Soil Conservation Service, 1982d); and
3. To generate and record the digital soils data in a manner that is maximally flexible and adaptable with respect to software systems and to potential end uses.

These are discussed individually below:

1. Input data conformity. The CRS staff has developed a procedure for digitizing soils from maps registered to U.S. Geological Survey (USGS) 7.5 minute topographic quadrangles or orthophotos (U.S. Soil Conservation Service, 1982c). Under this procedure, each quadrangle is digitized as a separate unit. The positions of the four corners of each quadrangle are digitized as control points so that several may be digitally mosaiced together. The state plane coordinate ticks on the maps are used to maintain sheet-to-sheet registration.

Kansas soils maps are not available on orthophotos but are compiled on partially-rectified 1:20,000 air photo bases. Consequently, the SCS-CRS approach has been modified by KARS staff. First, 1:20,000 transparent enlargements of the fifteen 1:24,000 quadrangles that encompass Harvey County were obtained from the USGS National Cartographic Information Center, Rolla, Missouri. Second, the 1:20,000 soils maps were visually registered to the topographic maps. Any inconsistencies or inadequate fits within a sheet, or between two adjoining sheets, were manually corrected on an overlay sheet. In effect, a compromise re-generalization of the line of demarcation indicated on the soils maps was performed. Digitization is being performed using the same basic procedures as specified by CRS.

2. Tape output. A simplified, standardized format for the recording of soils data on transportable magnetic tape has been proposed by CRS. This format involves an unlabelled tape with three files: a header file, a soils data file and a feature name file. KARS intends to support this format, with possible extension to allow for node and polygon definition files. Any extension will be downwardly compatible.

3. Flexibility. Since the Harvey County soils data may be used for various hard-copy mapping projects, as a source of data for any of several geographic information systems program packages, or for other purposes as yet unknown, it is important that the digital data be saved in as flexible a manner as possible. This will allow the generation of output data sets compatible with the requirements of different systems. KARS staff are, thus, digitizing the Harvey County soils in a "layered" fashion with three sorts of digital entities:

- arcs or lines reflecting the soils boundaries;
- nodes, or those places where arcs intersect; and
- polygons, which are sequences of nodes that delimit areas.

The procedure is to digitize nodes first, so that the ends of arcs can be forced to meet properly. Arcs are then digitized, verified and edited. The definitions of polygons are added as appropriate.

Status

The Zimmerdale quadrangle was selected as the first map to be digitized because of its central location in Harvey County. It was felt that digitizing a full quadrangle might expose problems in the digitizing process that a partial quadrangle would not. This proved to be true. The large number of arcs and nodes that were to be digitized strained the software. The software was modified a number of times to deal with the arc-node problem and to make it easier to use. Modifications were instituted to either speed up the digitizing process or allow the operator to reset a particular step rather than have to completely restart a polygon delineation due to operator error. This should save much time and frustration during the duration of the project and in future digitization projects.

Maps printed to date have been quite accurate for the most part, and replicate the detail of the original SCS soils maps quite well. This we attribute to both the time and care invested in software development, as well as the experience of the digitizer operator. One problem that persists, however, is that plotted maps appear smeared. This is a problem with our Versatec plotting equipment that has yet to be resolved. KARS staff are presently conferring with the hardware manufacturer and expect to have the problem isolated shortly.

Demonstration maps have been produced at various scales and for various categories. Plotting software will need to be modified for more efficiently printing large scale maps (e.g., 1:20,000) of a quadrangle, as the program is not presently fully compatible with the hardware for this purpose. However, complete 1:40,000 maps have been produced, as well as sub-maps and individual categories at the 1:20,000-scale for selected areas.

Digitization is complete for the Zimmerdale and Hesston quadrangles. Some editing needs to be completed on these, but it is presently believed that the final editing should be accomplished all at once (so that boundaries between adjacent quadrangles can be accurately matched).

Sample maps have been produced for the Zimmerdale (Figure 15) and Hesston quadrangles at 1:40,000. Single category maps and sub-maps at 1:20,000 have been prepared for selected areas.

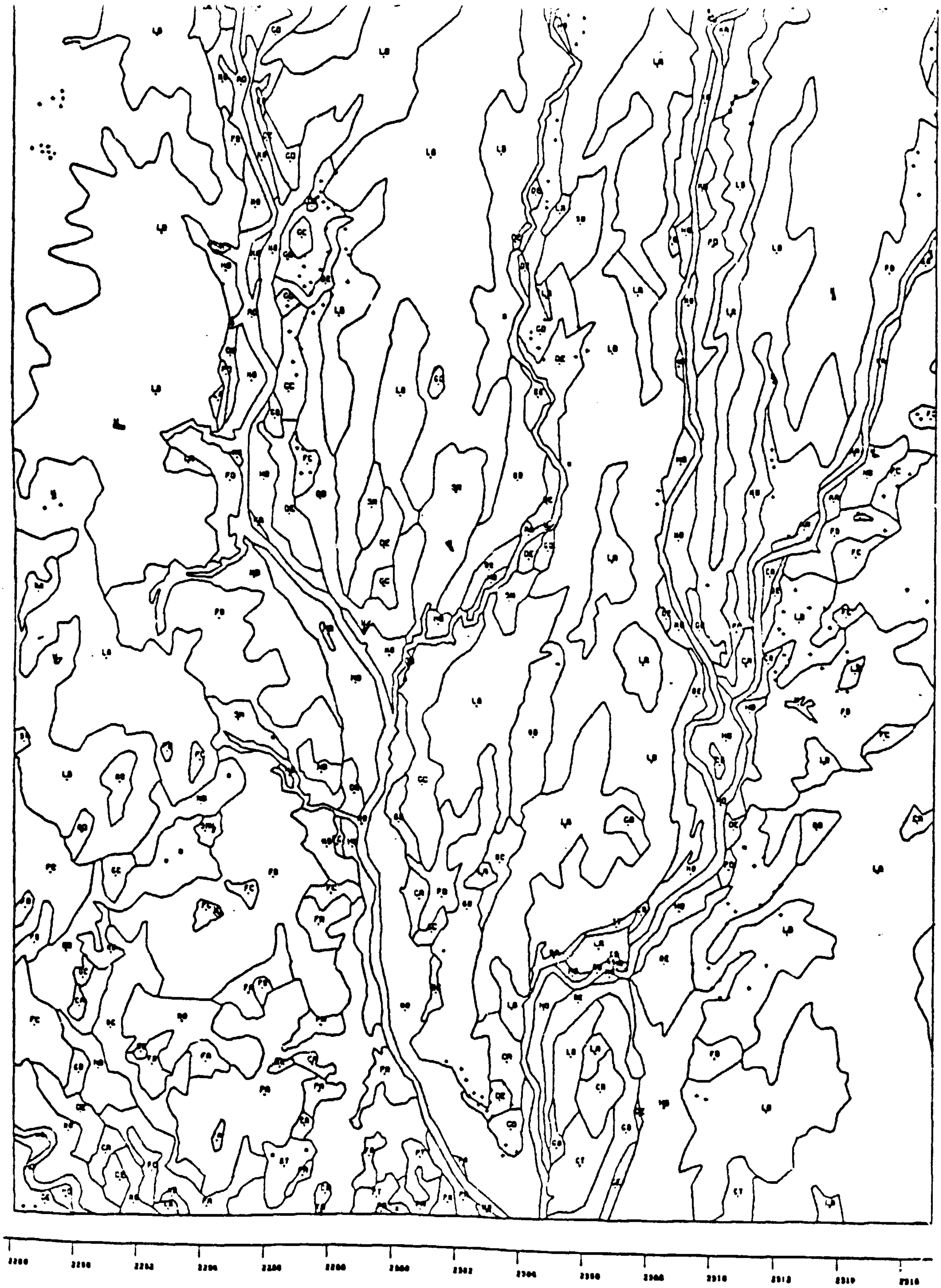

Figure 15. Zimmerdale Quadrangle. 1:40,000

Future Efforts

KARS staff have established the following schedule for project execution. This timetable prioritizes project tasks and sets goals for their completion.

July 1983

- Complete digitization, labelling and editing of all quadrangles
- Complete assignment of suitability, capability, productivity index values to respective soils
- Correct problems with Versatec plotter
- Continue evaluation of LESA applications

August 1983

- Complete the preparation of sample output products defined by potential data base users (various scales, areas, soils interpretations, etc.)
- Complete evaluation of application of data base to LESA. Initiate data base user training/evaluation and technology transfer; hold at least two one-day short courses at Space Technology Center - one for soils specialists (e.g., SCS), one for non-soils specialists (e.g., county planner, county assessor); provide opportunity for hands-on use of data base
- Support and assist SCS staff, Harvey County staff and other users in application of the data base
- Hold off-site technology transfer workshops/briefings as needed in order to widely disseminate information regarding data base

September 1983

- Continue user evaluation/technology transfer as needed
- Continue support of SCS staff, Harvey County staff and other users in application of the data base
- Prepare final project report

CHARACTERIZATION OF FALLOW LANDS USING LANDSAT MSS IMAGERY

The distribution and characteristics of fallow lands are of interest to both agribusiness and public agencies concerned with the agricultural community. The KARS Program has initiated a pilot study to define techniques for mapping and monitoring fallow lands and associated crop rotations. The study is being carried out on two test sites located in western Kansas, and will encompass a five-year period of time.

The main objectives of the study are to evaluate the utility of Landsat multispectral scanner imagery for:

- Detection and inventory of fallow lands and tracking of their changing areal distribution over time;
- Monitoring associated crop types over time, in an effort to identify cropping patterns deviating from what is normal, or predictable, for the area; and
- Discriminating (a) fallow lands that have been chemically treated for weeds (i.e., chemical fallow), from those that have not been treated; (b) stubble fallow from pasture and rangeland; and (c) varying levels of residue on fallow lands.

Study Area

It was necessary to choose a study area that was representative of dryland farming conditions, and where supporting information about use of minimum tillage practices was available. Dryland farming is practiced throughout western Kansas, and therefore fallow lands are readily observable.

Selection of a study area was based upon the following criteria:

- Implementation of different types of crop rotation patterns;
- Presence of other land cover types representative of the area, especially rangeland and pasture;
- Use of chemical nerbicides to control weeds on minimum tilled fallow lands; and
- Irrigated acreages absent or restricted.

Initially, individuals at the state level were contacted for recommendations regarding sites suitable for a fallow lands study. Several western counties were suggested, and following preliminary conversations with county officials, the search was limited to Lane, Logan, Scott and Thomas counties. Letters of inquiry were sent to the USDA/Agricultural Stabilization and

Conservation Service (ASCS) County Executive Director, USDA/Soil Conservation Service (SCS) Soil Conservationist, and Kansas State University Extension County Agent of each of these counties. On the basis of their recommendations, a site in central Lane County was selected for the Fallow Lands Study.

The Lane County study area is 60 square miles in size and has the following characteristics:

- Wheat-sorghum-fallow cropping pattern predominates;
- Minimum tillage and conventional tillage are both practiced;
- Records for use of chemical herbicides to control weeds on some minimum tillage sites exist;
- Most of the area is cropped, but some rangeland is present;
- Irrigated parcels are virtually absent;

Methodology

Landsat MSS images (Band 5) are being interpreted over a five-year period (1976-1980) to determine parcels of fallow lands and sequences of crop rotations over time. (Band 7 will also be evaluated for one year.) At least four dates from each growing season are being examined. Interpretation is partially based upon the knowledge that most farm operators in the area practice either a wheat-fallow rotation (one crop every other year) or a wheat-sorghum-fallow rotation (two crops every three years).

Multi-date interpretation is necessary because certain categories cannot be identified during certain times of the year. Image dates selected for the study include at least a late spring date, two in the summer, and one in the fall. This provides information necessary to separate general crop types (based on their phenology), and to identify fallow lands (based on the duration for which the parcels remain cropped).

The classification scheme for crop types and fallow lands includes the following categories:

- Fallow Land
  - Bare soil
  - Stubble: (1) with chemical treatment
    (2) without chemical treatment

- Non-Fallow Agricultural Land
  - Sorghum
  - Winter Wheat
  - Alfalfa
  - Other
- Rangeland/Pasture
- Other

The classification of these categories is based upon the spectral characteristics (gray tones) of each parcel throughout the growing season and is accomplished as follows:

1) Field parcels for the study area were delineated on high altitude aerial photography (1:80,000) and registered to Landsat imagery enlarged to a scale of 1:250,000. By numbering each parcel, the task of tracking its spectral characteristics over time is greatly facilitated (Figure 16).
2) Approximately eight gray tone levels can be easily discerned visually on Landsat MSS film positive transparencies. A gray tone bar from a Landsat film positive was used to guide gray tone level assignment, with white = 7, black = 0. The gray tone bar also assures calibration of interpretation by different individuals. Variations in gray tone rendition between different images are assumed to be minimal. The gray tones for each parcel are evaluated for each Landsat image date, and assigned an appropriate numerical value.
3) The gray tone values are plotted for each field and analyzed based on ground truth information, including farm records, ASCS 35mm aerial photography, Landsat color composites acquired for each growing season, and field data. This analysis is conducted in two stages:
   i) The interpreter uses ground truth data to identify characteristic gray tone curves for control parcels representing all cover types occurring in the study area.
   ii) The interpreter then analyzes the remaining gray tone curves based on the control parcels, and classifies each parcel accordingly.

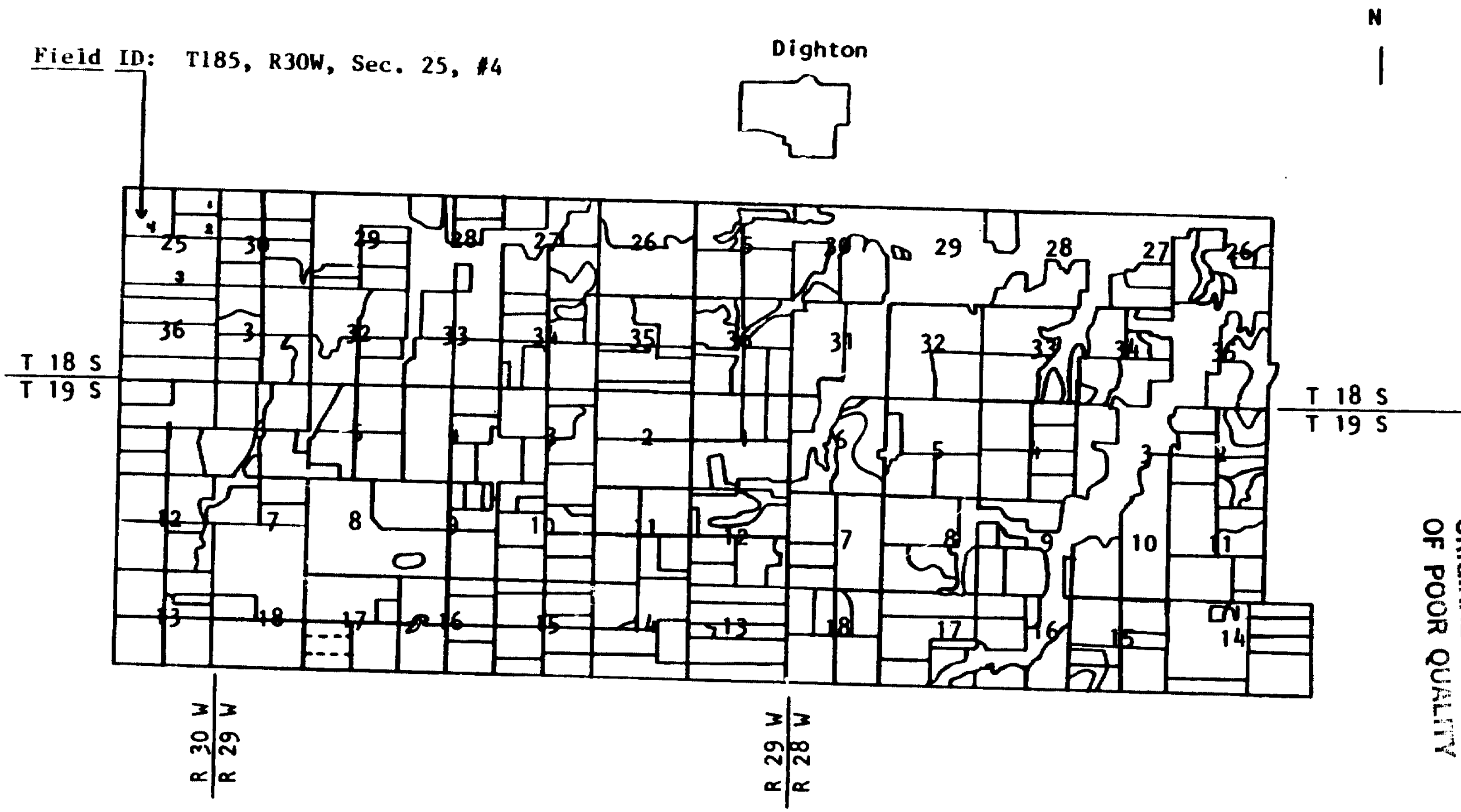

Figure 16. Field Boundaries for the Lane County Study Area. The fields are numbered in clockwise fashion for each section, starting at the northeast corner.

Preliminary Results

Interpretation of the Landsat MSS images has not yet been completed. However, some preliminary results are as follows:

- It is clearly feasible to locate and monitor fallow lands over time using visual interpretation of Landsat MSS imagery. Most errors in classification appear to involve confusion of grassland with fallow lands.
- Crop types can be identified and associated rotations determined from visual interpretation of Landsat imagery. Figure 17 illustrates examples of representative gray tone curves derived for parcels having wheat-fallow and wheat-sorghum-fallow rotations, respectively.
- Gray tone curves for fallow lands take on three characteristic appearances. No conclusions can be made at this time as to whether these variations are indicative of different tillage practices.

A discussion of the success of discriminating features such as (a) fallow lands that have been chemically treated for weeds from those that have not been treated, (b) stubble fallow from pasture and rangeland, and (c) varying levels of residue on fallow lands, will be included in a summary report at the completion of this study.

Implications of the Study

This study will assess the feasibility of using Landsat data for providing information on fallow lands and the amounts of residue remaining on those lands. Once the strategy is defined for how the data can best be extracted from the imagery, it will undoubtedly facilitate the design of procedures for digital analysis of Landsat MSS and Thematic Mapper (TM) data for characterizing fallow lands.

The identification and characterization of fallow lands and associated cropping sequences will be of substantial value to both soil conservationists and agribusinesses. This information will enable better planning for protection of soil during critical periods when erosion usually occurs; and will aid in marketing of chemicals for better control of weeds and increased conservation of soil moisture, by targeting areas where chemical fallow can be readily implemented.

Information of this type has become increasingly important to soil conservationists and other agricultural specialists in both the public and

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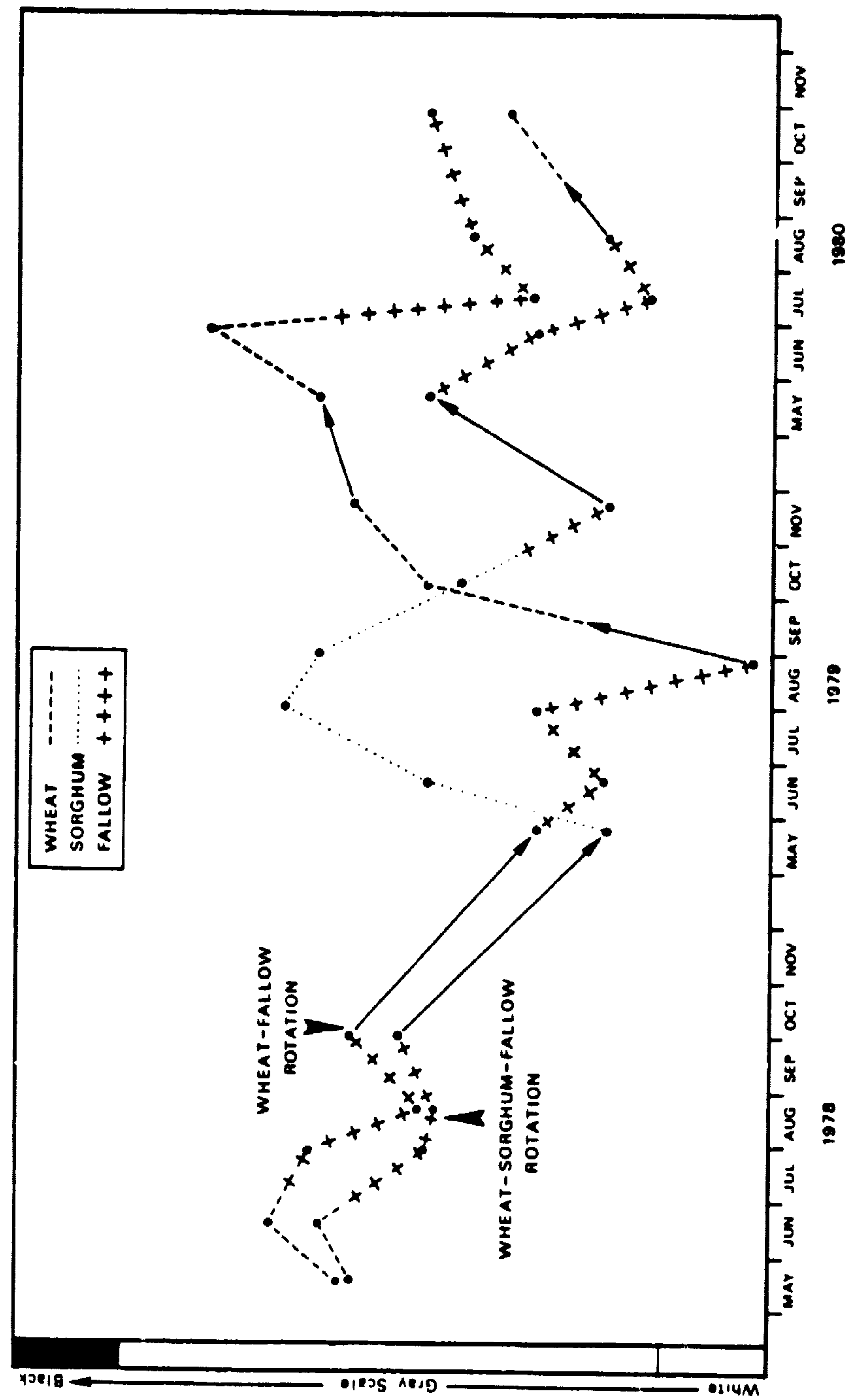

Figure 17. Representative Gray Tone Curves for a Wheat-Fallow Rotation and a Wheat-Sorghum-Fallow Rotation (data plotted for growing seasons only)

private sectors. Agrichemical businesses, for example, could utilize this type of information for streamlining their marketing of chemicals for weed control on fallow lands.

Remote sensing techniques provide a means for acquiring much of this data over large areas, at various times throughout the year. Multitemporal techniques utilizing Landsat Multispectral Scanner and Thematic Mapper data can provide estimates of acres of land lying fallow on a yearly basis, and can be used to monitor trends in agricultural land use (e.g., reversions to dryland farming). Our goal is to lay the groundwork for future studies to evaluate the improved spatial resolution and spectral properties of the Thematic Mapper for assessing fallow lands.

Future research efforts may include:

1. Testing various vegetation indices (e.g., Transformed Vegetation Index, Greenness-Brightness) by digitally processing Landsat MSS and TM data, in order to enhance discrimination of varying amounts of litter on fallow lands; and postulating criteria for dividing the United States into regions within which the characteristics of fallow lands and associated farm management practices would expect to remain similar throughout;
2. Analyzing the influence of soils type and other factors on the classification of fallow lands by spatially relating the data in a geographic information system.

AN INVENTORY OF STATE
NATURAL RESOURCES INFORMATION SYSTEMS

In September 1982 the KARS Program was awarded a grant to survey computer-based natural resources information systems and data bases throughout the United States. The work is being completed for the National Aeronautics and Space Administration's (NASA) Ames Research Center. NASA will use the information for supporting its ongoing efforts with respect to geographic information systems development. A special area of interest concerns efforts to facilitate the continuing inventory and appraisal of the state and condition of the Nation's soil, water and related natural resources by the U.S. Department of Agriculture's Soil Conservation Service (SCS). Responsibility for implementing the Soil and Water Resources Conservation Act of 1977 (RCA) has been assigned to the SCS.

The primary objectives of this project are to locate, identify and document computer-based natural resources information systems and/or data bases maintained by agencies of state government in all fifty states. Such systems include, but are not limited to, geographic information systems, in which geographically referenced data can be input, manipulated and analyzed. These systems or data bases will be documented where geographic coverage is statewide or regional in extent.

Documentation of state data bases will be limited to those containing natural resources data. Such data types broadly include air quality/meteorology, geology, land use/land cover, soils, vegetation and water. Some elements of interest to NASA include:

- Data type(s) included;
- Data format (e.g., classification scheme, resolution or scale, geographic reference, grid/polygon system);
- Geographic coverage;
- Accuracy/reliability of data, if known;
- Updating frequency/currency;
- Data sources;
- Availability of data base to non-agency users;
- Security restrictions, if any;
- Hardware/software support;
- Available documentation of the system or data base; and
- Implementation problems, if any.

Primary sources of information regarding state data bases will be published documents, a mail questionnaire, and personal contacts. The acquired data will be collated and entered into a master computer data base at the University of Kansas Space Technology Center. The master data base will facilitate cost-effective storage, analysis, manipulation, retrieval and dissemination of data collected during the study.

Methodology

The inventory of state data bases is being conducted for all 50 states, Puerto Rico and the Virgin Islands. The strategy for acquiring information about natural resources or related data bases involves (1) identification of contacts in each state/territory, (2) distribution of a preliminary synoptic questionnaire for data bases identified by state contacts, (3) review and evaluation of all data bases located through this process, (4) distribution of a detailed follow-up survey for all relevant data bases, (5) entry of data base descriptions into a master data base, and (6) preparation of a final tabular and textual summary report.

Progress and Accomplishments

Project work during the first seven months of this effort has focused on:

1. Project coordination, preparation of a filing system and status worksheets, and exchange of information with other interested parties;
2. Identification of contacts in each state/territory;
3. Distribution of preliminary questionnaires to acquire synoptic information about data bases identified by state contacts;
4. Review and evaluation of preliminary questionnaires returned by state contacts to determine what follow-up efforts are required;
5. Development of a follow-up survey designed to acquire detailed characteristics of all relevant data bases located;
6. Initiating distribution of the follow-up survey to state participants;
7. Testing the software being utilized for creating the KARS Master Data Base of information systems and repositories identified in the states; and
8. Establishment of a comprehensive work plan and timetable for completion.

The initial step in locating state and sub-state data bases involved identification of individuals in each state who would be able to provide information regarding natural resource data bases. At least two, and as many as eight, individuals were identified in each state. Such contacts were identified via personal knowledge of KARS Program staff and/or by referral to lists of conference participants published in the proceedings of recent meetings relevant to the objectives of this project (for example, proceedings of NASA Regional Applications Program conferences, Pecora symposia, and others). Individuals located through conference proceedings frequently were knowledgeable of information systems activities within their state. Publications relating to statewide information systems were also consulted (for example, Cornwell, 1981; Mead, 1981a and 1981b; Tessar and Caron, 1980).

Individuals solicited for information regarding state data bases were largely limited to those representing state agencies or regional levels of government. However, a number of university staff were also contacted in several states, especially when affiliated with a remote sensing center (Council of State Governments, 1981). These individuals typically were very attuned to image processing/geographic information systems applications within their respective states, and on many occasions were developing such capabilities on behalf of state agencies.

In addition to those contacts identified through the processes described above, "The National Directory of State Agencies, 1982-1983" was consulted for possible leads (Wright and Allen, 1982). This directory was especially helpful for states where very few contacts were identified through other means.

Each person identified by KARS project staff was asked to refer other state agency personnel responsible for managing automated repositories to the attention of project staff. This facilitated the task of locating data bases, by directing staff to individuals who were recognized by colleagues as being most likely to provide information regarding additional repositories in their state. Also, this approach provided a mechanism to quickly disperse information regarding the data base inventory throughout the states.

Preliminary questionnaires were mailed to each contact (Appendix A). Each preliminary questionnaire returned to the KARS Program was reviewed by project staff and evaluated for possible follow-up efforts. All computer-based natural resources repositories were flagged and will be more fully characterized through follow-up surveys. Non-automated data bases scheduled for automation, or being considered for automation, were identified and their status will be presented in the final report. All non-automated data bases identified through the questionnaire were deleted from further survey efforts, and thank you letters were sent to those respondents. Data bases/repositories not relevant to this study were also deleted (for example, state libraries, bibliographic data bases, NCIC affiliates).

During the first seven months of this project, 263 preliminary questionnaires were reviewed and evaluated. One hundred and eighty-five data bases will be further characterized through a detailed follow-up survey (Table 16). Note that these numbers do not reflect the total number of data bases actually identified, because individuals in several states have agreed to coordinate agency responses on behalf of their state. For example, the Mississippi Automated Resource Information System (MARIS) and the Texas Natural Resources Information System (TNRIS) are charged with the management of numerous data bases on behalf of the state agencies, and staff of those information systems have agreed to handle completion of detailed questionnaires for all state data bases coordinated through the system.

The design of a detailed follow-up survey developed to collect the information listed above was driven by two basic considerations:

- It was critical that the survey be flexible enough to accommodate diverse data bases of varying sizes. For example, the survey needed to address the characteristics of small data bases developed to handle single themes of data, as well as statewide information systems created to handle large volumes of data on behalf of several state agencies.
- The survey needed to be as brief as possible and easy to complete.

Accordingly, the design of the follow-up survey takes into consideration the tremendous variety of data bases/repositories and other information systems existing in the states, and reduces these into their basic compo-

Table 16. Computer-Based State and Sub-State Data Bases

Computer-based natural resources repositories identified through preliminary questionnaires, and retained for follow-up efforts (September 1982 - March 1983). All data bases followed by an asterisk (*) are coordinating centers which manage several discrete data bases, typically on behalf of a number of state agencies.

STATE - DATA BASE NAME	AGENCY
Alabama	
Alabama Resource Information System (ARIS)*	Alabama Development Office
Alaska	
Alaska Land and Resource System (ALARS)*	Department of Natural Resources
Arizona	
Arizona Vegetation Inventory	Arizona State Land Department
Digital Topo Database	Arizona State Land Department
California	
Land Use	Department of Water Resources
Land Classification (Suitability for Agriculture)	Department of Water Resources
Vegetative Water Use Program	Department of Water Resources
Division of Land Resources Protection-Soils Program	Department of Conservation
Farmland Mapping and Monitoring Program	Department of Conservation
BASIS (Bay Area Spatial Information System)	Association of Bay Area Governments
Colorado	
Colorado Resource Information System*	Department of Natural Resources
Delaware	
Center for Remote Sensing	University of Delaware-Marine Studies
Delaware Water Use Data System	Department of Natural Resources and Environmental Control
Florida	
Marine Resources Geobased Information System	Department of Natural Resources-Marine Research Laboratory
Natural Resources Management Systems and Services Data Center	Department of Natural Resources-Division of Recreation and Parks
Florida Subsurface Geological Data Base	Florida Bureau of Geology
Idaho	
Land Information and Mapping System	Department of Lands
Idaho Water Rights	Department of Water Resources
Idaho Water Use Data System	Department of Water Resources
Idaho (cont'd)	
1975+1980 Land Use Classifications of Ada and Canyon Cities	Department of Water Resources (Remote Sensing)
1977 Land Use Classification, Idaho Falls area	Department of Water Resources (Remote Sensing)
Big Game Winter Range Inventory	Department of Water Resources (Remote Sensing)
1980 Land Use Classification of the Snake River Plain	Department of Water Resources (Remote Sensing)
Vegetation Classification of Cascade Resource Area	Department of Water Resources (Remote Sensing)
1980 Irrigation Service - Source Districts	Department of Water Resources (Remote Sensing)
Wildlife Habitat Inventory, Fish and Game Unit 54	Department of Water Resources (Remote Sensing)
Irrigated Acreage Change Detection in CGW Areas	Department of Water Resources (Remote Sensing)
Upper Snake River, Idaho History File	Department of Water Resources (Hydrology)
Dam Inventory	Department of Water Resources (Dam Safety)
Water Rights Data Bank	Department of Water Resources (Water Allocation)
Illinois	
Illinois Natural Resource Information Center (INRIC)*	Department of Energy and Natural Resources
Indiana	
Model Implementation Project Data Base	Holcomb Research Institute
Planning Region 8 - Eight County Data Base	Holcomb Research Institute
Iowa	
Iowa Water Resources Data System (IWARDS)	Iowa Geological Survey
Kansas	
"Economic Data"	Department of Economic Development
Kansas Policy Database System (KPDS)	Center for Public Affairs
Terrestrial Data Base	Department of Fish and Game
Aquatic Data Base	Department of Fish and Game
Kentucky	
Kentucky Natural Resources Information System (KNRIS)*	Natural Resources and Environmental Protection Cabinet - Mine Data Branch
Louisiana	
Louisiana Water Well Inventory	Louisiana Geological Survey (Water Resources)
Maine	
Maine Lakes Water Quality and Data Base System	Department of Environmental Protection

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STATE - DATA BASE NAME	AGENCY
Maryland	
Maryland Automated Geographic Information System (MAGI)*	Department of State Planning
Maryland Geographic Districting Information System	Department of State Planning
Maryland Recreation Inventory System	Department of State Planning
Maryland Natural Heritage Program	Division of Natural Resources
Massachusetts	
ACID (Water Data)	Division of Fisheries and Wildlife
Wildlife Species Files	Division of Fisheries and Wildlife
Michigan	
Local Unit Computer Information (LUCI)	Department of Commerce
Michigan Resource Information System	Department of Natural Resources - Land Resource Program
Minnesota	
Minnesota Land Management Information Center (MLMIC)*	State Planning Agency
Regional Energy Information System	State Energy Agency
Mississippi	
Mississippi Automated Resource Information System (MARIS)*	Mississippi Research and Development Center
NATURAL HERITAGE	Mississippi Remote Sensing Center (Mississippi State University)
PUERTO RICO	Mississippi Remote Sensing Center (Mississippi State University)
LCSOILE & LCSOILW	Mississippi Remote Sensing Center (Mississippi State University)
LOWNDES	Mississippi Remote Sensing Center (Mississippi State University)
CHOCTAW GMA	Mississippi Remote Sensing Center (Mississippi State University)
LEAF RIVER GMA	Mississippi Remote Sensing Center (Mississippi State University)
TALLAHALLA GMA (CREATURE)	Mississippi Remote Sensing Center (Mississippi State University)
BIGBEE	Mississippi Remote Sensing Center (Mississippi State University)
NOXUBEE	Mississippi Remote Sensing Center (Mississippi State University)
Missouri	
Procedures: A Wildlife Information System for Missouri	Geographic Resources Center (University of Missouri)
Nature Conservancy	Department of Conservation
Caves of Missouri	Department of Conservation
Rare and Endangered Species	Department of Conservation

STATE - DATA BASE NAME	AGENCY
Missouri (cont'd)	
Natural Areas	Department of Conservation
Climatological Data (Missouri and other states)	University of Missouri
Federal-State Cooperative Programs for Population Estimates and Projections	Office of Administration
Montana	
Montana Trust Lands Inventory	Department of State Lands
Montana Water Quality Records System	Department of Health (Water Quality Bureau)
Reservoir Contents	Department of Natural Resources and Conservation
Stream Flows	Department of Natural Resources and Conservation
General Reconnaissance Irrigation Suitability Land Classification	Department of Natural Resources and Conservation
Irrigated Lands of Montana	Department of Natural Resources and Conservation
Montana Dam	Department of Natural Resources and Conservation
Nebraska	
Nebraska Natural Resources Information System*	Natural Resources Commission
Nevada	
Ground Water	Department of Data Processing
Surface Water	Department of Data Processing
New Jersey	
Department of Environmental Protection Geographic Data Base*	Department of Environmental Protection
New Mexico	
New Mexico Natural Resources Information System*	Natural Resources Department
Water Use Data	State Engineer Office
New York	
Resource Information Laboratory (LUNR)	Cornell University
Urban Wildlife Habitat Inventory	Department of Environmental Conservation
Significant Habitats Inventory	Department of Environmental Conservation
Wetlands Inventory (Freshwater)	Department of Environmental Conservation
North Carolina	
North Carolina Land Resource Information System*	Division of Land Resources
North Dakota	
Annual Use Reports on Water Permits	State Water Commission
Abandoned Mine Lands	Public Service Commission
Historical/Archaeological/Paleontological Site Data	Public Service Commission
Ohio	
Ohio Capability Analysis Program (OCAP)*	Division of Soil and Water Conservation

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STATE - DATA BASE NAME	AGENCY
Oregon	
Elk Habitat Inventory and Mapping	Department of Fish and Wildlife
Fish Inventory of Oregon Lakes and Streams	Department of Fish and Wildlife
Lake, Reservoir or Pond Fish Distribution	Department of Fish and Wildlife, Fish Division
Lake, Reservoir or Pond Fish Harvest and Recreation	Department of Fish and Wildlife, Fish Division
Natural Lake, Reservoir or Pond Habitat Inventory	Department of Fish and Wildlife, Fish Division
Salmon Statistics	Department of Fish and Wildlife, Fish Division
Stream Fish Distribution and Abundance	Department of Fish and Wildlife, Fish Division
Stream Fish Harvest and Recreation	Department of Fish and Wildlife, Fish Division
OSCUR Forest Inventory	Department of Forestry, Forestry Management Division
Fire Studies	Department of Forestry, Forest Protection Division
Forest Operator-Landowner Liability Law Administration File (FOLLAD Report)	Department of Forestry, Forest Protection Division
Insect Damage Survey	Department of Forestry, Insect and Disease Management Section
Annual Harvest Report for Oregon	Department of Forestry, Resource Studies Division
Forest Resources Survey	Department of Forestry, Resource Studies Division
Minerals Registry	State Land Division
Ground Water Sources and Aquifer Data, observation well net	Water Resources Department
Water Quality (WATSTORE & STORET)	Water Resources Department
Streamflow Records	Water Resources Department
Water Rights	Water Resources Department
Pennsylvania	
Permit Files	Department of Environmental Resources - Bureau of Mining and Reclamation
STORET	Department of Environmental Resources - Bureau of Water Quality Management
Pennsylvania Abandoned Mine Lands Inventory	Department of Environmental Resources - Bureau of Abandoned Mines Reclamation
National Coal Resources Data System (NCRDS)	Department of Environmental Resources - Pennsylvania Topographic and Geological Survey
Pennsylvania (cont'd)	
Picture-Rocks-Jonestown Trace Elements	Department of Environmental Resources - Pennsylvania Topographic and Geological Survey
Pennsylvania Mineral List	Department of Environmental Resources - Bureau of Topographic and Geological Survey
Directory of Mineral Industry	Department of Environmental Resources - Bureau of Topographic and Geological Survey
Reading Prong	Department of Environmental Resources - Bureau of Topographic and Geological Survey
Water Resources Data System	Department of Environmental Resources - State Water Planning Division
Water Well Inventory	Department of Environmental Resources - Bureau of Topographic and Geological Survey
Insect and Disease Storage and Retrieval	Bureau of Forestry - Division of Pest Management
Timber Volume Inventory	Bureau of Forestry
Pennsylvania Fish and Wildlife Data Base	Game Commission
Pennsylvania Stream Inventory	Fish Commission
Land Area Inventory	Bureau of Forestry
Pennsylvania Natural Diversity Inventory	Bureau of Forestry
Air Quality Permit Applications System	Department of Environmental Resources - Bureau of Air Quality Control
Pennsylvania Emission Data System	Department of Environmental Resources - Bureau of Air Quality Control
WAMIS - Water Supplies	Department of Environmental Resources - Bureau of Environmental Control
Pennsylvania Recreation Inventory	Department of Environmental Resources - Bureau of Environmental Planning
Nursery Inventory	Department of Environmental Resources - Bureau of Forestry
Forest Fire Statistics	Department of Environmental Resources - Bureau of Forestry
Minerals Storage and Retrieval	Department of Environmental Resources - Bureau of Forestry
Timber Sales Computation	Department of Environmental Resources - Bureau of Forestry
Mine Subsidence Insurance	Department of Environmental Resources - Bureau of Mining and Reclamation
Solid Waste Activity Monitoring (SWAM) Facility System	Department of Environmental Resources - Bureau of Solid Waste Management
State Park Basic Information Data System	Department of Environmental Resources - Bureau of State Parks
Demography	Pennsylvania State Data Center

STATE - DATA BASE NAME	AGENCY
Puerto Rico	
Land Use	Department of Natural Resources - Scientific Inventory Section
Hydrological Data Bank of Puerto Rico	Department of Natural Resources - Water Division
Rhode Island	
Landsat Remote Sensing Center GIS	Landsat Remote Sensing Center - URI/GSO
South Carolina	
South Carolina Natural Resource Information System*	University of South Carolina
South Dakota	
Division of Water Development Climatological Data	Department of Water and Natural Resources
File 27 (WNR-LEVELS) (Water well level readings)	South Dakota Geological Survey
File 28 (Litho., logs, water quality, geo. analyses)	South Dakota Geological Survey
Tennessee	
Tennessee Natural Heritage Database	Department of Conservation
Geographic Information System for Tennessee (GIST)	Middle Tennessee State University
Texas	
Texas Natural Resources Information System*	Texas Natural Resources Information System Central
Utah	
UGMS CRIB File	Utah Geological and Mineral Survey
Vermont	
Water Quality Data System	Department of Water Resources and Environmental Engineering
Groundwater Management Section's Data Base	Agency of Environmental Conservation
Center for Rural Studies - Vermont State Data Center	Center for Rural Studies - University of Vermont
Vermont State Data Center	Agency of Development and Community Affairs
WATER (Public Water System)	Department of Health
Virginia	
Commonwealth Data Base (CDB)*	Department of Taxation
Washington	
Shoreline Management Substantial Development Permits	Department of Ecology
Shoreline Management Conditional Use and Variance Permits	Department of Ecology
ATLAS CZGIS (Coastal Zone Geographic Information System)	Department of Ecology
Baselines Intertidal/Subtidal	Department of Ecology
Air Quality Data Handling System	Department of Ecology
Washington (cont'd)	
WRIS Water Right Claims, Permits, Certificates and Changes	Department of Ecology
Water Quality Classifications Monitoring Stations, and Non-Changing Data	Department of Ecology
Non-game Program Data Storage and Retrieval System Habitat Files	Department of Game
AIMS (Surface Mining Permits)	Department of Natural Resources
Forest Productivity	Department of Natural Resources
GRIDS - Gridded Resource Inventory Data System	Department of Natural Resources
LCD Element Occurrence (Nature Conservancy)	Department of Natural Resources
Wisconsin	
Flood Data Repository	Department of Natural Resources - Water Regulation and Zoning
Benchmark Inventory	Department of Natural Resources - Water Regulation and Zoning
Forest Fire Report	Department of Natural Resources - Bureau of Forestry
Farmland Preservation Planning and Mapping	Department of Agriculture
Towns, Population Data	Department of Administration - Demographic Services
Current Mineral Producers	Wisconsin Geological Survey
Well Logs System	Wisconsin Geological Survey
Public Lands	Department of Natural Resources
Wetlands	Department of Natural Resources
Shoreline Inventory	Department of Natural Resources
Southeast Regional Planning Commission File	Southeast Regional Planning Commission
Data Repository of Nongame, Endangered, Threatened Vegetation and Animals	Department of Natural Resources - Bureau of Endangered Resources
Scientific Areas	Department of Natural Resources - Bureau of Endangered Resources
General Waters	Department of Natural Resources - Fisheries
Forest Tax Law Reminder System	Department of Natural Resources - Bureau of Forestry
WTL (Woodland Tax Law Reminder)	Department of Natural Resources - Bureau of Forestry
Public Lands Forest Reconnaissance	Department of Natural Resources - Bureau of Forestry
Wyoming	
Wildlife Observation System	Game and Fish Department

nents--i.e., the data--which can then be addressed through a single questionnaire. This approach serves to provide a common ground for all data bases, regardless of their size or the variety of data they contain.

Once the decision was made to survey data types stored in data bases (rather than data bases, per se), it was necessary only to consider (1) the computer facilities available to the state agency for automating the data, regardless of how many or how few data categories were involved, and (2) the data categories, themselves. Thus, a survey was designed that allowed maximum flexibility with respect to each agency's approach to organizing its data (Appendix B). The format and substance of specific questions in the survey were derived by reviewing numerous questionnaires utilized by various state and federal agencies for assessing data needs or inventorying existing data (Armentano and Loucks, 1979; Brooks, 1980; Gordon, 1981; Hill-Rowley, 1981; Lettman, 1981; Naim, et al., 1980; NASIS, 1982; Potter, et al., 1972; Salmen, et al., 1977; U.S. Geological Survey, 1979; and others).

KARS staff have established the following schedule for project execution. This timetable prioritizes project tasks and sets goals for their completion.

April - May 1983

- Extract information from documentation received for state data bases, and insert it onto follow-up surveys; mail to state participants for completion
- Continue contacting new referrals regarding possible additional data bases
- Continue review and evaluation of preliminary questionnaires received; follow up as necessary
- Preparation of follow-up surveys for entry into the KARS Master Data Base
- Complete evaluation and testing of RTFILE software for storing, analyzing, and retrieving data base summaries

May - June 1983

- Continue distribution of follow-up surveys, as required
- Continue contacting new referrals
- Continue review, evaluation and follow-up of preliminary questionnaires
- Continue data entry into KARS Master Data File
- Initiate data editing

June - July 1983

- Continue distribution of follow-up surveys, as required
- Continue data entry and editing of the KARS Master Data File
- Pursue active follow-ups for any detailed surveys not returned to the KARS Program

August - September 1983

- Continue distribution of follow-up surveys, as required
- Continue data entry and editing of the KARS Master Data Base
- Initiate analysis of state and sub-state data bases
- Initiate preparation of a summary report for distribution to all state agencies and others participating in the project
- Present preliminary results of the study at the Fall Convention of the ACSM/ASP meeting in Salt Lake City, Utah

October 1983

- Complete analysis of state and sub-state data bases and prepare summary statistics for final report
- Complete final report
- Complete summary report for distribution to participating state agencies and others, and consult with NASA on the substance of the report and the timing of its release.

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STATE: ____________________

APPENDIX A

INVENTORY OF STATE AND SUB-STATE REPOSITORIES

Please complete one form for each repository and return to:

Loyola M. Caron
Kansas Applied Remote Sensing (KARS) Program
University of Kansas Space Technology Center
2291 Irving Hill Drive
Lawrence, Kansas 66045

Telephone: (913) 864-4775

GENERAL INFORMATION NEEDS

- Soils Data (Other than that collected by SCS)
  - Location description
  - Capabilities
  - Erosion levels
  - Conservation measures
- Flora/Fauna
  - Location
  - Species
  - Habitat
  - Threatened or endangered species
  - Wetlands (location, size, classification)
- Forests/Privately-Owned
  - Location
  - Species
  - Size
  - Production
  - Erosion
- Rangeland
  - Location
  - Species
  - Condition
  - Yield
- Cropland
  - Crop yields
  - Costs
  - Conservation measures
- Land Use Changes
  - Location
  - Extent, type
  - Trends
- Surface Water
  - Location
  - Levels/Flows
  - Quality
  - Runoff
  - Supply and storage
- Groundwater
  - Location
  - Aquifer
  - Water availability
  - Quality
  - Supply and storage
- Marine Estuarial Data
  - Location
  - Species
  - Habitat
- Geological Features
  - Surface
  - Subsurface
  - Exploration/extraction
- Terrain/Topography
  - Floodplain/Flood prone
  - Slope/aspect
- Climatological Data
  - Temperature
  - Precipitation
  - Wind data
  - Evapotranspiration
  - Radiation
- Demography
  - Social aspects
  - Economic aspects
- Natural/Manmade Disasters
  - Location
  - Type
  - Extent

NAME: ____________________ TITLE: ____________________

AGENCY: ____________________ TELEPHONE: ____________________

ADDRESS: ____________________

____

1. NAME OF REPOSITORY: ____________________

2. SUBJECT MATTER INCLUDED: ____________________

(OVER)

3. GEOGRAPHIC COVERAGE: ____________________

4. WHEN WAS REPOSITORY INITIATED? ____________ (year)

WHEN WAS IT LAST UPDATED? ____________ (month/year)

5. IS WRITTEN INFORMATION AVAILABLE?

YES ☐ NO ☐ (Please send if available)

6. THE REPOSITORY IS: AUTOMATED ☐ NONAUTOMATED ☐

7. IF AUTOMATED, THE COMPUTER IS MAINTAINED:

☐ In-house (stand-alone computer system)

☐ At a state data coordinating center (Name: ____________________ ____________________)

☐ At a university (Name: ____________________)

☐ Other (Please specify: ____________________)

8. IF AUTOMATED, PLEASE IDENTIFY:

COMPUTER VENDOR, MODEL: ____________________

PROGRAMMING LANGUAGE(S) OF ON-LINE SYSTEM: ____________________

____

9. IF AUTOMATED, DOES YOUR AGENCY SHARE, OR WOULD YOUR AGENCY CONSIDER SHARING, DATA WITH OTHER AGENCIES THROUGH AN ON-LINE COMMUNICATIONS LINK?

YES ☐ NO ☐

* * * * * * * * * * * * * * *

CAN YOU PROVIDE NAMES OF INDIVIDUALS WHO WOULD BE ABLE TO IDENTIFY OTHER DATA BASES IN THE STATE?

NAME: ____________	NAME: ____________
AGENCY: ____________	AGENCY: ____________
ADDRESS: ____________	ADDRESS: ____________
____________	____________
TELEPHONE: ____________	TELEPHONE: ____________

* * * THANK YOU FOR YOUR HELP * * *

APPENDIX B

SURVEY

INVENTORY OF STATE AND SUB-STATE COMPUTER-BASED
NATURAL RESOURCES REPOSITORIES

The purpose of this questionnaire is to obtain descriptions of natural resources and related data bases in your state. Instructions for completing the survey are attached (tan paper). If you have any questions or need clarification regarding any aspect of this form, please contact:

Loyola M. Caron
University of Kansas Space Technology Center
Kansas Applied Remote Sensing (KARS) Program
2291 Irving Hill Drive
Lawrence, Kansas 66045-2969

Telephone: (913) 864-4775

NAME(S) OF DATA BASE(S): ____________________

____

____

QUESTIONNAIRE COMPLETED BY:

NAME: ____________________

TITLE: ____________________ TELEPHONE: ____________________

ADDRESS: ____________________

____

____

PART I — DATA BASE CONTACTS/FACILITIES

1. *OTHER CONTACTS (Please complete all that apply -- in-house only):*

- ADMINISTRATIVE HEAD: ____________________

  TITLE: ____________________ TELEPHONE: ____________________

- USER SERVICES AND PRODUCTS: ____________________

  TITLE: ____________________ TELEPHONE: ____________________

- COMPUTER OPERATIONS: ____________________

  TITLE: ____________________ TELEPHONE: ____________________

2. DOCUMENTATION: Do you have any written documentation of your data base(s)/information system? (Please send a copy of any available materials if you have not previously done so.)

- ☐ Yes, hardware
- ☐ Yes, software
- ☐ Yes, data structure
- ☐ Yes, data assessment procedures
- ☐ No
- ☐ Yes, data encoding format/procedure
- ☐ Yes, data type
- ☐ Yes, general information
- ☐ Yes, newsletter

3. USER FEES: Are fees charged by your office for providing data from this information system?

- ☐ Yes, fees charged for all products and services according to a fee schedule
- ☐ Yes, fees charged for products only
- ☐ Yes, fees charged on a cost recovery basis
- ☐ No, products and services available at no charge
- ☐ No policy established
- ☐ Other (Please specify: ____________________

  ____

  ____________________)

(Over)

— PLEASE DO NOT SEPARATE THESE PAGES —

PART [illegible] (Continued)

4. COMPUTER FACILITIES. Which of the following describes your computer facilities? (Check all that apply.)

- ☐ Own or rent and operate own computer
- ☐ Use Central government computer center
- ☐ Use another department's computer (Please specify: ______________________)
- ☐ Use a private sector computer center (Please specify: ______________________)
- ☐ Use a university computer center (Please specify: ______________________)
- ☐ Other (Please specify: ______________________)

5. The information system operates in which of the following modes?

- ☐ Batch
- ☐ Interactive

6. Would you describe your system as a GEOGRAPHIC INFORMATION SYSTEM (i.e., components can be spatially related so that multiple information types can be registered)?

- ☐ Yes
- ☐ No
- ☐ Partially (Please explain: ______________________)

7. COMPUTER(S)

- ☐ Microcomputer (Make and model: ______________________)
- ☐ Mini/Super-mini (Make and model: ______________________)
- ☐ Main Frame (Make and model: ______________________)
- ☐ Other (Please specify make and model: ______________________)

Please answer questions 8 - 11 only if your office owns or rents and operates its own computer and can therefore summarize these features for the entire system.

8. OPERATING SYSTEM: ______________________

9. SYSTEM CAPACITY:

- ☐ Main memory (bytes): ______________________
- ☐ Disk storage (bytes): ______________________
- ☐ Simultaneous users supported: ______________________

10. PROGRAMMING LANGUAGES USED (Please estimate percentage of lines of all code):

- ☐ Fortran (%______)
- ☐ Pascal (%______)
- ☐ Assembler (%______)
- ☐ C (%______)
- ☐ BASIC (%______)
- ☐ COBOL (%______)
- ☐ Other (Please specify: ______________________)

11. SPECIALIZED SOFTWARE used for system operation includes:

- ☐ Mapping/plotting package(s): ______________________
- ☐ Image processing: ______________________
- ☐ Data base management system: ______________________
- ☐ Statistical package(s): ______________________
- ☐ Other: ______________________
- ☐ Other: ______________________

12. Does your office maintain any of the following devices in-house?

DISPLAYS

- ☐ Monochrome graphics CRT (How many? ________)
- ☐ Color (CAD/CAM, business) graphics CRT (How many? ________)
- ☐ Color image display
- ☐ Other (Please specify: ______________________)

DIGITIZERS

- ☐ Mechanical (How many? ________)
- ☐ Line following (How many? ________)
- ☐ Tablet-free cursor (How many? ________)
- ☐ Scanning (How many? ________)
- ☐ Other (Please specify: ______________________)

HARD-COPY GRAPHICS/TERMINALS

- ☐ Line printer (character graphics)
- ☐ Dot matrix printer with graphics
- ☐ Color dot matrix printer with graphics
- ☐ Color ink-jet
- ☐ Laser film recorder
- ☐ Electrostatic plotter
- ☐ Small flatbed pen plotter
- ☐ Drum pen plotter
- ☐ Large or precision flatbed pen plotter
- ☐ Hard copy terminal (How many? ________)
- ☐ Alphanumeric CRT (How many? ________)
- ☐ Other (Please specify: ______________________)

PART II — DESCRIPTION OF DATA CATEGORIES

IMPORTANT: PLEASE COMPLETE ONE OF THESE FORMS (PART II) FOR EACH MAJOR DATA CATEGORY CONTAINED WITHIN YOUR REPOSITORY

INSTRUCTIONS: (1) Circle the data category (e.g., CLIMATE/WEATHER) contained within your repository from those listed below. If your repository contains data on a topic not listed below, or not properly identified, feel free to create your own category and identify it under "OTHER CATEGORY."

(2) Check all data types that are included in the category which you have circled (e.g., Rainfall, Wind, Temperature). If your data category contains data types other than those listed beneath the category name in this list, please itemize those data types in the box below ("OTHER DATA TYPES").

(3) Identify the name of the data base/repository in which this data category and associated data types can be found.

- CLIMATE/WEATHER
  - ☐ Rainfall
  - ☐ Wind
  - ☐ Exposure
  - ☐ Evapotranspiration
  - ☐ Temperature
  - ☐ Snowfall/snow depth
  - ☐ Solar radiation
  - ☐ Natural disasters
- DEMOGRAPHY
  - ☐ Populations
  - ☐ Social aspects
  - ☐ Economic aspects
- ENERGY
  - ☐ Resources - coal/lignite
  - ☐ Resources - natural gas
  - ☐ Resources - oil
  - ☐ Resources - hydro-electric
  - ☐ Ownership
  - ☐ Production
  - ☐ Conversion
  - ☐ Transmission
- ENVIRONMENTAL QUALITY
  - ☐ Air quality
  - ☐ Water quality
  - ☐ Point pollution
  - ☐ Non-point pollution
  - ☐ Hazardous wastes
- GEOLOGY
  - ☐ Physiography
  - ☐ Surficial geology
  - ☐ Bedrock geology
  - ☐ Exploration/extraction
- HYDROLOGY - GROUNDWATER
  - ☐ Quantity
  - ☐ Quality
  - ☐ Recharge
  - ☐ Discharge/pumpage
  - ☐ Well location
  - ☐ Water rights
- HYDROLOGY - SURFACE
  - ☐ Discharge/volume/stage
  - ☐ Quality
  - ☐ Water body type
  - ☐ Supply and storage
  - ☐ Watershed boundaries
  - ☐ Flooding
  - ☐ Floodplains
  - ☐ Flood prone areas
  - ☐ Stream orders
  - ☐ Water rights
- LAND COVER
  - ☐ Barren land
  - ☐ Forest land
  - ☐ Perennial ice & snow
  - ☐ Rangeland
  - ☐ Water
  - ☐ Wetlands
  - ☐ Estuaries
  - ☐ Cropland
  - ☐ Pasture
  - ☐ Urban/built-up
- LAND USE (RESOURCES)
  - ☐ Timber
  - ☐ Mineral extraction/energy production
  - ☐ Water use
  - ☐ Cropland
  - ☐ Livestock production
  - ☐ Transportation
  - ☐ Urban/built-up
  - ☐ Recreation
  - ☐ Parks
  - ☐ Unique areas
  - Cultural areas
    - ☐ - Historical
    - ☐ - Archaeological
    - ☐ - Paleontological
  - ☐ Ownership
- BOUNDARIES
  - ☐ State
  - ☐ Counties
  - ☐ Townships
  - ☐ Census blocks
  - ☐ Watersheds
  - ☐ River basins
  - ☐ Regional planning districts
- SOILS DATA
  - ☐ Type
  - ☐ Series
  - ☐ Association
  - ☐ Engineering characteristics
  - ☐ Capability class
  - ☐ Productivity
  - ☐ Erosion
  - ☐ Conservation measures
- TOPOGRAPHY
  - ☐ Elevation
  - ☐ Slope
  - ☐ Aspect
  - ☐ Relief
- VEGETATION
  - ☐ Species
  - ☐ Communities
  - ☐ Quality/condition
  - ☐ Biomass/volume
  - ☐ Succession
  - ☐ Age
  - ☐ Rare and endangered
- WILDLIFE
  - ☐ Game - mammals
  - ☐ Game - birds
  - ☐ Game - fish
  - ☐ Game - other
  - ☐ Non-game - mammals
  - ☐ Non-game - birds
  - ☐ Non-game - fish
  - ☐ Non-game - marine/estuarial
  - ☐ Non-game - reptiles/amphibians
  - ☐ Non-game - other
  - ☐ Quantity (populations)
  - ☐ Management
  - ☐ Habitat
  - ☐ Threatened and endangered
- OTHER CATEGORY (Please specify) ____________

OTHER DATA TYPES (itemize for category circled above): ____________ ____________

____________ ____________ ____________

____________ ____________ ____________

THESE DATA ARE CONTAINED WITHIN (NAME OF DATA BASE/REPOSITORY): ____________________

1. GEOGRAPHIC COVERAGE: What is the extent of the geographic coverage in this data category? (Please sketch this area on the map below, if necessary.)

☐ Watershed (Name: ____________________)

☐ Resource management district(s) (Name: ____________________)

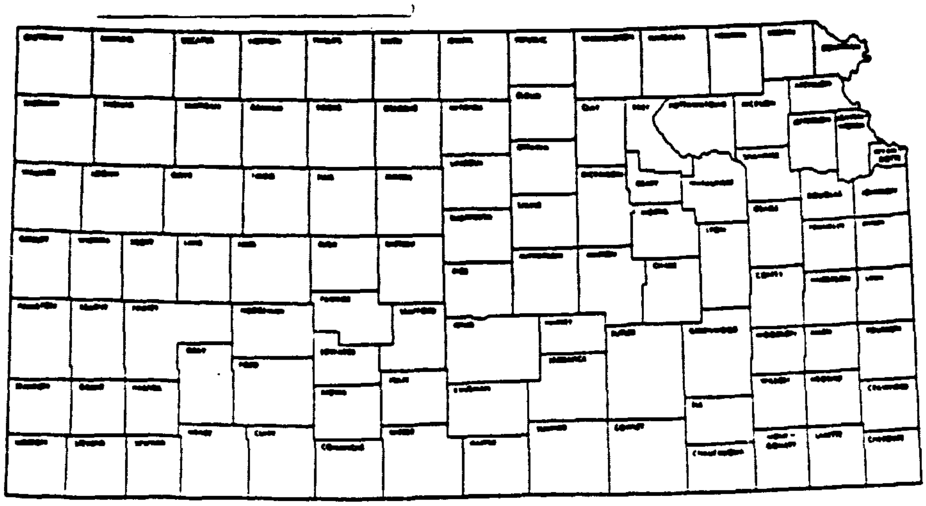
☐ Special project area (Name: ____________________)

☐ Regional (an area encompassing several counties, e.g., the area covered by a regional planning district or conservation district)

☐ Statewide

☐ Other (Please specify: ____________________)

(Over)



2 GEOGRAPHIC REFERENCE. How are these data referenced geographically? (Check all that apply.)

- ☐ Latitude/longitude
- ☐ Universal Transverse Mercator (UTM)
- ☐ Public Land Survey (township/range/section)
- ☐ State Plane Coordinates
- ☐ Ad hoc grid, unreferenced (i.e., arbitrary X, Y)
- ☐ Not geographically referenced
- ☐ Other (Please specify: ______________________________
______________________________)

1. RESOLUTION. To what minimum level are the data aggregated in this data category? (Check all that apply, if different from one data type to the next.)

- ☐ By watershed or river basin
- ☐ By ownership unit
- ☐ By management unit
- ☐ By county
- ☐ By township
- ☐ 640 acres (section, 1 square mile)
- ☐ 160 acres (¼ section)
- ☐ 40 acres
- ☐ 10 acres
- ☐ 2-5 acres
- ☐ 1 acre
- ☐ Site specific
- ☐ 10,000 m^2 (UTM cell)
- ☐ 500-meter cell
- ☐ Hectare
- ☐ Other (Please specify: ______________________________
______________________________)

4. DATA STORAGE FORMAT. In what format are the data stored? (Check all that apply.)

- ☐ Grid
- ☐ Polygon
- ☐ Arc/node
- ☐ Coordinate point
- ☐ Tabular
- ☐ Other (Please specify: ______________________________
______________________________)

5. OUTPUT PRODUCTS. Available output products include (check all that apply):

- ☐ Maps - variable scale
- ☐ Maps - one scale only (Please specify: ______________)
- ☐ Tables
- ☐ Graphics (e.g., charts, histograms, plots)
- ☐ Computer tape
- ☐ Modelling capability
- ☐ Statistical summaries (e.g., acreage, mean depth to groundwater)
- ☐ Composite mapping (overlays)
- ☐ Interactive video display capability
- ☐ Other (Please specify: ______________________________
____
______________________________)

6. PRIMARY/SECONDARY DATA. Are the source data primary (i.e., collected by your staff or by someone on your behalf), secondary (i.e., collected by another agency), or a combination of both? (Check all that apply.)

- ☐ Primary
- ☐ Secondary, collected by (name of agency): ____________
____
____
- ☐ Unknown

7 DATA SOURCES. If the data are primary, what sources were used to obtain the data? (Check all that apply.)

- ☐ Historical records
- ☐ Published surveys and maps
- ☐ Field survey
- ☐ Telephone/mail surveys
- ☐ Laboratory analysis
- ☐ Aerial photography
- ☐ Landsat
- ☐ Other remote sensing data
- ☐ Unknown
- ☐ Interpretation of other data within the system/data base
- ☐ Other (Please specify: ______________________________
______________________________)

8(a) RELIABILITY. A subjective assessment of the reliability of the data, taking into account collection methods, resolution, and other variables, prior to data base entry.

- ☐ Highly reliable
- ☐ Moderately reliable
- ☐ Low reliability
- ☐ Unknown

(b) By what method is this reliability determined?

- ☐ Random field check
- ☐ Expert opinion
- ☐ Unknown
- ☐ Other (Please specify: ______________________________
____
______________________________)

9(a) UPDATING FREQUENCY. How often are the source data updated? (Check all that apply.)

- ☐ Continuously
- ☐ Daily
- ☐ Weekly
- ☐ Monthly
- ☐ Annually
- ☐ Biennially
- ☐ Every 5 years
- ☐ Every 10 years
- ☐ Other (Please specify: ______________________________
______________________________)

(b) DATE LAST UPDATED: ______________________________

10. CONFIDENTIALITY. Are any of the data in this category subject to restricted access?

- ☐ Yes (Please explain: ______________________________
____
______________________________)
- ☐ No

11. CLASSIFICATION SCHEME EMPLOYED. If applicable (e.g., Anderson's classification for land cover derived from remote sensing data; or National Wetlands Classification) If classification was developed in-house, please attach a copy.

____
____
____
____

12. Are any of the data in this category routinely supplied to a repository of a federal agency (e.g., NAWDEX, CRIS, STORET)?

- ☐ Yes (Name of agency/repository: ______________
______________________________)
- ☐ No

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OF POOR QUALITY

INSTRUCTIONS

PART I - DATA BASE CONTACTS/FACILITIES

Part I is included so that an overview of contacts, computer hardware, software, and peripheral devices can be obtained. Spaces are provided for listing individuals having special responsibilities with respect to coordination of the data base(s), dissemination of information, and computer operations. Please provide names, titles and phone numbers (if different from your number) for these individuals, as appropriate.

Complete questions 8 - 11 (screened inset) only if your office owns (or rents) and operates a computer[illegible], only if your office is in a position to provide comprehensive details on the system as a whole. If your computer facilities are located at another site, skip this portion of the survey, and proceed to question 12.

PART II - DATA BASE CONTACTS/FACILITIES

The remainder of the survey deals explicitly with the information contained in your data base/repository. The intent is to survey the data, not the organizational or hierarchical structures of the data base, which vary from one repository to the next.

It will be necessary to complete one form (Part II) for each major category of data in your data base. Also, if data on one category (e.g., Land Cover) are contained in more than one data base, a separate Part II form must be completed for each repository.

A list of major data categories is included in Part II of the survey to assist you in identifying broad data categories in your data base. Several data types are listed within each data category. If your data base/repository contains data not included or properly represented on this list, FEEL FREE to create new data categories or data types in the spaces indicated.

For example, wildlife may not be of much importance within your data base, but perhaps you have information about the species and populations of animals within your Forest Resources Data Base. The header at the beginning of Part II may be filled out to reflect this lesser significance of wildlife, as well as the importance of forestry, as follows:

INSTRUCTIONS: *(1) Circle one data category (e.g., CLIMATE/WEATHER) contained within your repository from those listed below. If your repository contains data on a topic not listed below, or not properly identified, feel free to create your own category and identify it under "OTHER CATEGORY."*

(2) Check all data types that are included in the category which you have circled (e.g., Rainfall, Wind, Temperature). If your data category contains data types other than those listed beneath the category name in this list, please itemize those data types in the box below ("OTHER DATA TYPES").

(3) Identify the name of the data base/repository in which this data category and associated data types can be found.

- **CLIMATE/WEATHER**
  - ☐ Rainfall
  - ☐ Wind
  - ☐ Exposure
  - ☐ Evapotranspiration
  - ☐ Temperature
  - ☐ Snowfall/snow depth
  - ☐ Solar radiation
  - ☐ Natural disasters
- **DEMOGRAPHY**
  - ☐ Populations
  - ☐ Social aspects
  - ☐ Economic aspects
- **ENERGY**
  - ☐ Resources - coal/lignite
  - ☐ Resources - natural gas
  - ☐ Resources - oil
  - ☐ Resources - hydro-electric
  - ☐ Ownership
  - ☐ Production
  - ☐ Conversion
  - ☐ Transmission
- **ENVIRONMENTAL QUALITY**
  - ☐ Air quality
  - ☐ Water quality
  - ☐ Point pollution
  - ☐ Non-point pollution
  - ☐ Hazardous wastes
- **GEOLOGY**
  - ☐ Physiography
  - ☐ Surficial geology
  - ☐ Bedrock geology
  - ☐ Exploration/extraction
- **HYDROLOGY - GROUNDWATER**
  - ☐ Quantity
  - ☐ Quality
  - ☐ Recharge
  - ☐ Discharge/pumpage
  - ☐ Well location
  - ☐ Water rights
- **HYDROLOGY - SURFACE**
  - ☐ Discharge/volume/stage
  - ☐ Quality
  - ☐ Water body type
  - ☐ Supply and storage
  - ☐ Watershed boundaries
  - ☐ Flooding
  - ☐ Floodplains
  - ☐ Flood prone areas
  - ☐ Stream orders
  - ☐ Water rights
- **LAND COVER**
  - ☐ Barren land
  - ☐ Forest land
  - ☐ Perennial ice & snow
  - ☐ Rangeland
  - ☐ Water
  - ☐ Wetlands
  - ☐ Estuaries
  - ☐ Cropland
  - ☐ Pasture
  - ☐ Urban/built-up
- **LAND USE (RESOURCES)**
  - ☐ Timber
  - ☐ Mineral extraction/energy production
  - ☐ Water use
  - ☐ Cropland
  - ☐ Livestock production
  - ☐ Transportation
  - ☐ Urban/built-up
  - ☐ Recreation
  - ☐ Parks
  - ☐ Unique areas
  - Cultural areas
    - ☐ - Historical
    - ☐ - Archaeological
    - ☐ - Paleontological
  - ☐ Ownership
- **BOUNDARIES**
  - ☐ State
  - ☐ Counties
  - ☐ Townships
  - ☐ Census blocks
  - ☐ Watersheds
  - ☐ River basins
  - ☐ Regional planning districts
- **SOILS DATA**
  - ☐ Type
  - ☐ Series
  - ☐ Association
  - ☐ Engineering characteristics
  - ☐ Capability class
  - ☐ Productivity
  - ☐ Erosion
  - ☐ Conservation measures
- **TOPOGRAPHY**
  - ☐ Elevation
  - ☐ Slope
  - ☐ Aspect
  - ☐ Relief
- **VEGETATION**
  - ☐ Species
  - ☐ Communities
  - ☐ Quality/condition
  - ☐ Biomass/volume
  - ☐ Succession
  - ☐ Age
  - ☐ Rare and endangered
- **WILDLIFE**
  - ☐ Game - mammals
  - ☐ Game - birds
  - ☐ Game - fish
  - ☐ Game - other
  - ☐ Non-game - mammals
  - ☐ Non-game - birds
  - ☐ Non-game - fish
  - ☐ Non-game - marine/estuarial
  - ☐ Non-game - reptiles/amphibians
  - ☐ Non-game - other
  - ☐ Quantity (populations)
  - ☐ Management
  - ☐ Habitat
  - ☐ Threatened and endangered
- **OTHER CATEGORY** (Please specify) Forest Resources

OTHER DATA TYPES (itemize for category circled above):

	Species	Volume
Age	Management	Wildlife

THESE DATA ARE CONTAINED WITHIN (NAME OF DATA BASE/REPOSITORY): Forest Resources Data Base

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The questions on Part II of the survey form are designed to characterize each major data category within your data base. It will probably be necessary to generalize this information for each category, or to select the answer which represents the "best fit."

Certain features, however, vary drastically from one type of data to the next (e.g., geographic coverage, resolution). If the characteristics of some data types cannot be generalized with the others, you may prefer to complete a separate survey form for those data types; or, alternatively, you might simply note major discrepancies in the margins of the survey.

For example, in the data category *Land Use*, cultural areas may be entered into the data base on a site specific basis, whereas parks may be aggregated to 40-acre cells. This difference in resolution could be reflected in any of the following ways:

- A separate survey form (Part II) could be completed for each data type (i.e., cultural areas and parks);
- Both *site specific* and *40 acres* could be checked on the survey, and appropriate annotations made in the margin to indicate which type of resolution applies to cultural areas and parks; or
- If the data on cultural sites is very limited, you may choose to generalize the response by checking *40 acres* on the survey, to reflect the resolution of parks which comprise a much greater portion of the data category.

PLEASE FEEL FREE to include published materials regarding the contents of your data base.

APPENDIX I

KARS PROJECTS

KANSAS APPLIED REMOTE SENSING PROGRAM
April, 1972 to March, 1983

Project Number	Project Title	Cooperating Agency	Type of Governmental Organization: Federal	State	Regional	County	Municipal	Private	Data Source: Landsat	Skylab	High Altitude	Medium Altitude	Low Altitude
1.	Developmental Planning on Clinton Dam and Reservoir	Lawrence/Douglas County Planning Department				X	X						X
2.	Decision on Completion of I-35 and Pattonsburg Reservoir	Governor's Office - State of Missouri Missouri Department of Natural Resources		X					X				X
3.	Kansas City, Kansas Flooding Disaster	Mayor's Office, Kansas City, Kansas Civil Defense Office, Kansas City, Kansas					X						X
4.	Using Remote Sensing for Wildlife Habitat Inventory in Kansas	Kansas Fish & Game Commission		X					X		X		
5.	Regional Land Use Map for the Four Rivers Resource Conservation and Development Project	Four Rivers Resource Conservation and Development District U.S. Department of Agriculture - Soil Conservation Service	X		X				X				
6.	Land Use Map of Cherokee County, Kansas	Cherokee County Commissioners Kansas Department of Economic Development Kansas Geological Survey		X		X					X		
7.	Sanitation Route Allocation in Kansas City, Kansas	Kansas City, Kansas Department of Planning and Development					X				X		
8.	Evaluating Environmental Impact on Road Construction in Kansas City, Kansas	Kansas Department of Transportation Kansas City, Kansas Planning and Development Department		X			X						X
9.	Census Tract Division: Mid-America Regional Council	Mid-America Regional Council			X						X		
10.	Mapping Center Pivot Irrigation in Southwest Kansas	Kansas Fish & Game Commission		X					X				
11.	Habitat and Stream Order Mapping of The Chikaskia River Basin	Kansas Fish & Game Commission U.S. Fish & Wildlife Service Kansas City Area Office Sunflower Resource Conservation and Development District	X	X	X				X	X			
12.	Mapping and Monitoring of Vegetation in Cheyenne Bottoms Waterfowl Management Area	Kansas Fish & Game Commission		X					X		X		X
13.	Republican River Canoe Trail and Campsite Planning	Cloud County Commissioners Concordia, Kansas Chamber of Commerce Four Rivers Resource Conservation and Development District Kansas State Park and Resources Authority USDA/Soil Conservation Service	X	X	X	X	X						X
14.	County Line Lake Missouri Project	Governor's Office - State of Missouri Missouri Department of Natural Resources		X									X

Project Number	Project Title	Cooperating Agencies	Federal	State	Regional	County	Municipal	Private	Landsat	Skylab	High Altitude	Medium Altitude	Low Altitude
			Type of Governmental Organization						Data Source				
15.	Mapping Aquatic Vegetation at Douglas County State Lake	Kansas Fish & Game Commission		x									x
16.	Delineation of Drainage Patterns in Strip Mined Areas of Southeast Kansas	Kansas Fish & Game Commission Kansas Department of Health & Environment Kansas Attorney General's Office		x							x		
17.	Conversion of Prime Agricultural Land to Urbanized Land Use	Mid-America Regional Council			x						x		
18.	Barber County Sage and Cedar Infestations	USDA/Soil Conservation Service Barber County, Sunflower Resource Conservation and Development District	x		x				x	x			x
19.	Mapping and Monitoring Musk Thistle Infestations of Kansas Rangeland	Kansas Department of Agriculture - Weed and Pesticide Division Environmental Protection Agency	x	x					x		x		x
20.	Assessment of Distributional Change in Eastern Red Cedar	Kansas Department of Agriculture		x					x	x	x		x
21.	Development of Wildlife Habitat Areas in Southeast Kansas Strip-Mined Region	Kansas Fish & Game Commission		x									x
22.	Land Use Mapping for Planning and Zoning in Sumner County	Chikaskia, Golden Belt and Indian Hills Regional Planning Commission Sumner County Commission			x	x				x			
23.	Law Enforcement Planning for the Republican National Convention	Kansas City, Kansas Police Department Johnson, Wyandotte and Leavenworth Law Officials				x	x				x		
24.	Using Landsat to Select a Pronghorn Antelope Release Site in Kansas	Kansas Fish & Game Commission		x					x				
2.	Lawrence-Douglas County Zoning Decisions	Lawrence-Douglas County Planning Commission				x	x						x
26.	Planning for the Sand Hills State Park, Kansas	Kansas Park and Resources Authority		x									x
27.	Total Irrigation Mapping	Legislative Research Department		x					x				
28.	Tauy Creek Watershed Planning	Tauy Creek Watershed Board of Directors USDA/Soil Conservation Service	x			x							x
29.	Kansas Land Use Patterns Map	Kansas Department of Economic Development		x					x				

Project Number	Project Title	Cooperating Agency	Type of Governmental Organization: Federal	State	Regional	County	Municipal	Private	Data Source: Landsat	Skylab	High Altitude	Medium Altitude	Low Altitude
30.	Soldier Creek Watershed 208 Planning	USDA/Soil Conservation Service Soldier Creek Watershed Steering Committee, Kansas Department of Health and Environment		X	X	X	X						X
31.	Fugitive Dust Source Analysis	Kansas Department of Health and Environment		X									X
32.	St. Jacob's Well Natural Landmark	Kansas State Fish and Game Commission U.S. National Park Service	X	X					X				
33.	Bald Eagle Habitat Mapping	Douglas County Audubon Society U.S. Fish and Wildlife Service	X					X					X
34.	Riley County Landfill	Riley County Engineer				X							X
35.	Natural Disaster Response and Analysis	Emergency Preparedness Planning		X									X
36.	Clinton Park Planning	Kansas State Park and Resource Authority		X							X		X
37.	Mine Creek Battlefield Archaeological Reconnaissance	Kansas State Historical Society		X									X
38.	Louisburg Health Care Facility	Miami County Health Care Consultant				X					X		
39.	Mapping the Diminishing Sandsage Prairie Ecosystem	Kansas Fish & Game Commission		X					X				
40.	Tallgrass Prairie National Park	Save the Tallgrass Prairie, Inc.						X			X		
41.	Mapping of Land Use/Land Cover and Prime Agricultural Land in Saline County, Kansas	Saline County Department of Planning and Zoning				X						X	
42.	Arkansas River Irrigation Moratorium	U.S. Geological Survey - Water Resources Division Kansas State Board of Agriculture - Division of Water Resources	X						X				X
43.	Land Use, Land Cover, Land Use Change, Flood Plain Scour, Gully and Stream Channel Inventory of Pony Creek and Roy's Creek Watersheds, Kansas and Nebraska	USDA/Soil Conservation Service	X										X
44.	Remote Sensing Short Courses	NASA-Earth Resources Laboratory	X										

Project Number	Project Title	Cooperating Agency	Type of Governmental Organization: Federal	State	Regional	County	Municipal	Private	Data Source: Landsat	Skylab	High Altitude	Medium Altitude	Low Altitude
45.	Wildlife Habitat Inventory for the Proposed Pine Ford Lake, Missouri	U.S. Fish and Wildlife Service	X								X		X
46.	Abandoned Mined Lands Inventory and Hazard Assessment	USDI - Office of Surface Mining	X								X	X	X
47.	Walnut Creek Watershed Groundwater Model - Irrigated Lands and Crop Inventory	Kansas Geological Survey		X					X				
48.	Rangeland Management in the Cimarron National Grassland	USDA - Forest Service	X						X			X	X
49.	Resources Management Geo-Data Base for Kansas Indian Owned Lands	USDI - Bureau of Indian Affairs	X									X	X
50.	Geo-Data Base for Tax Re-Assessment	Kansas Department of Revenue		X					X				
51.	Applied Research and Development in Agricultural Remote Sensing	Farmland Industries, Inc.						X					X
52.	Crop Phenology and Landsat-Based Irrigated Lands Inventory in the High Plains	NASA-Ames Research Center	X						X				
53.	Land Use/Land Cover Inventory of the Missouri River Flood Plain	Missouri River Basin Commission			X						X		X
54.	Inventory of State Natural Resources Data Bases	NASA - Ames Research Center	X										
55.	Harvey County, Kansas, Digital Soils Data Base	USDA/Soil Conservation Service	X	X		X							
56.	Thematic Mapper Data for Habitat Inventory	Kansas Fish and Game Commission		X					X				
57.	Characterization of Fallow Lands for Wind Erosion Modeling	NASA	X						X				

APPENDIX II

KARS NEWSLETTERS

ORIGINAL PAGE IS OF POOR QUALITY

KARS Newsletter

The University of Kansas | April 1982 | Volume II, Number 2

KANSAS LEGISLATURE PROVIDES MANDATE FOR REMOTE SENSING TASK FORCE

The Kansas Interagency Task Force on Applied Remote Sensing has recently received formal recognition and direction from the Kansas Legislature. Senate Concurrent Resolution No. 1644, introduced by Senators Fred A. Kerr and Jane M. Eldredge in January 1982, was endorsed by both the Kansas Senate and House of Representatives in April. The Task Force has been meeting on an ad hoc basis since May 1981.

Resolution 1644 states, in part, "That it is in the interest of the people of the state that a task force on applied remote sensing be created to evaluate the ways the Kansas Applied Remote Sensing Program can be most efficiently and effectively maintained..." The Task Force will be comprised of "a person designated by the governor, a person designated by the president of the senate, a person designated by the speaker of the house, a person designated by the director of the Kansas water office, a person designated by the director of the Kansas geological survey, a person designated by the secretary of the department of revenue, a person designated by the secretary of the state board of agriculture, a person designated by the secretary of health and environment, a person designated by the director of the Kansas park and resources authority, a person designated by the director of the Kansas fish and game commission, a person designated by the Kansas department of economic development, a person designated by the state corporation commission, a representative of local governments designated by the state association of counties, a person designated by the director of the Kansas Applied Remote Sensing Program, a person designated by the president of the Kansas association of groundwater management districts and a person designated by the chancellor of the University of Kansas."

(Continued on page 6)

REMOTE SENSING EDUCATION AT THE UNIVERSITY OF KANSAS

The University of Kansas offers a complete undergraduate and graduate curriculum in both theoretical and applied remote sensing through the Departments of Geography, Electrical Engineering and Geology. Coursework in remote sensing is closely allied and integrated with the research programs of the Kansas Applied Remote Sensing Program and the Remote Sensing Laboratory. The curriculum in remote sensing offered at the University of Kansas is reviewed in this issue (see pages 4 and 5).

ESTIMATING GROUNDWATER WITHDRAWALS FOR AQUIFER MODELING IN THE WALNUT CREEK WATERSHED

The KARS Program is nearing the end of a project designed to assess the utility of Landsat data for estimating groundwater withdrawals. The project has been a cooperative effort between the KARS Program and the Kansas Geological Survey (KGS).

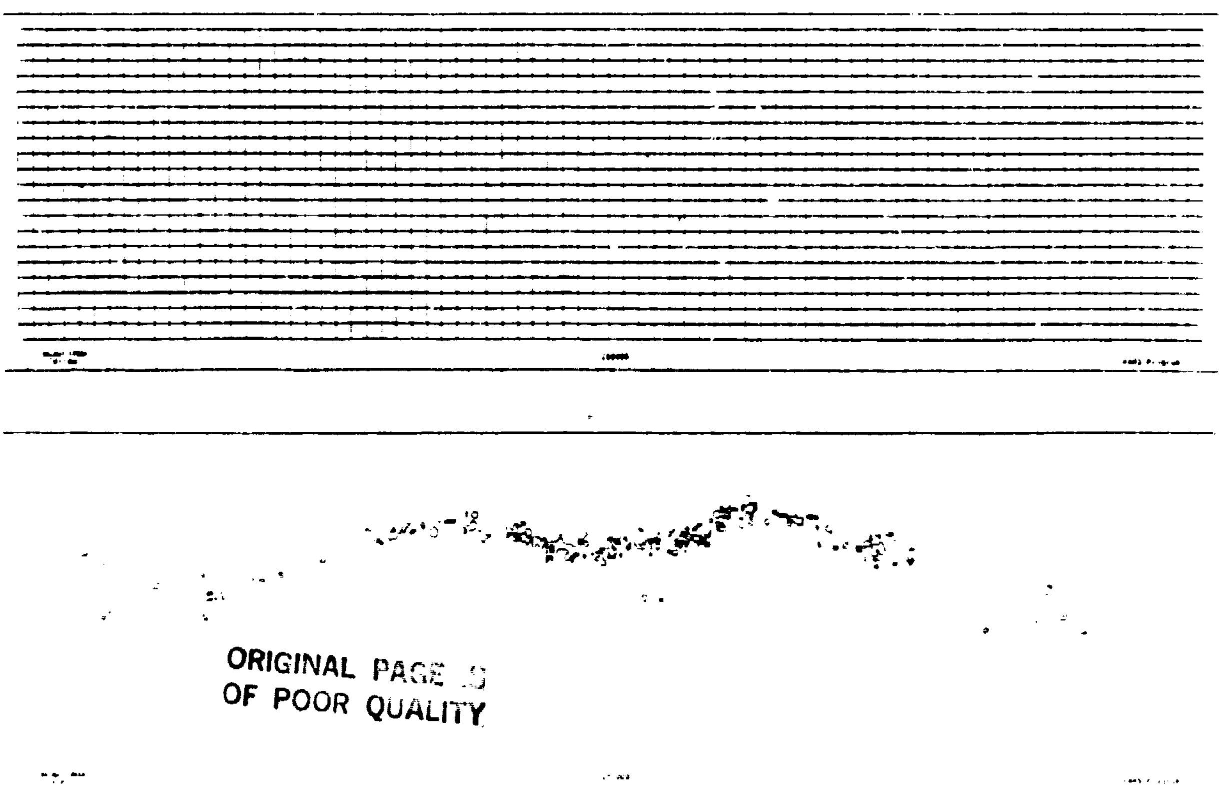
The Geohydrology Section of KGS is conducting a study of the water resources of the alluvial aquifer underlying the Walnut Creek Watershed in central Kansas. The objective of the KARS study is to develop a predictive groundwater model that will allow mathematical simulation of geohydrologic processes within the aquifer in order to determine future groundwater availability under various conditions of withdrawal and recharge.

The Walnut Creek study area is about 65 miles long. It extends eastward from Ness City in Ness County, through Rush County and into Barton County, where it joins the Arkansas River at Great Bend. Pumping for irrigation is the major form of withdrawal from the aquifer and is one of the key pieces of data required for developing the groundwater model.

Although data describing withdrawals is available in the form of well permits and usage reports, both of these sources have problems associated with them that limit their reliability. Well permits tell only what the irrigator is legally allowed to pump, not what was actually pumped. There may be much less water pumped than the legal total if there is above average precipitation or if a crop such as winter wheat (which requires relatively little irrigation) is grown rather than corn or alfalfa (which are heavy users of irrigation water).

The other source of data, yearly water usage reports, could provide very good information if the data were objectively collected by a well meter. However, because reports are based on the subjective estimates of irrigators, they may vary in reliability from individual to individual. Furthermore, these reports are incomplete. In any one year only about 60-80% of the irrigators in the valley actually turn in reports.

The KARS Program has, therefore, developed a third technique for estimating withdrawals. The tech-



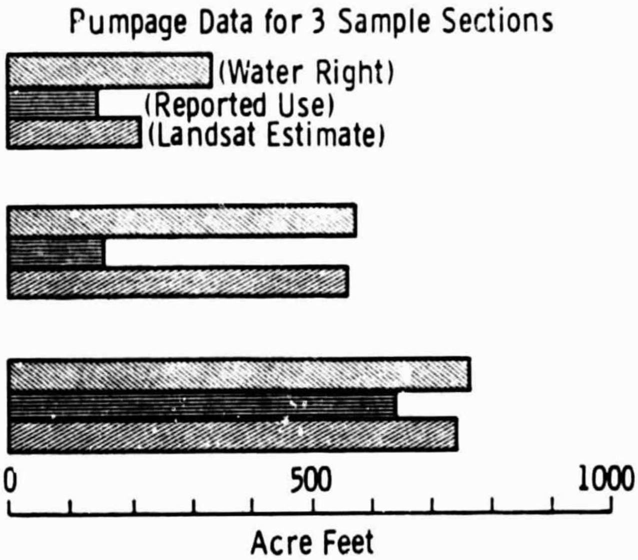
Two of the computer plots used to verify the digitized data with the original compilations. The upper plot represents the one-square mile section line grid of the study area; the lower plot is the area identified as being irrigated in the middle part of the growing season (July/August) and represents the irrigated corn and sorghum in the valley.

nique is based upon interpretation of Landsat Multispectral Scanner (MSS) imagery. Three years of Landsat data were analyzed for the KGS study -- 1973, 1976 and 1979. For each of the years imagery from three parts of the growing season was obtained: early season imagery (April/May), mid-season imagery (July/August), and late-season imagery (September/October). It was necessary to employ imagery from three parts of the growing season in order to be able to observe each of the dominant irrigated crops at its height of vigor. This enabled accurate identification of each crop. Thus the early season imagery was needed to identify irrigated winter wheat, the mid-season imagery to identify irrigated corn and sorghum, and the late season imagery as a check to identify irrigated alfalfa. Whenever a field appeared irrigated in any two or all three parts of the season, it was identified as alfalfa, because alfalfa has multiple harvests and thus multiple high-vigor irrigation periods throughout the growing season.

Visual interpretation of Band 5 Landsat imagery was performed on 1:125,000 scale enlargements of the valley areas. The interpretations for all three parts of the same growing season were recorded on a single acetate overlay. A color-coding scheme was used to identify in which part or combination of parts of the growing season each of the identified areas was irrigated. Following a check of the interpretation, each year's compilation was digitized and a separate data file created for each color. A computer plot of each color was then prepared and overlayed on the original compilation to provide a visual check of the accuracy of digitizing.

A computer program was then employed to calculate the total acreage of each crop within each section (640 acres) of the watershed. The totals were derived by section in order to provide data that would match the one square mile sections that KGS is employing in the groundwater model. These acreage totals and data supplied by the Soil Conservation Service (SCS) pertaining to the irrigation requirements of the various crops in the area are used to estimate the amount of water pumped in each section in a given year. It is this phase of the study that is currently being completed.

Preliminary data for several sample sections indicate that the Landsat-based estimation technique is providing results that appear reasonable and consistent. A comparison of the Landsat-based estimates and the other two sources for the sample sections show that the Landsat-based data is consistently lower than the legal water right for the section and higher than the reported use. Because the water use reports are based on incomplete records, the higher estimate from the Landsat-based technique is precisely what would be expected. Final evaluation of the results must await completion of the groundwater model development and the empirical testing of the Landsat-based estimates.



A comparison of the pumpage data obtained from well permits, water use reports and the Landsat-based estimation technique in three sample sections.

It is probable that some additional development of the calculation technique used to estimate the pumpage from the acreage data will be required. At this point, however, the estimation technique appears extremely promising and may prove to be a very valuable contribution in future groundwater modeling studies.

Additional results of the Walnut Creek project will be reported in future KARS Newsletters. For details, contact Joseph Poracsky or Edward Martinko, KARS Program; or Tom McClain, Kansas Geological Survey, Lawrence, KS.

REGIONAL SEMINAR TO ADDRESS REMOTE SENSING, MAP DATA APPLICATIONS

A regional seminar and workshop dealing with remote sensing, surveying, photogrammetry and map data applications will be held in Rolla, Missouri, on October 14-15, 1982. The meeting is being sponsored jointly by the local chapters of the American Congress of Surveying and Mapping and the American Society of Photogrammetry.

The two-day program will include concurrent seminars and demonstration workshops involving the utilization of automated and conventional methods in mapping and map data applications. A poster session and various commercial exhibits are also planned.

For further information about this meeting, contact Gary W. McKeown, Coordinator ACSM-ASP Symposium, 1400 Independence Road, Mail Stop 601, Rolla, MO 65401; telephone (314) 341-0940.

REMOTE SENSING EDUCATION IN THE DEPARTMENT OF GEOGRAPHY

The KARS Program maintains strong links with the remote sensing program in the Department of Geography at the University of Kansas, through student and faculty appointments and collaboration in research, teaching and extension activities. Research collaborations have been discussed in previous issues of this Newsletter but teaching activities have received less notice.

Because undergraduate and graduate instruction forms the basis of long-range adoption of remote sensing in the applied environmental sciences, it is appropriate here to describe the course structure and philosophy behind the teaching program. It is particularly timely in view of the extensive changes that have taken place in the remote sensing course structure in response to the needs of applied remote sensing and in response to the expansion of remote sensing interests into geographic information systems.

A major objective of Remote Sensing I (Geog 526) is to provide students with a solid foundation in air photo interpretation.

The Geography courses provide a sequence of formal lecture/laboratory work, research seminars and independent work, with an emphasis on the interpretation and uses of remotely sensed data.

Remote Sensing I (Geog 526), the first course in the sequence, provides a basic working knowledge of applied remote sensing techniques in environmental analysis. Emphasis is placed on the visual interpretation and mensuration of visual, infrared and microwave sensor imagery.

Students in Remote Sensing II (Geog 726) work in teams to complete a project in digital image processing. This project involves identification of a problem, selection of a study area, supervised and unsupervised Landsat data classification, and estimation of classification accuracy.

Remote Sensing II (Geog 726) emphasizes quantitative image analysis, concentrating on photographic densitometry and digital image processing. A comprehensive instructional image processing software package (see KARS Newsletter, October 1980) developed at KU provides intensive practical experience and understanding of image processing concepts, procedures and algorithms. Access to KARS' and other image processing systems provides exposure to various operational hardware/software configurations.

Remote Sensing III (Geog 826) concludes the basic course sequence and deals with remote sensing input to geographic information analysis techniques. The course covers data structures and input/output techniques, but the primary emphasis is on spatial information analysis and modeling.

Seminar in Remote Sensing (Geog 926) provides advanced study of special topics: image processing and GIS software development are recent examples.

Topics in Remote Sensing (Geog 627) allows students to undertake independent work in research, education or technology transfer.

Practicum in Applied Remote Sensing (Geog 626) provides a realistic work experience in which the student designs, executes and completes a project within the KARS Program.

(Continued on page 7)

ELECTRICAL ENGINEERING AND GEOLOGY DEPARTMENTS EMPHASIZE MICROWAVE REMOTE SENSING

Courses on remote sensing systems and applications are offered by both the Department of Electrical Engineering and the Department of Geology at the University of Kansas. These courses are particularly designed for students planning to specialize in microwave systems engineering and applied geology, but they complement remote sensing coursework offered through the Department of Geography (see page 4). Major emphasis in these courses is on the fundamentals of various passive and active (e.g., radar) microwave systems and their applications, although other systems are also covered. The coursework in both departments is fully integrated with research activities of the KU Remote Sensing Laboratory.

ELECTRICAL ENGINEERING

A number of laboratory facilities are available to students enrolled in the microwave engineering program, many of which are made available by the Remote Sensing Laboratory. These facilities include a microwave systems engineering laboratory, two radar laboratories and an antenna range. The department also has a computer-aided analysis and design-software system that is used by students to perform design trade-off studies and performance evaluation. A series of four courses in microwave systems are offered at the graduate level. These are:

Radiometric Remote Sensing (EE 826) -- Analysis of radiative transfer theory, including emission, scattering and absorption and its application in microwave remote sensing of the atmosphere and terrestrial surfaces. Operation and design of radiometer receivers and imaging considerations are discussed.

Radar Remote Sensing (EE 827) -- Description and analysis of radar systems used in remote sensing including scatterometers, real-aperture imaging radar and synthetic-aperture imaging radar. This course is designed to provide an overview of the fundamentals underlying radar systems, with particular emphasis on those relevant to remote sensing radars.

Advanced Microwave Remote Sensing (EE 828) -- The course consists of a survey of advanced techniques and systems used in microwave remote sensing, including altimeters, synthetic aperture radar processing techniques, and specialized scatterometers. Additionally, the course gives a state of the art review of microwave remote sensing applications in the fields of oceanography, meteorology, geology, hydrology and agriculture.

Scattering Theory (EE 829) -- Theoretical models for scattering and emission from natural surfaces and volumes are derived and compared to experimental measurements. Various approaches are considered including geometric optics, physical optics, perturbation method, and the radiative transfer technique.

Additional information about the remote sensing program in the Department of Electrical Engineering and the Remote Sensing Laboratory can be obtained from Dr. Fawwaz T. Ulaby, Remote Sensing Laboratory, Center for Research, Inc., University of Kansas, Lawrence, Kansas 66045; (913) 864-4832.

GEOLOGY

Remote sensing courses are offered through the Department of Geology's program in applied geology. The Department maintains a strong connection with the University's Remote Sensing Laboratory, where emphasis in research has been on an understanding of the interaction of microwave energy and the target and its effect on the recorded return signal. Utilization of radar imagery, aerial photography, and satellite imagery in solving geologic problems is encouraged in individual research.

Two courses are offered through the Department, both of which are co-taught by faculty of Geology and Electrical Engineering. These are designed to emphasize remote sensing applications for geologic studies.

Remote Sensing (Geol 756) -- Deals with the principles and applications of remote sensing in the ultraviolet, infrared and microwave regions of the electro-magnetic spectrum. Topics discussed include theoretical concepts of energy emission; techniques for the detection of this energy; detection devices commonly used; and utilization of remote sensors in geologic, agricultural, hydrologic, oceanographic, and meteorologic studies.

Radar Imaging (Geol 591) -- Provides an in-depth survey of system operations and aids in the development of an understanding of the influence of system and operational parameters on the return signal. Laboratory exercises (informal) are provided.

For more information about remote sensing studies in geology, contact Dr. Louis F. Dellwig, Remote Sensing Laboratory, Center for Research, Inc., University of Kansas, Lawrence, Kansas 66045; (913) 864-4832.

Contributors to this issue of the KARS Newsletter include Fawwaz T. Ulaby, Department of Electrical Engineering; Louis F. Dellwig, Department of Geology; T. H. Lee Williams, Department of Geography; and KARS staff Joseph Poracsky, Loyola Caron, and Jim Merchant. Loyola Caron also served as editor for this issue.

STAFF PARTICIPATE IN ANNUAL ACSM/ASP MEETING

KARS Program staff recently participated in the 1982 annual convention of the American Congress of Surveying and Mapping and the American Society of Photogrammetry. This meeting was held in Denver, Colorado during the week of March 15-19. Dr. T. H. Lee Williams chaired a session on Remote Sensing Contributions to Hydrologic Studies in the Great Plains and Mountain States. Also, the following papers were prepared and presented by KARS Program staff:

*McClain, T. J., J. Poracsky, C. Gunn, and R. McDowell. *Groundwater Withdrawal Estimation Utilizing Landsat Imagery*. Landsat MSS data were used to determine crop types and the extent of irrigation in the Walnut Creek watershed of western Kansas for the years 1973, 1976, and 1979. The data were geocoded and are being used in a digital groundwater model to estimate groundwater withdrawal in the study area.

Merchant, James W. *Spatial Modeling of the Conversion of Irrigated Lands to Other Land Uses in the Great Plains*. A geographic information system was employed to evaluate the disposition of irrigated lands in Finney County, Kansas to revert to non-irrigated land uses. The data base was also used to assess the environmental risk which might be associated with such land use change.

Martinko, E. A. and E. R. Kipp. *Landsat Image Date Selection for an Irrigated Lands Inventory over a Large Geographical Area Using General Crop Phenology and Irrigation Management Data*. This paper outlined two methodologies that were developed in a cooperative effort with NASA's Ames Research Center to select optimal Landsat dates for digitally classifying irrigated lands throughout the High Plains Regional Aquifer. For information on obtaining the summary and final reports regarding this project, contact Anne Kahle, KARS Program.

Williams, T. H. Lee. *An Integrated Inventory of Abandoned Coal Mine Lands in Kansas*. Seasonal high altitude infrared color aerial photography and a low altitude oblique aerial photo-survey were used in an inventory and hazard evaluation of abandoned coal mine sites in Kansas. A program of multi-film multi-scale medium format photography was also acquired over selected sites to evaluate remote sensing input to detailed site analysis and reclamation monitoring. The results will be available in a report to be completed in May.

* Thomas McClain and Ronald McDowell are, respectively, assistant scientist and graduate research assistant with the Groundwater Section of the Kansas Geological Survey, Lawrence, Kansas.

... TASK FORCE (Continued from page 1)

The Legislature has directed that "the task force shall exist until December 31, 1983, and shall report its progress, findings and recommendations to the governor and the legislature on or before December 31, 1982, and December 31, 1983."

The resolution was the primary topic of discussion by the Task Force at its fifth meeting held April 7, 1982 at the State Capitol in Topeka. Other issues addressed at the meeting included:

- Fee fund for the KARS Program -- As recommended by Governor John Carlin in his 1983 budget, a fee fund account is being established for the KARS Program. This fund will facilitate transfer of funds from user agencies to the KARS Program. Details regarding the operation of the account will be provided at the next Task Force meeting.
- Landsat-D status and data price increases -- Landsat-D, to be launched in July 1982, will have both a multispectral scanner and a thematic mapper. Characteristics of both sensors were discussed. NOAA will raise prices of Landsat data by about 2.5 times the present price on October 1, 1982 (see KARS Newsletter, January 1982). Agencies were encouraged to identify data needs and place orders prior to that date.
- Proposals for new projects -- The KARS Program has been discussing the initiation of a number of new projects dealing with tax appraisal, wildlife habitat inventory, noxious weed inventory and land use planning. All agencies were asked to provide, at the next Task Force meeting, a listing of potential projects which they wish to see accomplished during the next two years.
- ASCS 35 mm aerial photography -- The KARS Program will petition the USDA Agricultural Stabilization and Conservation Service (ASCS) on behalf of the Task Force, to archive its annual 35 mm aerial photography of Kansas counties at the KARS Program after the photography is no longer of use to ASCS offices. The KARS Program would then file and index the photography and make it available for use by Kansas agencies and local units of government.

The Task Force will meet again early in May. Task Force members will be notified when a date and location are set. All agencies were requested to have permanent representatives appointed (re: Resolution 1644) prior to the next meeting. The May meeting agenda will focus on finalization of the administrative structure of the Task Force, definition of specific tasks, methodologies and time schedules required to meet charges of Resolution 1644, and establishment of agency project priorities for 1982-1983.

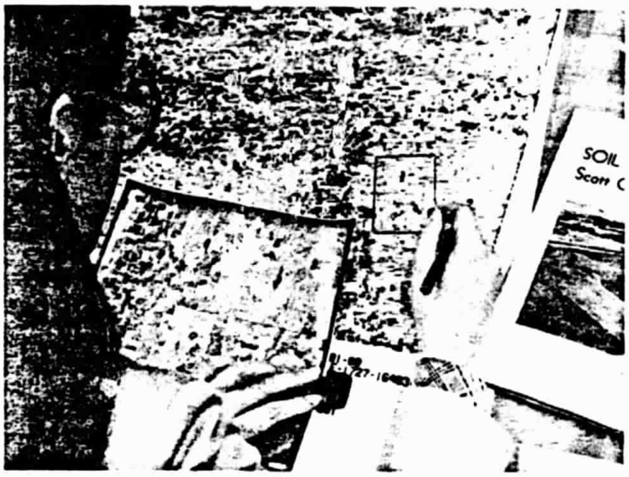
Additional details regarding the Kansas Interagency Task Force on Applied Remote Sensing can be obtained from either Edward Martinko or James Merchant, KARS Program.

FALLOW LANDS STUDY INITIATED BY KARS PROGRAM

The distribution and characteristics of fallow lands are of interest to both agribusiness and public agencies concerned with the agricultural community. The KARS Program has initiated a study to define techniques for mapping and monitoring fallow lands and associated crop rotations. The study is being carried out on two test sites located in western Kansas, and will encompass a five-year period of time.

The main objectives of the study are to evaluate the utility of Landsat multispectral scanner imagery for:

1) Detection and inventory of fallow lands and tracking of their changing aerial distribution over time;



The Scott County study area is outlined at the lower right hand corner of this Landsat print. The predominance of dryland farms contrasts sharply with irrigated parcels to the west.

2) Monitoring associated cropping patterns; and

3) Discriminating between differing farm practices relating to fallow lands. A primary goal will be to evaluate the use of Landsat data for discriminating minimum tillage parcels from conventionally tilled parcels. The project will also examine the feasibility of detecting fallow lands that have been chemically treated for weed control, vs. those that have not been treated.

Project areas selected for this study are located in Lane and Scott counties in western Kansas. The Lane County study area is representative of dryland farming where a wheat-sorghum-fallow cropping system predominates. Minimum tillage is known to be practiced by some farm operators in the area and records exist regarding the use of chemicals to control weeds on minimum tillage sites.

The Scott County study area typifies a dryland farming situation where the wheat-fallow cropping system predominates. It was selected as a companion site to the Lane County area because it has a rolling topography and a diversity of soils and land use. Excellent field data are available for both study areas.

Landsat MSS images acquired over a five-year period (1975-1980) will be visually interpreted. Image interpretation will be based upon the phenology of crops and other vegetative growth. At least three dates from each growing season will be interpreted. Ancillary data in the form of aerial photography and farm records will be used to guide and verify image analysis.

Results of the study should be available by September, 1982. For more information, contact Loyola Caron, KARS Program.

... DEPARTMENT OF GEOGRAPHY
(Continued from page 4)

Seminar in Remote Sensing of China (Geog 480) offers experience in regional analysis of an area using remote sensing, emphasizing Landsat.

Aerial Photography and Photogrammetry (Geog 527) teaches the practical aspects of aerial photography, mission planning, camera operation (nine-inch cartographic camera and medium format 70mm multi-camera cluster), basic photogrammetry and stereo plotting using a Kelsh Plotter.

The remote sensing program emphasis is on the application of remote sensing techniques within the geographic and environmental studies. It has achieved a high (and unusual) degree of integration with the various sub-disciplines. The recently renovated departmental facilities offer complete remote sensing teaching and research laboratories, a computer graphics laboratory, and teaching and research cartographic production laboratories. The Department also houses modern palynology, vegetation-dendrochronology, soils, geomorphology and meteorology laboratories. The China Maps and Imagery Repository in the Department provides an extensive and unique collection of maps and imagery for teaching and research. The KARS Program and the remote sensing program in geography together offer a complete range of basic and advanced image analysis and interpretation facilities for both basic and applied research instruction.

For more information, contact Dr. T. H. Lee Williams (913) 864-5143.

PUBLIC MEETINGS SCHEDULED FOR LANDSAT USERS

Present and prospective users of remote sensing products acquired by the Landsat satellites will be able to discuss their needs with Landsat managers at a series of public meetings to be held throughout the Nation during April, May and June 1982. The National Oceanic and Atmospheric Administration (NOAA) is holding the meetings to help it improve its plans for scheduling routine data acquisitions by the satellite.

The Multi-spectral Scanner (MSS) will be the operational sensor when NOAA first takes over the Landsat D system on January 31, 1983. It will take additional months to implement routine Thematic Mapper operations. NOAA is currently developing alternate MSS data acquisition schedules to find out which of them can be fitted to the engineering and cost constraints of the Landsat-D system.

System output will be capped at 136 processed MSS scenes per day for the first year or two of operation. Disaster and emergency events will have first call on this capacity; special acquisitions, for which requestors pay the full cost, come next. Remaining capacity will be used to collect the MSS Basic Data Set -- scenes of general interest acquired, to the extent possible, according to a published plan. The MSS Basic Data Set will be the routine scene collection objective of the operational system.

Tentative plans for scheduling of data acquisition will be announced at the public meetings. Participants will be invited to comment on data coverage and timeliness, and on the new prices to be charged for Landsat data beginning in October 1982. (Prices will increase about 2½ times the present fees. See KARS Newsletter January 1982).

Meeting dates are as follows:

- April 20: Washington, D.C. -- Department of Commerce Auditorium, 14th St. and Constitution Ave., N.W.
- April 30: Houston, TX -- William Marsh Rice University, Department of Space Physics and Astronomy, Sewall Hall, Room 301.
- May 4: New Orleans, LA -- NASA/MSFC Michoud Assembly Facility Auditorium.
- June 3: Boulder, CO -- National Bureau of Standards Auditorium, 325 Broadway, Radio Building.
- June 8: San Francisco, CA -- Presidio of San Francisco, Post Theater, Bldg. 99.

For more information about these meetings contact Roland D. Paine, NOAA Public Affairs, Rockville, MD 20852; telephone (301) 443-8243.

The Kansas Applied Remote Sensing Newsletter is published in January, April, July and October by the University of Kansas Applied Remote Sensing (KARS) Program. Publication of the KARS Newsletter is supported by NASA University Applications Program Grant No. 17-004-024. Contributions of research findings, announcements of meetings, publications and information pertinent to remote sensing applications in Kansas or the Midwest/Great Plains region are encouraged. Inquiries and contributions should be addressed to Editor, KARS Newsletter. All correspondence related to specific projects should be addressed to the person indicated.

Kansas Applied Remote Sensing Program
University of Kansas
Space Technology Center
2291 Irving Hill Drive
Lawrence, KS 66045

APPENDIX III
REPRESENTATIVE CONFERENCES, WORKSHOPS, SHORT COURSES AND BRIEFINGS

REPRESENTATIVE CONFERENCES, WORKSHOPS, SHORT COURSES AND BRIEFINGS

Governor's Conference and Space Technology Center Dedication - September 28-30, 1972 - University of Kansas, Lawrence, 200 attended.

Seminar on Agricultural Applications of Remote Sensing - December 7, 1972 - Hays, Kansas, 30 attended.

Governor's Conference on the Application of Space Technology to Resource Management and Environmental Quality - March 29, 1973 - University of Kansas, Lawrence, 200 attended.

Image Interpretation Workshop for State Agency Personnel - October 2-4, 1974 - Garden City, Kansas, 25 attended.

Short-Course on Remote Sensing/Aerial Photo Interpretation and Terrain Analysis - March 15-19, 1976 - Dr. Douglas Way, Instructor - University of Kansas, Lawrence, 35 attended.

Kansas Noxious Weed Workshop - March, 1977 - University of Kansas Space Technology Center, Lawrence, sponsored by the Kansas State Biological Survey and the Kansas State Board of Agriculture - Weed and Pesticide Division, 75 attended.

University of Kansas Continuing Education Program, Geography 598, Introduction to Remote Sensing Technology - October 28-29, 1977 - Garden City, Kansas, 13 attended.

A Symposium on Remote Sensing in Environmental Analysis and Planning in Kansas - 110th Annual Kansas Academy of Science Meeting - April 14, 1978 - University of Kansas, Lawrence, 50 attended.

Remote Sensing Workshop for the Kansas Adjutant General's Office of Emergency Preparedness Planning - July 31 - August 11, 1978, Topeka, Kansas, 7 attended.

Briefing for Kansas Legislators and Agency Personnel - January 16, 1980, Topeka, Kansas, 75 attended

Soil Conservation Society of America Field Trip to University of Kansas Applied Remote Sensing Program and KU Space Technology Center, October 29, 1980, University of Kansas, Lawrence, 90 attended.

University of Kansas Applied Remote Sensing Program - Remote Sensing Short Courses - Funded by NASA Contract Nos. NAS 12-131 and NAS 13-131:

Kansas City, Kansas, April 2, 1980
Salina, Kansas, April 9, 1980
Wichita, Kansas, April 10, 1980
Emporia, Kansas, April 14, 1980
Topeka, Kansas, April 16, 1980
Hays, Kansas, April 21, 1980

Colby, Kansas, April 22, 1980
Lawrence, Kansas, April 23, 1980
Garden City, Kansas, April 28, 1980
Manhattan, Kansas, April 28, 1980
Pittsburgh, Kansas, April 30, 1980
Kansas City, Kansas, March 31, 1981
Topeka, Kansas, April 2, 1981
Salina, Kansas, April 7, 1981
Pratt, Kansas, April 8, 1981

A total of 82 individuals participated in these short courses.

University of Kansas Applied Remote Sensing Program - Five-Day Short Course "Fundamentals of Applied Remote Sensing," Funded by NASA Contract Nos. NAS 12-131 and NAS 13-131:

August 11-15, 1980, University of Kansas, Lawrence, 18 attended
September 8-12, 1980, University of Kansas, Lawrence, 16 attended
June 1-5, 1981, University of Kansas, Lawrence, 15 attended
July 13-17, 1981, University of Kansas, Lawrence, 12 attended

Briefing for Kansas Legislators and State Agency Personnel (with National Conference of State Legislatures) - March 18, 1981, Topeka, Kansas, 80 attended.

Remote Sensing of Surface Mined Lands - presented twice during National Symposium on Surface Mining Hydrology, Sedimentology and Reclamation, Lexington, Kentucky, December 1982.

APPENDIX IV
REPRESENTATIVE KARS ACTIVITIES
APRIL 1982 - MARCH 1983

REPRESENTATIVE KARS ACTIVITIES
APRIL 1982 - MARCH 1983

- Attended and participated in meetings (e.g., Kansas Groundwater Managers' meetings) in order to maintain familiarity with Kansas problems, agencies and agencies' needs, and discuss new developments in KARS Program and Task Force

- Prepared project proposals, cost estimates

- Provided information and consulting regarding remote sensing applications, costs, imagery availability and coverage, acquisition

- Provided tours and briefings to agency visitors

- Provided briefings and training for agencies, educational institutions, Kansas Legislature, and others

April 1, 1982	James Merchant met with the Harvey County, Kansas planning director to discuss a possible project to create a micro-computer based GIS for the county. The data base would be used for county planning, tax reappraisal, soils suitability evaluations, and other applications.
April 2, 1982	Edward Martinko, James Merchant and Christopher Gunn met with officials of the Kansas Geological Survey to review their progress on constructing a digitized topographic mapping data base for Kansas. The ways in which the KARS Program might draw upon this data base were explained.
April 5, 1982	James Merchant attended a meeting at the U.S. Geological Survey in Lawrence, KS, at which representatives of Comsat General Corporation reviewed their work on the use of data-collection platforms for hydrologic analysis.
April 7, 1982	The Kansas Interagency Task Force on Applied Remote Sensing met at the State Capitol in Topeka. The passage of Senate Resolution 1644, which gives the Task Force a mandate to explore alternatives for maintaining the KARS Program, was discussed.
April 8, 1982	James Merchant, Joe Poracsky and Phillip Orlowski met at the Space Technology Center with Bill Brooner, Earth Satellite Corporation, to discuss the SPOT satellite and the potential applications of SPOT data by Kansas agencies.
April 23, 1982	Joseph Poracsky, Debora Sidor, Phillip Orlowski and Emily Roth presented a paper entitled "Finney County, Kansas Viewed by a Micro-Computer Based Geographic Information System" at the Annual Meeting of the Kansas Academy of Science in Manhattan. The paper described the demonstration geographic information system recently prepared for the Kansas Department of Revenue.
	Robert Yoos and Phillip Orlowski also presented a paper, entitled "Land Use/Land Cover Inventory, Kansas River Floodplain (Eudora to Kansas City)", at the meeting.
April 25-28, 1982	James Merchant presented a paper entitled "Spatial Complexity in Computer Classified Landsat MSS Data" at the annual meeting of the Association of American Geographers in San Antonio, Texas. He also met with the Landsat-D MSS basic data set.

April 27, 1982	Lee Williams met with the Ambassador of the People's Republic of China, faculty from the University of Nanking and other officials to discuss the University of Kansas China Maps and Imagery Collection, Landsat and the KARS Program. The discussion focused on remote sensing research on China.
May 14, 1982	Ed Martinko made a presentation entitled "Assessing and Monitoring Our State's Resources by Remote Sensing" to the 1982 Leadership Kansas Class sponsored by the Kansas Association of Commerce and Industry. The Leadership Class was composed of approximately 40 executives in Kansas business and industry.
May 14, 1982	The Kansas Interagency Task Force on Applied Remote Sensing met at the State Capitol in Topeka. The agenda included a discussion of proposed new projects, the administration of the Task Force under Senate Resolution 1644, and KARS funding.
May 18, 1982	Charles Killpack, President, IRIS International, Phoenix, Arizona, demonstrated the ERDAS image processing system for KARS staff. Possible implementation of ERDAS software on the KARS Digital Image Processing System was discussed.
June 7, 1982	Christopher Gunn made a presentation to the TriCounty Regional Planning Commission, Newton, Kansas, regarding a possible remote sensing/geographic information system project in Harvey County, Kansas.
June 7-11, 1982	James Merchant participated in an Advanced Digital Image Processing short course at the EROS Data Center, Sioux Falls, South Dakota.
June 14, 1982	James Merchant met with officials of Basin Electric Power Cooperative, Bismarck, North Dakota, to discuss potential contractual work and KARS-industrial cooperation via a National Center for Applied Remote Sensing.
June 15, 1982	James Merchant met with natural resource managers of the Bureau of Indian Affairs' Regional Center in Aberdeen, South Dakota, to discuss potential contractual work with the BIA in Kansas and other Western states.

June 21-25, 1982	Ed Martinko taught a class, "Remote Sensing: An Overview," for 40 senior citizens enrolled in the University of Kansas Elderhostel Program, conducted as part of the National Elderhostel Program at the Space Technology Center.
June 28, 1982	Elizabeth Kipp and James Merchant met with Kris Abrahamson, Topeka/Shawnee County Metropolitan Planning Commission, to discuss a possible project to develop a geographic information system for Shawnee County. Kipp also aided Abrahamson in acquiring copies of NASA imagery for the area which was on file in the KARS Program image collection. Abrahamson will use the imagery for presentation of the Commission's land management plan at a public hearing of July 9, 1982.
June 29, 1982	Elizabeth Kipp mailed 300 copies of the KARS brochure and several hundred copies each of the last four KARS Newsletters for distribution at the Landsat-D Educators' and Users' Conference, held July 8 and 9, 1982, in Santa Maria, California. It was anticipated that participation in the conference would include at least 300 persons. Any remaining literature will be distributed to remote sensing educators throughout twelve Western states for use as instructional material.
June 30, 1982	Edward Martinko and James Merchant travelled to Topeka to attend a presentation on USDA/AGRISTARS' program to derive land cover statistics for Kansas using their Landsat-based wheat acreage estimation procedures. The meeting was sponsored by the Kansas Crop and Livestock Reporting Service.
July 1, 1982	The Kansas Interagency Task Force on Applied Remote Sensing met at the State Capitol in Topeka. The agenda focused on KARS baseline funding and a proposed statewide land cover inventory.
July 6, 1982	Elizabeth Kipp met with Lawrence Langdon, Kansas Park and Resources Authority, to present and arrange to duplicate the ASCS aerial 35mm slides acquired by the KARS Program, which covered state park lakes and reservoirs. Langdon will use the slides for park planning and display purposes.
July 13, 1982	In response to a request from the Kansas Interagency Task Force on Applied Remote Sensing, Frank Mosier, Kansas State Executive Director, USDA Agricultural Stabilization and Conservation Service (ASCS), has

arranged for at least 60 of the 105 ASCS county offices to transfer obsolete aerial photography to the KARS Program. The photography, acquired to assist in compliance programs which the ASCS oversees, is obtained twice each year and is in the form of 35mm color slides at an approximate scale of 1" = 1 mile. To date, the KARS Program has received slides from 51 counties. Copies of the July issue of the KARS Newsletter will be sent to each of the 105 counties in the state in hopes that this will result in additional counties contributing their slides to the KARS Program.

July 14, 1982	Robert Yoos made an invited presentation on remote sensing in rangeland management to the quarterly meeting of the Flint Hills Resource Conservation and Development Project - a four-county planning area - held in Strong City, Kansas.
July 16, 1982	James Merchant met with Dan Bearth, Kansas Business News, who is doing a story on KARS' efforts to work with Kansas industry to use remote sensing/GIS technology.
July 28, 1982	James Merchant and Elizabeth Kipp met with Don Kostecki, Kansas Water Office, to discuss a possible project to inventory land use/land cover data for the Upper Neosho Watershed in Kansas.
August 6, 1982	James Merchant and Elizabeth Kipp met with Gary Toebben, Lawrence Chamber of Commerce, to present and arrange for acquisition of imagery covering the city of Lawrence. Toebben will use the imagery to aid in designating sites for new industries interested in building in the Lawrence area.
August 17, 1982	KARS staff met at the Space Technology Center with staff of the U.S. Geological Survey's Mid-Continent Mapping Center, Rolla, Missouri, to discuss mutual interests in digital data analysis, geographic data bases and computer graphics.
August 23, 1982	Christopher Gunn participated in the Statewide Soil Survey Work Planning Conference held in Salina, Kansas.
August 24, 1982	Edward Martinko spoke to the Kansas Business Executive Group on the KARS Program and KARS' interests in working with private industry.

August 25, 1982	James Merchant and Elizabeth Kipp met with representatives of the Kansas Geological Survey to discuss KGS interests in remote sensing applications in groundwater modelling and geographic information systems.
August 26, 1982	James Merchant and Christopher Gunn met with Dr. Orville Bidwell, Kansas State University, to discuss a KARS project to digitize soils and create a geographic information system for Harvey County, Kansas.
August 31, 1982	Edward Martinko and James Merchant met in Topeka with the Kansas Interagency Task Force on Applied Remote Sensing's Committee on Baseline Funding to discuss funding requirements for a statewide operational data base/remote sensing program.
September 3, 1982	Edward Martinko and James Merchant met in Topeka with representatives of the USDA Crop and Livestock Reporting Service, the Kansas Department of Administration - Division of the Budget, and the Director of the Kansas Fish and Game Commission to discuss the work of the Kansas Interagency Task Force on Applied Remote Sensing, the concept of a statewide program, new projects and KARS funding.
September 7, 1982	Christopher Gunn met with Robert Onstott, Research Associate for the University of Kansas Remote Sensing Lab (RSL). KARS will use its digitizing equipment to record the profile of the surfaces of various kinds of sea ice. The profiles are on photomosaics prepared by Onstott. RSL will use the data in its work with radar remote sensing of ice and snow.
September 8, 1982	James Merchant met in Salina, Kansas, with representatives of the USDA Soil Conservation Service to discuss new projects, KARS' work, and to negotiate an SCS supported grant to digitize the soils survey for Harvey County, Kansas.
September 10, 1982	The Kansas Interagency Task Force on Applied Remote Sensing met at the State Capitol in Topeka. The major item on the agenda was a report of the Committee on Baseline Funding regarding funding of a statewide operational data base/remote sensing program.
September 15, 1982	Larry Bright, Research Project Leader of the Oregon Department of Fish and Wildlife (Forest Grove, Oregon), met with KARS Program staff to discuss wildlife projects completed by the KARS Program, to tour KARS facilities and to discuss current Oregon

	wildlife projects that utilize remote sensing data.
September 21-24, 1982	Edward Martinko travelled to Monterey, California, to attend the final review of the California Irrigated Lands Assessment for Water Management, a joint research project of the University of California, NASA and the California Department of Water Resources.
September 22, 1982	Jim Merchant and Elizabeth Kipp met with Professor William Allen, Pittsburg State University, Pittsburg, Kansas, to discuss teaching materials for remote sensing education.
September 22 - October 1, 1982	James Merchant travelled to Colorado and Wyoming to make an invited presentation at a regional meeting of the Association of American Geographers and to meet with agency personnel in regard to KARS projects. Agencies visited included the U.S. Fish and Wildlife Service, U.S. Forest Service, USDA Science and Education Administration, U.S. Bureau of Land Management, National Park Service, Colorado Department of Natural Resources, Colorado Division of Wildlife, Wyoming Water Development Commission, Wyoming Game and Fish Department, Wyoming Department of Agriculture and U.S. Geological Survey.
September 26 - October 1, 1982	Edward Martinko travelled to Washington, D.C. to meet with NASA, USDA and other federal agency personnel with regard to KARS projects.
October 1, 1982	The KARS Program was awarded a $50,000 grant from NASA Ames Research Center to conduct a survey of natural resources data bases in the fifty states. This work has been undertaken in cooperation with the USDA Soil Conservation Service.
October 1, 1982	The KARS Program was awarded a $15,000 contract from the USDA Soil Conservation Service, Salina, to digitize the soils data for Harvey County, Kansas. The work has been undertaken on a cooperative basis with Kansas agencies to develop a geographic information system for Harvey County planners.
October 5, 1982	James Merchant spoke to a group of representatives of the Kansas Association of Realtors about remote sensing and the KARS Program.
October 8, 1982	Elizabeth Kipp attended a seminar entitled "Computer Water Stored Data" held by the U.S. Geological Survey, Lawrence, KS.

October 14-15, 1982	KARS staff participated in a USGS/ASP regional symposium and workshop on remote sensing, GIS and map applications in resources management held in Rolla, Missouri. KARS staff presented two poster papers, and James Merchant presented an invited plenary paper entitled "Applications of Aerial Photography in Contemporary Natural Resources Management."
October 26, 1982	The Kansas Interagency Task Force on Applied Remote Sensing met at the State Capitol in Topeka. The major item on the agenda was the first interim report of the Task Force covering the period July-December 1982.
November 2, 1982	KARS staff met at the Space Technology Center with Professor Mikael Stern, University of Lund, Sweden, to discuss mutual research interests in desertification and range research.
November 9, 1982	James Merchant spoke to the Harvey County Planning Commission in Newton, Kansas, regarding the construction of an integrated geographic information system for Harvey County.
November 10, 1982	Edward Martinko, James Merchant and Loyola Caron met with representatives of the Governor's Office and the Kansas Division of Budget at the State Capitol in Topeka to discuss state funding for KARS application activities in FY84.
November 16-18, 1982	George Bluhm, USDA Soil Conservation Service and Sherman Rosen, Natural Resource Planning, visited Ed Martinko, Loyola Caron and others at the KARS Program to discuss the NASA contract to inventory state natural resources data bases. KARS' work on geographic information systems, rangeland management and technology transfer was also reviewed and future work was discussed.
November 18, 1982	James Merchant spoke to a remote sensing class from Kansas State University visiting the Space Technology Center.
November 19, 1982	Edward Martinko visited the Oklahoma State University Remote Sensing Program and spoke with OSU officials about the administration of the KARS Program at the University of Kansas and state funding of the KARS Program. He also gave a seminar to the OSU Geography Department on the results of KARS' research efforts on pronghorn antelope.

November 30, 1982	The Kansas Interagency Task Force on Applied Remote Sensing met at the State Capitol in Topeka. Final action was taken on the 1982 Interim Report to the Governor and Legislature. Three committees were established to examine, respectively, establishment of a state information center, KARS' agency support, and a state applied remote sensing conference for Fall 1983.
December 1, 1982	Bill Barr, Edward Martinko and James Merchant met with officials of the Mobay Chemical Company to discuss cooperative work and the proposal submitted to NASA for the establishment of the National Center for Applied Remote Sensing. Mobay requested a preproposal to investigate agricultural issues.
December 10, 1982	The KARS Program received a computer compatible tape of the first high quality Landsat-4 Thematic Mapper scene acquired over Kansas. KARS will be using the scene extensively throughout 1983.
December 21, 1982	Edward Martinko and James Merchant met with Bob Wootton, Governor's Office, and Doris Nagel, Kansas Division of Budget, at the State Capitol in Topeka. Wootton emphasized the Governor's support for the KARS Program. Funding possibilities for FY 1984 and the work of the Kansas Interagency Task Force on Applied Remote Sensing were discussed.
December 22, 1982	Edward Martinko and James Merchant participated in production of a videotape on KARS research and applications programs. The videotape will be used by the University of Kansas to recognize and promote selected high visibility research activities.
January 6, 1983	James Merchant attended the bimonthly meeting of the Kansas Groundwater Managers' Association and Kansas water agencies in Topeka. He reported on KARS' water-related research, Landsat-4 and the work of the Kansas Interagency Task Force on Applied Remote Sensing.
January 12, 1983	Loyola Caron, Debora Sidor and Robert Yoos attended a four-state conference on soil conservation in Maryville, Missouri - "Men-Women-the Land: Mid-America's Future." The four-state region includes Iowa, Kansas, Missouri and Nebraska. The conference covered conservation tillage systems, the effects of soil erosion on yields, economics of land treatment, and forage systems.

January 14, 1983	James Merchant and Christopher Gunn met with Bill Roth, USDA Soil Conservation Service - Salina, Kansas, to review progress on KARS' project to construct a digital geographic data base for Harvey County, Kansas. SCS is funding the digitization of soils data and related research.
January 18, 1983	Edward Martinko and James Merchant briefed Kansas Senator Fred Kerr, Representative Ron Fox and Representative Mike Meacham on the activities of the KARS Program and the Kansas Interagency Task Force on Applied Remote Sensing in preparation for 1983 Legislative deliberations.
January 20, 1983	Edward Martinko made a presentation entitled "High Technology and Water Issues in Kansas: The Role of Remote Sensing" at the 32nd Annual Meeting of the State Association of Kansas Watersheds in Topeka, Kansas.
January 21, 1983	Edward Martinko and Bill Barr toured facilities of the Mobay Chemical Company and discussed funding for remote sensing research. KARS has been invited to submit two research proposals.
January 26, 1983	James Merchant made a presentation on KARS research and applications activities for scientists from the People's Republic of China and their American hosts, who were touring University of Kansas remote sensing facilities. The scientists included Professor Yang Sheren, Deputy Manager, Institute of Remote Sensing, Academy of Sciences, People's Republic of China; Associate Professor Li Li, Chief, Laboratory of Digital Image Processing; Zhu Chong Guang, Institute of Remote Sensing, Academy of Sciences, People's Republic of China; Shen Zuixun, Institute of Remote Sensing, Academy of Sciences, People's Republic of China; Dr. Janet Bare, President, Satlab, Inc.; Mr. Jeff Alholm, Supervisor, ISI Inc.
January 27, 1983	The Kansas Interagency Task Force on Applied Remote Sensing Committee on Alternative Institutionalization Mechanisms met in Pratt, Kansas.
January 28, 1983	James Merchant met in Lawrence, Kansas, with the Kansas Interagency Task Force on Applied Remote Sensing committee which is planning a statewide conference on remote sensing and spatial data analysis for Fall 1983.

January 31, 1983	Edward Martinko briefed the Kansas House of Representatives' Committee on Computers, Communications, and Technology on the work of the Kansas Interagency Task Force on Applied Remote Sensing and the KARS Program. The Committee toured the Space Technology Center and KARS facilities.
February 8, 1983	Edward Martinko, James Merchant and Christopher Gunn met at the Space Technology Center with representatives of LogE/Interpretation Systems, Inc. to discuss cooperative research and development projects and ISI involvement in the proposed National Center for Applied Remote Sensing.
February 9, 1983	The Kansas Interagency Task Force on Applied Remote Sensing Committee on Baseline Funding met in Topeka, Kansas.
February 17, 1983	James Merchant attended the February meeting of the Kansas Groundwater Managers' Association in Topeka.
February 18-19, 1983	Robert Yoos participated in the Conference on Challenges to Local Governments: Economics and the Use of Land, sponsored by SCSA, the Kansas Chapter of the American Planning Association, and the Kansas Association of County Planning and Zoning Officials, held in Manhattan, Kansas. The conference focused on the Agricultural Land Evaluation and Site Assessment (LESA) system developed by the USDA/SCS and water issues in the Midwest.
February 21, 1983	James Merchant attended a meeting of the Kansas Interagency Task Force on Applied Remote Sensing Committee on Institutional Alternatives. The meeting was held in Topeka, Kansas.
February 25, 1983	Harland Priddle, Secretary of the Kansas State Board of Agriculture, and M. E. Johnson, Director of the Kansas Crop and Livestock Reporting Service, visited the KARS Program to tour KARS facilities and discuss future cooperative work.
February 28, 1983	The Kansas Interagency Task Force on Applied Remote Sensing met at the State Capitol in Topeka. Reports were presented from three committees dealing with, respectively, establishment of a state information center, KARS' agency support, and a state applied remote sensing conference to be held in Fall 1983.

March 2, 1983	James Merchant met with representatives of the U.S. Geological Survey to discuss a joint project to model water use in the High Plains. Landsat would be used to map irrigated crops.
March 3, 1983	James Merchant hosted a class of graduate students in Landscape Architecture from Kansas State University. He presented a talk on remote sensing and geographic information system applications.
March 4, 1983	James Merchant and Christopher Gunn met with representatives of the U.S. Geological Survey at the Space Technology Center to demonstrate KARS' digital image processing and geographic data analysis capabilities. They discussed using such techniques in a multiyear study of water use in the High Plains.
March 4, 1983	Robert Yoos attended the Kansas Academy of Science annual meeting at Benedictine College in Atchison, Kansas. He presented a paper entitled "Identifying and Monitoring Crop Rotations and Associated Fallow Lands Using Landsat MSS Imagery."
March 8-10, 1983	James Merchant attended the annual statewide meeting of USDA Soil Conservation Service (SCS) soils scientists in Salina, Kansas. He spoke on current KARS-SCS projects and on applications of geographic information systems.
March 16, 1983	KARS staff met with several members of the Geoprocessing Committee for Overland Park, Kansas. This committee is comprised of representatives of the City Planning Department, Public Utilities, Data Processing, and the Police Department. They visited the KARS Program to discuss potential applications of geoprocessing for the City of Overland Park, and to tour the computer facilities.
March 18, 1983	Edward Martinko and James Merchant met with Freeman Biery, Director, Weed and Pesticide Division, Kansas State Board of Agriculture, to discuss the work of the Kansas Interagency Task Force on Applied Remote Sensing and remote sensing applications in weed and pest management.
March 20-22, 1983	Two poster papers were presented by Loyola Caron, Robert Yoos and Lee Williams at the 48th North American Wildlife and Natural Resources Conference, Kansas City, Missouri. These are: "A Strategy for Inventorying Fallow Lands and Associated Crop Sequences

Using Landsat MSS Imagery" and "The Agricultural Land Evaluation and Site Assessment (LESA) System: An Automated Approach."

March 21, 1983	The Kansas Interagency Task Force on Applied Remote Sensing met in Topeka, Kansas. The agenda included a discussion of the Thematic Mapper and a review of Task Force Committee work.
March 25, 1983	James Merchant, Loyola Caron and Christopher Gunn met at the Space Technology Center with George Cole, USDA Wind Erosion Lab, Manhattan, Kansas, to discuss digitizing/geographic information system applications in wind erosion modelling.
April 1, 1983	James Merchant met at the Space Technology Center with personnel of the Kansas Water Office to discuss the use of remote sensing to evaluate change in urban areas and resulting water demand.
April 7, 1983	Edward Martinko and James Merchant met with personnel of the Kansas Water Office, Kansas Department of Revenue and Kansas State Board of Agriculture to discuss final recommendations of the Kansas Interagency Task Force on Applied Remote Sensing.
April 8, 1983	James Merchant, Loyola Caron and Christopher Gunn met in Manhattan, Kansas, with staff of the USDA Wind Erosion Laboratory to discuss cooperative applied research involving the use of geographic information systems in wind erosion modelling.
April 12, 1983	James Merchant and Christopher Gunn met with representatives of the USDA Soil Conservation Service and the Topeka-Shawnee County Metropolitan Planning Commission to discuss the construction of an integrated digital data base for Shawnee County.
April 14, 1983	James Merchant and Christopher Gunn met with representatives of the U.S. Geological Survey National Water Use Program and the U.S.G.S. Kansas State Office to discuss a project to identify irrigated lands and crop types using Landsat data and to construct a geographic information system for water use modelling.

APPENDIX V
HIGHLIGHTS OF THE INTERIM REPORT OF THE
KANSAS INTERAGENCY TASK FORCE ON APPLIED REMOTE SENSING

HIGHLIGHTS OF THE INTERIM REPORT OF THE KANSAS INTERAGENCY TASK FORCE ON APPLIED REMOTE SENSING

In 1982, the Kansas Legislature endorsed Resolution 1644, which formally recognized the Kansas Interagency Task Force on Applied Remote Sensing. The Task Force was directed to evaluate the ways in which the Kansas Applied Remote Sensing (KARS) Program can be most efficiently and effectively maintained, so that remote sensing and geographic information systems technologies are available on a statewide basis. This article summarizes the progress of the Task Force during its first year, as detailed in its Interim Report: A Program to Enhance the Utility of Remote Sensing and Related Technologies Within the Framework of a Kansas Resources Information Center.

I. INTRODUCTION/BACKGROUND

The Governor and the Kansas Department of Economic Development have recently cited high technology industrial development as one of the most important means by which the economy of Kansas can be significantly strengthened. The State of Kansas already has considerable resources which could be mobilized to foster such development. Space technology represents one area of high technology in which the State is recognized for its research and development efforts.

The Kansas Applied Remote Sensing (KARS) Program, established more than 10 years ago in the University of Kansas' Space Technology Center, has played an active role in promoting the use of advanced technologies to assist state agencies and others in effectively planning and managing Kansas' agricultural, environmental and natural resources. Remote sensing is the science of acquiring information about the earth with instruments such as cameras, scanners, and radars mounted aboard aircraft and satellites. Remote sensing is increasingly being used to inventory, evaluate, and monitor the extent and condition of the earth's land and resources.

Projects undertaken by the KARS Program have involved land use/land cover inventory, monitoring land use change, wildlife habitat evaluation, mapping of irrigated lands, surface mined lands inventory, recreational area planning, soil conservation needs assessment, aquatic vegetation mapping, rangeland condition evaluation, urban area analysis, and education and training.

The Kansas Interagency Task Force on Applied Remote Sensing was initiated on an *ad hoc* basis in May 1981. Its primary objective was to work with the KARS Program to assess alternatives for greater and more operational utilization of remote sensing/geographic information systems (GIS) technology on a statewide basis.

A major accomplishment of the Task Force was completion of an assessment of Kansas' state agency data needs which might be better met through the application of remote sensing/geographic information systems technology. The Task Force acknowledged that *agencies often have common requirements for similar data*, and that *it would therefore be advantageous to coordinate data collection efforts.*

In 1982, the Kansas Legislature endorsed a resolution which formally recognized the Task Force. This document reports the findings of the Kansas Interagency Task Force on Applied Remote Sensing during its first year of formal operation.

II. THE KANSAS APPLIED REMOTE SENSING (KARS) PROGRAM

The University of Kansas Applied Remote Sensing Program was established by the National Aeronautics and Space Administration (NASA) in 1972, to conduct applied research on techniques which will enable public agencies and private industry to better utilize available satellite and airborne remote sensing systems. The KARS Program provides a full range of remote sensing, mapping, geographic information analysis, and related services. Its mission is to facilitate the tasks of other state agencies, not to replace any part of their operations. Products and services provided by the Program assist the resources planner or manager by supplying more comprehensive, less costly, more accurate and/or completely new information which had previously not been available.

During the 10-year period 1972-1982 NASA funds granted to the State of Kansas through the KARS Program have totalled approximately $1,340,000. These funds have supported a program which has provided the opportunity for Kansas agencies, via over 40 cooperative (usually free) demonstration projects, to test, evaluate and adapt remote sensing technology for meeting their data needs.

Beginning in FY83, NASA will begin to adjust its priorities to better reflect current national research requirements. This will mean that user support activities will no longer be funded.

In order to provide the State of Kansas with the opportunity to maintain a viable applied remote sensing program, NASA will not abruptly terminate demonstration and service funding, but will gradually phase down funding for these activities over a three-year period.

III. KANSAS INTERAGENCY TASK FORCE ON APPLIED REMOTE SENSING

Formal establishment of the Kansas Interagency Task Force on Applied Remote Sensing in the spring of 1982 was accompanied by funds appropriated to the KARS Program to work more operationally with Kansas agencies, and a fee fund established to facilitate such work. Senate Concurrent Resolution 1644 states, in part, "That it is in the interest of the people of the state that a task force on applied remote sensing be created to evaluate the ways the Kansas Applied Remote Sensing Program can be most efficiently and effectively maintained . . ."

A fee fund was established to facilitate the transfer of funds by state agencies to the KARS Program. Fees paid by users of KARS' services (federal, local and private, as well as state) will provide long-term support for the KARS Program.

The Task Force believes, however, that "baseline funding" from the General Revenue is required to enable long-term planning, provide continuity in KARS staff and programs and to support many products and services which are non-project related and, thus, cannot be charged to a single user agency. Baseline funding would provide:

1. Retention of a skilled, experienced core staff

2. Maintenance of KARS equipment, library, software

3. Staff support for the Task Force

4. Communications (e.g., Task Force mailings, telephone, KARS Newsletter)

5. Consulting and information services for Kansas agencies

6. Assistance in project development, design and proposal preparation

7. Training and short courses, briefings and presentations for public agencies and professional groups and the Task Force

8. Travel in support of above services

9. Support of individual projects of statewide interest dependent on level of baseline funding.

User fees will be charged for products and services needed by individual agencies. It is important to note that non-state (i.e., federal, private) users will also be providing fees that would assist in maintaining and enhancing KARS services.

IV. INTERIM FUNDING RECOMMENDATION

Members of the Kansas Interagency Task Force on Applied Remote Sensing unanimously supported a recommendation to the Legislature that funding be appropriated for the KARS Program for FY84. Such funding would enable the KARS Program to continue its activities during FY84 and allow the Task Force to complete its review of various long-range options to maintain the Program.

V. A KANSAS RESOURCES INFORMATION CENTER - OPTION A

One option being considered by the Task Force is a five-year program to develop a Kansas Resources Information Center. This concept has been designated Option A, and provides for establishment and maintenance of a statewide information clearinghouse, for use by all state agencies; implementation of remote sensing/GIS technologies; training and short courses; state-federal liaison; and other tasks. This center would retain and expand all of the current capabilities of the KARS Program. In addition, it would be charged with inventorying, cataloging and coordinating data about Kansas maintained by state, local and regional agencies, federal agencies, some private firms and institutions of higher education.

The proposed system would provide services and capabilities such as:

- Clearinghouse and referral services
- Federal-state coordination
- Spatial data analysis
- Spatial data base development for state users
- Statistical analyses, simulation and forecasting
- Remote sensing data/imagery interpretation
- Training, briefings, and short courses
- Development and/or implementation of new technologies

While the resources information center would be comprehensive, its information base would not necessarily be centralized. Each state agency would continue to maintain its data, unless they specifically arranged for the data to be managed by the center.

Such a center would (1) provide a mechanism to coordinate ongoing and planned data collection and analysis efforts; (2) make existing information more accessible, and identify gaps in current knowledge; (3) result in savings in time and costs in gathering information; (4) provide the State of Kansas a unique status in the eyes of federal data-producing agencies, making the state an attractive place for pilot projects on new methods of federal data collection and dissemination; and (5) make available new technologies in spatial modelling, remote sensing and other areas where advances are rapidly taking place. The resources information center could facilitate enormous tasks such as a statewide reappraisal, water resources planning, soil erosion assessment, and prime agricultural land use change.

VI. TASKS YET TO BE UNDERTAKEN

Chief among the tasks remaining to be addressed by the Kansas Interagency Task Force on Applied Remote Sensing is to continue the process of identifying and evaluating additional options for institutionalizing, establishing and operating the KARS Program to serve the needs of the State of Kansas.

APPENDIX VI

AGENCY LETTERS OF SUPPORT

United States Senate

COMMITTEE ON COMMERCE, SCIENCE,
AND TRANSPORTATION
WASHINGTON, D.C. 20510

June 10, 1982

Mr. Edward A. Martinko
The University of Kansas
Space Technology Center
Raymond Nichols Hall
2291 Irving Hill Drive -
Campus West
Lawrence, Kansas 66045

Dear Mr. Martinko:

I appreciate your correspondence regarding continuation of applied remote sensing programs.

I am well aware of the active involvements of Kansas University in the development and application of remote sensing technology the last few years. I am also aware of the recent support of the state legislature for these programs. As you know, the Administration is interested in modifying the federal role in these matters and believes that some functions should be transferred to institutions such as the National Oceanic and Atmospheric Administration. Although this has occurred in part, a number of questions remain about long-term commitments and long-term data continuity.

I do not expect final action on legislation this year to finally resolve the matter, but Congress is investigating the matter. The Commerce, Science, and Transportation Committee, on which I serve, held joint hearings this spring with the House Science and Technology Committee. The importance of this program to Kansas is well documented. I appreciate your concerns and welcome your continued advice as we determine how to best accommodate these needs within the federal budget.

Warmest regards,

Nancy

Nancy Landon Kassebaum
United States Senator

STATE OF KANSAS

JANE M. ELDREDGE
SENATOR, SECOND DISTRICT—DOUGLAS COUNTY
839½ MASSACHUSETTS STREET
LAWRENCE, KANSAS 66044

COMMITTEE ASSIGNMENTS

CHAIRMAN: JOINT COMMITTEE ON SPECIAL CLAIMS
VICE CHAIRMAN: JUDICIARY
MEMBER: ASSESSMENT AND TAXATION
GOVERNMENTAL ORGANIZATION
LABOR AND INDUSTRY
LOCAL GOVERNMENT

TOPEKA

SENATE CHAMBER

February 22, 1982

Mr. Edward A. Mart[illegible]
Associate Director
The University of Kansas Space Technology Center
Raymond Nichols Hall
2291 Irving Hill Drive--Campus West
Lawrence, Ks 66045

Dear Ed:

Thank you for your letter of February 15, 1982. I am pleased and delighted to have such a remarkable program within my district. I appreciate the time and effort you have expended in educating me.

Please don't hesitate to contact me at any time if I may be of service to you. I will watch the progress of the resolution to make sure we have no problems.

Sincerely,

Jane M. Eldredge

Jane M. Eldredge
Senator--Second Dist.

JME/cw

STATEMENT
to
SENATE COMMITTEE ON ENERGY AND NATURAL RESOURCES
WITH RESPECT TO
SENATE CONCURRENT RESOLUTION 1644

by

Allyn O. Lockner, Director
Kansas Water Office
February 10, 1982

The Kansas Water Office wishes to take this opportunity to go on record in support of Senate Concurrent Resolution 1644. This Resolution would formally establish a Task Force on Applied Remote Sensing which has existed on an ad hoc basis since May 1981. The Kansas Water Office is on record in support of the Task Force approach to clarify state agency data and information needs that might be addressed through the use of remote sensing technology, in particular data available through the LANDSAT Satellite. The efforts of the ad hoc task force to date have demonstrated that there is considerable commonality of data and information needs among several state agencies. The directive to state agencies embodied in Senate Concurrent Resolution 1644 would give needed resolve to efforts by the agencies most likely to benefit to make more routine and operational use of data and information derived from remote sensing technology. It would, as it were, bring agency data management efforts into the space age.

A Task Force on the Kansas Applied Remote Sensing Program embodied in Senate Concurrent Resolution 1644, would further highlight the good fortune of the State of Kansas to have within the state a group of highly competent and dedicated individuals constituting the Kansas Applied

Remote Sensing Program housed in the Space Technology Center at the University of Kansas. Finding a feasible and acceptable way to maintain this capability and expertise within the state is certainly a worthy effort. To charge the agencies most likely to benefit from such expertise and information with the task of finding and evaluating ways to effectively and efficiently maintain the Kansas Applied Remote Sensing Program is a task heartily endorsed by the Kansas Water Office. We will do everything we can to contribute to the meeting of this challenge. To this end we would urge the passage of Senate Concurrent Resolution 1644.

THE STATE OF KANSAS

KANSAS WATER OFFICE

Suite 303
503 Kansas Avenue
Telephone (913) 296-3185
TOPEKA, KANSAS 66603

August 11, 1981

Dr. Ed Martinko, Associate Director
Kansas Applied Remote Sensing Program
Space Technology Center
University of Kansas
2291 Irving Hill Drive
Lawrence, Kansas 66045

Dear Dr. Martinko:

The commonality of state agency data needs which can be supplied through the use of remote sensing technology is evident from the results of the survey just completed by your staff and the interagency task force on applied remote sensing. The convening of a task force to explore the feasibility and desirability of establishing an operational program to provide several types of basic data through a remote sensing/geo-based information system was an excellent idea, and it has been both rewarding and enlightening. The Kansas Water Office supports the interagency task force approach to priortizing the types of data that might be routinely supplied to user agencies in the state. However, the task force will be of little consequence without the establishment of a minimum level of program activity involving qualified staff such as is now available within the Kansas Applied Remote Sensing (KARS) Program.

The demonstration projects which have thus far been supported by federal funding through the National Aeronautics and Space Administration have served to enlighten state agencies as to the utility of remote sensing in meeting agency goals and objectives. However, the NASA funding was limited to projects of a demonstration nature. An operational program to provide remote sensing data and geographical information on a routine basis is beyond the scope of that program. It is highly desirable that the state retain the expertise developed through the KARS program and utilize it to the fullest extent by establishing an adequately staffed facility supported with state funds to provide remote sensing data to user agencies on an operational basis. This concept is also heartily endorsed by the Kansas Water Office.

Sincerely,

Francine Neubauer

Francine Neubauer
Director (Acting)

FN:th

THE STATE OF KANSAS

KANSAS WATER OFFICE

Suite 303
503 Kansas Avenue
Telephone (913) 296-3185
TOPEKA, KANSAS 66603

August 6, 1981

Mrs. Elizabeth Kipp
Kansas Applied Remote Sensing Program
Space Technology Center
University of Kansas
2291 Irving Hill Drive
Campus West
Lawrence, Kansas 66045

Dear Mrs. Kipp:

Enclosed you will find a copy of the list of state agency data requirements which you compiled following the second meeting of the Interagency Task Force on Remote Sensing. The data and information requirements of the Kansas Water Office which might be supplied through remote sensing technology have been prioritized according to the categories defined in your letter of July 20, 1981. I would note that a priority has been assigned to several additional entries on the list than was the case prior to the task force meeting on July 9, 1981.

As an indication of the worth of data and information given a priority 1 on the enclosed data requirements listing, we have estimated annual expenses on the order of $4,260 for collection of these data by conventional means (Two person-months of technician time plus one month professional staff time). Admittedly, this office requires other data which may or may not be obtainable through remote sensing, and which represent expenditures considerably in excess of this amount. The dollar figure given above is a starting point from which to assess the economies of resorting to a remote sensing/geobased information system as the source of these particular types of data. The Kansas Water Office eagerly looks forward to working with you and others in the KARS Program and trust that the wisdom of initiating a state funded program for the routine handling and dissemination of remote sensing data to state agencies will become abundantly clear in the weeks and months ahead.

Sincerely,

Donald F. Kostecki

Donald F. Kostecki
Senior Meteorologist

DFK:cg

Enclosure

KANSAS STATE BOARD OF AGRICULTURE

TOPEKA, KANSAS 66612

Harland Priddle
XWX XWXBWXWXW
Secretary

901 Kansas Avenue
913-296-3556

February 5, 1982

Dr. B. G. Barr, Director
University of Kansas Space Technology Center
Raymond Nichols Hall
2291 Irving Hill Dr., Campus West
Lawrence, Kansas 66045

Dear Dr. Barr:

First, I wish to express interest in meeting you and your staff. Please consider this an invitation to you and your staff to stop by when your work brings you to Topeka.

Second, I have received a briefing from my staff, who have been working with you, namely Mr. Johnson, Director of our Statistical Division; Dean Garwood, Director, Entomology Division; David Pope, Assistant Chief Engineer, Water Resources Division; and Freeman Biery, Director, Weed and Pesticide Division.

I was impressed with the amount of cooperative programs between our agencies. During my military tour I had the privilege of learning about the Federal remote sensing and other space programs.

The Board of Agriculture with its varied programs is very interested in continuing to work with your agency to develop on-going projects using information available through the KARS program.

We are pleased to be included in the Senate Concurrent Resolution No. 1644, to serve as a part of the state task force to work on remote sensing matters. We will have a designated person to participate in the work of the task force.

I feel the State is fortunate to have the Kansas Applied Remote Sensing Program which you and your staff have created.

Sincerely,

Harland E. Priddle

Harland E. Priddle
Secretary

HEP:tl

KANSAS STATE BOARD OF AGRICULTURE

ENTOMOLOGY DIVISION
H. DEAN GARWOOD, *Director*
901 Kansas Avenue
Topeka, Kansas 66612
913-296-3016

W. W. DUITSMAN
Secretary

August 11, 1981

Dr. Edward A. Martinko
Associate Director
Nichols Hall
2291 Irving Dr., Campus West
University of Kansas
Lawrence, KS 66045

Dear Dr. Martinko:

This letter is to inform you of the benefits that the Entomology Division could realize by the use of information supplied by the Kansas Applied Remote Sensing Program and to support your request for state funding.

Remote sensing data would be helpful to the Entomology Division in administering the Kansas Plant Pest Act (K.S.A. 2-2112 through 2-2128) and the Kansas Pesticide Law (K.S.A. 2-2438a through 2-2467a).

The Kansas Plant Pest Act was adopted to (1) provide protection for agricultural crops and other plants in the state from insect pests and plant diseases not currently found in the state, (2) provide survey information needed to intelligently deal with insect pests and plant diseases found in the state, and (3) provide inspection services required by other states and foreign countries before Kansas products can be shipped into those areas. The act authorizes the Kansas State Board of Agriculture to carry out measures to locate, eradicate, or suppress serious plant pests in Kansas. In addition, the act also provides for adoption for interstate and intrastate quarantines when the Board feels such steps are necessary to protect the state from unwanted pests.

The Kansas Pesticide Law requires licensing of pest control businesses and certification of persons who apply restricted use pesticides.

The business license provisions provide protection to the public from unscrupulous or uninformed exterminators and applicators who are selling services which they are either unwilling or unable to provide and to insure that pesticides are used safely and effectively by exterminators and other applicators.

The certification provisions are designed to afford environmental protection. To receive certification, a person must show a basic knowledge of pests, and proper use, handling, application, storage, and disposal of pesticides and pesticide containers.

The types of remote sensing data needed by the Entomology Division are listed below along with an explanation of how the data would be used and the benefits obtained.

1. LAND USE. This information would assist in planning surveys for various insects and plant diseases. More efficient use of travel dollars could be realized by concentrating surveys in areas of intensive crop production. Land use maps would also identify smaller areas of crop production not readily visible from the ground.

2. IDENTIFICATION AND CLASSIFICATION OF IRRIGATED LAND. This information would also assist in insect and plant disease survey planning and execution. This data would also allow for statistically sound survey planning.

3. CROP IDENTIFICATION. The Entomology Division conducts special insect and plant disease surveys on specific crops. Knowing exactly where these crops are could save considerable time and travel as well as provide more effective survey planning. This data could also be used to forecast insect and plant disease activity in certain areas of the state.

4. CROP AND RANGELAND CONTION MONITORING. This information would be extremely valuable in the early detection of possible outbreaks of an insect pest or plant disease. If early detection is acheived, the dollars saved in terms of reducing crop or rangeland loss by early control and/or eradication would be considerable. It is essential that the early detection of pests such as gypsy moth, soybean cyst nematode, and grasshoppers be realized as serious damage results when populations of these pests increase. Populations of these pests have to be fairly high to be detected by ordinary methods which makes control both more expensive and difficult. Early detection not only saves time and money spent on control, but also reduces losses from the pest. Early detection is not only important in finding pests new to Kansas, but also in monitoring insects and plant diseases that already exist in the state. By early detection of insect and plant disease activity, growers can be advised of the situation and early and more effective control measures can be taken resulting in better control and more efficient pesticide use.

The types of data described in 1-4 above will also aid the Entomology Division in conducting its phytosanitary certification work. Each state in the United States and all foreign countries have certain requirements concerning pest occurrance that must be met before plants or plant products will be allowed into the state or country. It is the responsibility of the Entomology Division to insure these requirements can be met, thus assuring the optimum marketability of Kansas products in the United States and around the world.

5. PESTICIDE DRIFT. This information would be of use in the investigation of pesticide misuse complaints as provided for in the Kansas Pesticide Law. More accurate damage assessments would be possible using this type of data.

6. ENDANGERED SPECIES HABITAT. For the past two years, Kansas has been granted a special emergency exemption by the Environmental Protection

Agency to use non-registered pesticides under Section 18 of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). Under this provision, special precautions must be outlined in the exemption application. This includes the possible effects of the pesticide on known endangered species in the control area. It would be helpful to be able to more accurately define specific endangered species habitats to minimize the effects of the pesticide on the endangered species in the area.

As you can see, many types of remote sensing data can be used by the Entomology Division. However, it is difficult to place a dollar value on some of these types of data. Uncontrollable factors, such as weather, always affect the activity of insects and plant diseases. The cost of remote sensing programs would be small compared to the losses that could occur if a serious insect outbreak or a plant disease epidemic occur. Thus, long-term use of the remote sensing data discussed above can be expected to produce increasingly larger reductions in the crop and rangeland losses from insects and plant diseases.

One other point that should be stressed is that while the types of data listed above would be very useful to the Entomology Division, it will not necessarily reduce the personnel level or total travel expenditures the Entomology Division needs to carry out its legislative mandates. It will, however, enable the Entomology Division to improve its efficiency in carrying out those mandates. This will bring about a significant reduction in the pest control costs now experienced in agricultural production.

Sincerely,

H. Dean Garwood, Director

HDG:jlb

KANSAS GEOLOGICAL SURVEY
Office of the Director

1930 Avenue "A", Campus West
The University of Kansas
Lawrence, Kansas 66044
913-864-3965

July 6, 1981

Mr. B. G. Barr
Mr. Edward A. Martinko
University of Kansas
Space Technology Center
KARS Program
Raymond Nichols Hall
2291 Irving Hill Drive
Campus West
Lawrence, Kansas 66045

Gentlemen:

The Kansas Geological Survey is keenly interested in developing a mechanism whereby the capabilities of the Kansas Applied Remote Sensing Program can be made available to State agencies on a regular operational basis with firm funding.

Certainly, the utility of remote sensing for use by Kansas agencies has been demonstrated by the Program over the last eight years, and the Program now should move from the demonstration to continuing support.

We look forward to working with you in an exploration of ways to bring remote sensing to its full potential, and to assure continuing funding. I will be pleased to continue, at least for the present time, as a representative on the Task Force from the Kansas Geological Survey.

With every good wish.

Sincerest regards,

William W. Hambleton

William W. Hambleton
Director

WWH:ds

OF POOR

KANSAS GEOLOGICAL SURVEY
Groundwater Section

1930 Avenue "A", Campus West
The University of Kansas
Lawrence, Kansas 66044
913-864-4321

July 29, 1981

Dr. E. A. Martinko
KARS Program
KU Space Technology Center
Lawrence, Kansas 66044

Dear Dr. Martinko:

I am writing this letter on behalf of the staff of the Foley Geohydrology Center in support of KU's remote sensing program. We at the Foley Geohydrology Center are convinced that this is a valuable research program for the evaluation of natural resources, and in particular water resources.

Our research efforts are directed toward evaluation of hydrologic and geologic resources of Kansas. We need many types of data to perform this task, some of which are difficult to obtain. As examples, we need remote sensing for the following:

a) to determine irrigated acreage and from that water use;
b) to locate groundwater recharge areas;
c) to determine the existence of geologic structures that may influence water movement; and
d) to delineate the extent of flooding in a river valley after recent heavy rains.

None of these data are easy to come by and many times we have to make estimations based on the best available data. Remote sensing improves the basis for our recommendations for the future use of water resources.

As an example of the value of Landsat data, crop types and irrigated acreages can be determined. From this, groundwater irrigation pumpage can be estimated for given areas. These values are internally consistent. An alternate approach is to obtain water use reports from DWR, but reporting procedures make this pumpage data inconsistent. It also takes many man-hours to obtain the data from the files.

The spatial and temporal characteristics of remote sensing data are important for determining the location of features of interest and evaluating changes over time (e.g., irrigated acreage). The maintenance of a library with historical and current imagery for the State is a valuable service in itself.

KU must be proud of itself for establishing a remote sensing program which very few universities possess. This program is internationally known. Now is the time to apply remote sensing research to Kansas problems. We at the Geohydrology Center feel that this program can help in the evaluation of groundwater resources. We already have a cooperative program with your office, and if I were going to make further decisions, I would expand this program and explore new applications of remote sensing.

Sincerely,

Manoutch Heidari

Manoutch Heidari
Section Chief

MH:kl

cc: W. W. Hambleton
Jane Denne
Tom McClain

Kansas

DEPARTMENT OF REVENUE

State Office Building
TOPEKA, KANSAS 66625

June 22, 1981

Ms. Liz Kipt
University of Kansas Space Technology Center
Raymond Nichols Hall
2291 Irving Hill Drive - Campus West
Lawrence, Kansas 66045

Dear Ms. Kipt:

In response to your request, we are submitting the following information.

The primary mission of our agency is to assist local units of government to the end that all property is appraised and assessed in a uniform and equal manner. Other responsibilities include the appraisal of utility property and to devise and/or prescribe guides for use by the county appraisers in estimating the value of various types of personal property.

Several projects are now underway which we hope will lead to a more uniform system of ad valorem taxation. Two projects which can be directly related to an applied remote sensing program are:

1. Develop uniform procedures for the identification and classification of irrigated lands.

2. Define the various homogeneous regions of agricultural lands in the State of Kansas. This will include considering such things as rainfall, climate, availability of underground water, land capability classes, topography, crops common to the area, etc.

The needs for the projects mentioned above (and others) are apparent in view of the responsibilities assigned to the Director, by statute.

[illegible] to accomplish the desired objective should be obtained on the [illegible] of:

1. The most current that will satisfy the needs of the user.

If we can assist in any other way, please call.

Sincerely,

Robert C. Walters

Robert C. Walters, MAI
Supervisor, Real Estate
Division of Property Valuation
(913) 296-2365

RCW:das

cc: Director

Kansas

DEPARTMENT OF REVENUE

State Office Building
TOPEKA, KANSAS 66625

June 9, 1980

Dr. Ed Martinko
Project Coordinator, KARS
Raymond Nichols Hall
University of Kansas - Campus West
Lawrence, Kansas 66044

Dear Dr. Martinko:

This office is charged by statute with supervising the property taxation system of Kansas, lending support to each local appraisal official.

As part of our duties, and in anticipation of certain mandated activities aiming toward a uniform and equal system of property taxation in Kansas, the Real Estate Division of this office will, in the forseeable future, be required to divide the land area of Kansas by homogeneous regions taking into consideration such things as rainfall, soil types, cropping practices, land use patterns, topography, and other descriptive criteria. The various homogeneous regions established can then be used as a part of the criteria in determining the fair market value in money of the agricultural land in Kansas, and/or in comparing the current values and classifications with objectively-determined data. We would therefore appreciate any assistance you can give us in making these divisions.

In order to understand the magnitude of the decisions which will depend on an appropriate determination of these homogeneous regions, it is appropriate to point out that the taxes gathered under this system of valuation will serve as the total local fund base for all of the urban and municipal subdivisions of the state, and taxes gathered under this system will also serve as the primary funding source for each county government, and provide an important source of state funds. In 1979, the real property of Kansas was valued at approximately 16 billion on the tax rolls, and resulted in nearly a half-billion dollars in taxes.

As part of this decision-making process, we suggest the following steps to be jointly undertaken in coordinating our efforts:

A. We shall determine the nature of the criteria to be considered, and after discussion with your office, determine which, if any, of those criteria are appropriately considered by remote sensing.

B. We shall provide you with any relevant data, determined by other than remote sensing, to aid you in your determinations.

C. We shall mutually determine a suitable time frame for collection of data and determination of results.

Thank you for your interest in this project.

Sincerely,

Robert C. Walters

Robert C. Walters, M.A.I.
Supervisor, Real Estate
Division of Property Valuation
(913) 296-2365

RCW:skt

cc: Director

STATE OF KANSAS

RICHARD W. RYAN
DIRECTOR
BEN F. BARRETT
ASSOCIATE DIRECTOR
MARLIN L. REIN
CHIEF FISCAL ANALYST

STAFF—
LEGISLATIVE COORDINATING COUNCIL
INTERIM COMMITTEES
STANDING COMMITTEES
LEGISLATIVE INQUIRIES

THE LEGISLATIVE RESEARCH DEPARTMENT
ROOM 545-N. STATEHOUSE
PHONE: (913) 296-3181
TOPEKA, KANSAS 66612

June 18, 1981

Ms. Liz Kipp
University of Kansas
Space Technology Center
Lawrence, Kansas 66045

ORIGINAL PAGE IS
OF POOR QUALITY

Dear Ms. Kipp:

In regard to your request for a listing of possible uses by our agency of data gathered by remote sensing, the Kansas Legislative Research Department responds to requests directed to us by legislative committees or by individual legislators. Therefore our need of data or information from the Kansas Applied Report Sensing (KARS) Program is usually dependent upon legislative direction.

However, from time to time our Department does conduct independent research on topics which may in the future be of use or interest to the Legislature or individual legislators. At such times the staff member from our office determines the pertinent data needed.

Following are examples of subject areas for which data generated by the KARS Program may be of use by the Kansas Legislative Research Department.

1. Mined Land Reclamation (abandoned mined-lands)
2. Water Quality Planning
3. Monitoring the Use of Irrigation
4. Use-Value Appraisal
5. Land Use Planning
6. Crop Reporting Data

If we can be of further assistance to you in this matter, please do not hesitate to contact us.

Sincerely,

Randy Gilliland

Randy Gilliland
Research Assistant

RG/aem

Kansas Fish & Game

BOX 54A, RURAL ROUTE 2, PRATT, KANSAS 67124
(316) 672-5911

REGIONAL OFFICES:

Northwest Regional Office
2204 Vine
Hays, Kansas 67601

Northcentral Regional Office
Box 489, 511 Cedar
Concordia, Kansas 66901

Northeast Regional Office
3300 S.W. 29th Street
Topeka, Kansas 66614

Southwest Regional Office
808 Highway 56
Dodge City, Kansas 67801

Southcentral Regional Office
Box 764, 204 West Sixth
Newton, Kansas 67114

Southeast Regional Office
222 West Main Building
Suite C & D
Chanute, Kansas 66720

May 20, 1981

B. G. Barr, Director
University of Kansas Space Technology
Center
Raymond Nichols Hall
2291 Irving Hill Dr., Campus West
Lawrence, Kansas 66045

Dear Bill:

With regard to the Interagency Task Force meeting on applied remote sensing, we would like to heartily endorse the concept. Our agency has long been interested and reasonably active in the use of applied remote sensing. We feel that the technology of remote sensing has "come of age" and is a very important tool that many state agencies can utilize effectively.

Attached is a list of projects that our agency has been involved with utilizing KARS and remote sensing. Also enclosed is a list of potential projects that we feel a need for and which could probably best be undertaken with the remote sensing technology. It would appear to us that the sharing of the remote sensing program by various state agencies will serve two important objectives: 1) reduce overlap of effort and allow sharing of various data between agencies and, 2) ultimately provide a more cost-effective means of undertaking projects through the use of remote imagery that heretofore have been labor intensive and very costly to the agencies.

While the issue of remote imagery is well-known to our agency, it is still a new technology to others. In some cases, the potential of this tool is not known. If the utilization of remote imagery is undertaken utilizing interagency input and suggestions, the agency itself will become more adept in its use and the taxpayer will ultimately be the benefactor due to more efficient use of tax dollars.

For all these reasons, we heartily endorse the Interagency Task Force and will be most happy to assist in further efforts.

Sincerely,

Bill Hanzlick

Bill Hanzlick Director
Kansas Fish and Game Commission

jlr

PAST INVOLVEMENT WITH KARS

- Mapping center-pivot irrigation in 32 southwest Kansas counties (Water Resources and Geological Survey also involved).

- Wildlife habitat inventory in Jefferson, Ottawa & Thomas counties.

- Habitat and stream order mapping in Chikaskia River Basin (Pratt, Kingman, Barber, Harper and Sumner counties).

- Vegetation mapping and monitoring at Cheyenne Bottoms.

- Aquatic vegetation mapping on Douglas SFL.

- Map drainage patterns on Mined Land Areas.

- Evaluating effects of water level manipulation on reservoirs (Council Grove).

- Selection of antelope release sites (Ellsworth, Saline, Clark, Meade, Trego, Gove, Logan, Lane, and Scott counties).

- Vegetation mapping and monitoring at Jamestown.

- High altitude photogs on Ark River regarding the Rennick situation.

POTENTIAL PROJECTS

- Statewide habitat inventory.
- Statewide pond inventory.
- Total irrigation mapping for wildlife habitat impact assessment.
- Rangeland burning monitoring.
- Vegetation mapping of Mined Land Wildlife Area.
- Antelope habitat update

Kansas Fish
& Game
BOX 54A, RURAL ROUTE 2, PRATT, KANSAS 67124
(316) 672-5911

REGIONAL OFFICES:

Northwest Regional Office
2204 Vine
Hays, Kansas 67601

Northcentral Regional Office
Box 489, 511 Cedar
Concordia, Kansas 66901

Northeast Regional Office
3300 S.W. 29th Street
Topeka, Kansas 66614

Southwest Regional Office
808 Highway 56
Dodge City, Kansas 67801

Southcentral Regional Office
Box 764, 204 West Sixth
Newton, Kansas 67114

Southeast Regional Office
222 West Main Building
Suite C & D
Chanute, Kansas 66720

July 24, 1981

Elizabeth R. Kipp
University of Kansas
Space Technology Center
2291 Irving Hill Dr-Campus West
Lawrence, KS 66044

Dear Ms. Kipp:

Our recent cost projection of conventional methodology of land use/cover dealing with the antelope habitat survey boiled down to about $2500 (17.5 mandays) per county.

That projection was based on defining cropland versus rangeland. In order to fine-tune the information for more varied information; type of crops, amount of timbered lands, water bodies, etc., would take at least 3 times as much effort, or about $7500 (52.5 mandays) per county.

Expanding those estimates statewide results in crude estimates of $787,500 (21 man-years).

We can't afford to invest that much money or divert the manpower from other duties for one year, let alone for the annual information to detect changes over time.

Even if we did divert that amount, informational detail would not be adequate. You can't see all of the areas from the roads. Trees, hills and buildings block your view, and some areas don't have roads. If we could get 60% coverage, we'd be lucky.

If we had this type if information, it would be valuable to our decision making processes. We could better direct our efforts to areas where we could most efficiently benefit wildlife.

Sincerely,

Bill

Bill Hanzlick
Director

BH/mh

Kansas Fish & Game

BOX 54A, RURAL ROUTE 2, PRATT, KANSAS 67124
(316) 672-5911

REGIONAL OFFICES:

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Dodge City, Kansas 67801

Southcentral Regional Office
Box 764, 204 West Sixth
Newton, Kansas 67114

Southeast Regional Office
222 West Main Building
Suite C & D
Chanute, Kansas 66720

July 14, 198?

ORIGINAL PAGE IS OF POOR QUALITY

Mr. Ed Martinko
Associate Director,
KARS Program
University of Kansas
2291 Irving Hill Road
Lawrence, KS 66045

Dear Ed:

I've worked up some estimates for the antelope habitat study based on our doing it by "conventional" methods. These figures assume two investigations biologists would have made the surveys using all existing roads to visually verify land uses, prepared the maps and narrative explanations in each of the four years covered in the study (1972-1975). The conservative annual investment by us would have been around 33 mandays (≈ $3100), and another $1250 for vehicle and subsistence expenses, for an annual sum of around $4350. Over the four years, that would run the total to about $17,400.

I'm not sure of how to attach a dollar value to completeness of the survey, but from rough calculations of miles of roads available in the two study areas, we would only be able to see about 53 to 63% of the areas from a vehicle based survey. This data gap may have been possible to fill with supplemental low altitude (piper cub type) flights to verify what was happending in the roadless areas. So to the annual total cost, an estimated 8 hours of flight time at around $50 per hour ($400) and 2 mandays ($188) could be added. That would bring the 4 years total to about $19,750.

Let me know if this is adequate for your use in preparing for the comparisons of remote sensing vs. coventional methods on special projects. If not, I'll dig deeper for better estimates.

Sincerely,

Verlyn

Verlyn Ebert,
Planner

VE/mh

State of Kansas . . . John Carlin, Governor
DEPARTMENT OF HEALTH AND ENVIRONMENT
Joseph F. Harkins, Secretary
Forbes Field
Topeka, Kansas 66620
913-862-9360

June 12, 1981

B. G. Barr, Director
University of Kansas Space
and Technology Center
Raymond Nichols Hall
2291 Irving Hill Drive - Campus West
Lawrence, Ks. 66045

Dear Mr. Barr:

The Kansas Applied Remote Sensing (KARS) Program's activities over the last eight years have demonstrated the utility of remote sensing/ geographic information system technology for use by Kansas agencies. The Kansas Department of Health and Environment has needs and potential applications of remote sensing and therefore support and endorse efforts of the KARS Program and the Kansas Interagency Task Force on Applied Remote Sensing to explore and evaluate mechanism through which such technology can be made available to agencies on a continual and operational basis.

We look forward to the opportunity of working with you on the Task Force and will be in contact with you in the coming weeks to name our Task Force representative.

Sincerely,
DIVISION OF ENVIRONMENT

James Aiken, Director
Division of Environment

JA:mm

State of Kansas . . . John Carlin, Governor

DEPARTMENT OF HEALTH AND ENVIRONMENT

Joseph F. Harkins, *Secretary*

Forbes Field
Topeka, Kansas 66620
913-862-9360

June 30, 1981

Ms. Liz Kipp
Kansas Applied Remote Sensing Program
Raymond Nichols Hall
2291 Irving Hill Drive -
Campus West
Lawrence, Ks. 66045

Dear Ms. Kipp:

This letter is in response to your June 21, 1981 telephone inquiry regarding KDHE projects and activities and associated remote sensing needs. The instructions you provided addressed the following items:

1. What KDHE projects have been mandated by the Kansas Legislature?
2. What are the geographic (land use, land cover, topographic, etc.) data needs associated with 1?
3. What are our repetitive geographic data and frequency?

Because of the limited amount of time available to work on this, our response is necessarily limited and subject to further refinement.

All of KDHE's project activity has a basis in state or federal statutes. Programs and associated projects resulting from state legislative action include; Kansas Hazardous Waste Management Plan, Kansas Solid Waste Management Plan and Kansas Water Quality Management Plan.

<u>Kansas Hazardous Waste Management Plan.</u>

This is the result of 1981 legislative action and plan specifications have not been fully developed. Based on past uses of remote sensing techniques we would need periodic surveillance of active and inactive hazardous waste disposal sites. Data needs include land use, vegetative stress, surface water movement and leachate discharge points. Such data would be needed on an annual basis for 2 active sites and once every 2 years for 9 inactive and remedial action sites. Remote surveillance may also be useful for identification of abandoned sites.

Kansas Solid Waste Management Plan.

This plan has been in place for a number of years and has resulted in making suitable solid waste management facilities accessable to all Kansas communities.

Remote surveillance could be used to monitor the management practices at active sites, closing out filled sites and locating potential new sites.

Kansas Water Quality Management Plan

This was established in 1979 and set out a series of water quality management projects. Some of the projects include agricultural non-point source pollutant management, potential pollutant problems from irrigation activities, pollutants from construction activities and county wide waste water management planning.

The Division of Environment has a continuing need for monitoring and surveillance methods which are less labor intensive. Examples include: septic tank failures, lake trophic studies, impact of waste water discharge on surface water - (mixing zone determination), stream bank erosion, stream and lake sedimentation patterns, land use and land cover and riparian habitat and stream cover.

We are interested in predicting sinkhole development in central Kansas. We believe landcover data with interpretations involving vegetative stress, surface lineation connected to drainage development and subsidence events is needed.

The Division has responsibilities for various land reclamation activities such as old brine salt scars, filled sanitary land fills, abandoned dumps, and spill sites. Remote surveillance would seem to be a cost effective means of determining the extent of damage and the rate of recovery.

The Division has recently observed a great deal of oil field exploration activities. We are interested in using remote surveillance to identify new operations, monitor active site management and close-out of sites.

Mz. Liz Kipp
June 30, 1981
Page 3

We hope this brief summary provides the information you need. Please contact me (KANSAN 569-1249) if you have any questions.

Sincerely,

DIVISION OF ENVIRONMENT

Donald D. Snethen, P.E., Chief
Planning and Policy Section
Bureau of Technical and Support Services

DDS:mm
cc: Bill Bryson
John Paul Goetz
Karl Mueldener
Jim Power
Gerald Stoltenberg

THE STATE OF KANSAS

THE KANSAS STATE PARK AND RESOURCES AUTHORITY
503 KANSAS AVENUE, P.O. BOX 977
Phone (913) 296-2281
TOPEKA, KANSAS 66601

June 18, 1981

Ms. Elizabeth Kipp
University of Kansas Center for Research
2291 Irving Hill Drive - Campus West
Lawrence, Kansas 66045

Dear Ms. Kipp:

Thank you for your continued interest in our agency and our recreation planning needs. On several occasions past, we have submitted requests to your agency for information on specific projects around the state. The following are some of the data requested where we still have an interest:

1. Identification of natural features along the Kansas and Arkansas Rivers.
   a. Open Tree areas
   b. Underbrush areas
   c. Main streambed boundaries
   d. Prominent sand bars
2. Man-made influences
   a. Access roads to the streams
   b. Railroad lines nearby
   c. Areas of visable pollution -i.e. public dumping or sewage flowing into the streams.

Currently, we are planning trails development at five state parks (Cheney, Lovewell, Glen Elder, Wilson and Prairie Dog). Detailed information similar to that furnished us for Sand Hills State Park would be very helpful in designing these trails. It would be necessary to include the entire reservoir since our trails are planned to cross boundaries of other public agency lands in order to create a good trail recreation experience.

Three of our most recent state parks are currently in the planning and/or development stages. Repetitive data annually or every two years would be very helpful to identify the progress of recreation development and the build-up of private and commercial developments around each reservoir for the next 10 to 15 years. The three reservoirs are: Clinton, Melvern and Hillsdale.

One of our primary concerns is the siltation problems that occur in all reservoirs and lakes where state parks are located. Identification of silt progress on a repetitive basis for all of these impoundments would be most valuable to our agency. Aerial photos of our state park areas reproduced from reservoir information every four to five years would also be invaluable.

We hope this will provide you the information that you requested. All or any part of the above suggested data would be helpful to us. Thank you again for your interest in this regard.

Sincerely,

Wayne Herndon

Wayne Herndon
Planning Coordinator

WH:bam

KANSAS DEPARTMENT OF ECONOMIC DEVELOPMENT
503 KANSAS—6th FLOOR, TOPEKA, KANSAS 66603
Phone (913) 296-3485

August 12, 1981

Mr. Ed Martinko
Associate Director
Kansas Applied Remote
Sensing Program
Nicholls Hall
University of Kansas
Lawrence, Kansas 66044

Dear Mr. Martinko:

We at the Planning Section of KDED wish to express our hope that State funds will be used to support the KARS program in the future. If State funds become available, we would like to see an update of the "Kansas Land Use Patterns" map, originally produced for KDED in 1974. The cost of that project was $9,000, and I understand an update would cost about $18,000, today.

Satellite imagery provides the only feasible source of land use information on such a large scale, as no reasonable alternative of producing this valuable set of information exists.

Sincerely,

Kevin Carr

Kevin Carr
Economic Development
Representative

KC:kp

Tomorrows Water Must Be Managed Today
INDUSTRY. AGRI BUSINESS. MUNICIPAL
GMD No 3 1976

Southwest Kansas
Groundwater Managemen
District No. 3

Suite 106
409 Campus Drive

Phone 316-275-7147
Garden City, Kansas 67846

June 15, 1981

Mr. B. G. Barr, Director
University of Kansas Space
Technology Center and KARS Program
Lawrence, Kansas 66045

Dear Bill,

At the June 10th Board Meeting, the Directors authorized me to make the following comments regarding the Kansas Applied Remote Sensing (KARS) Program.

The Kansas Applied Remote Sensing (KARS) Program's activities over the last eight years have demonstrated the utility of remote sensing or geographic information system technology for use by Kansas agencies. In view of the District's needs potential applications of remote sensing, we support the concept of the Kansas Interagency Task Force on Applied Remote Sensing to explore and evaluate mechanisms through which such technology can be made available to agencies on a continual and operational basis.

Additionally I have had conversation with Elizabeth Kipp on the research projects we are involved in and the nature of the data we will be acquiring. Consequently, here is that summary:

Project	Data
Pilot Recharge Projects	1) Climatological - evaporation & rainfall 2) Effective Recharge - water level measurements in observation well
Coop Ford County Ogallala Study	1) Hydrologic Properties - a) Saturated thickness b) Bedrock map c) Water level contour 2) *Aquifer Response to Pumping Stress - a) All of the above data plus the amount of water actually withdrawn

*for this particular segment of the study, a quick method for determining the water budet i.e. irrigated crops and their subsequent needs, would be great.

If I can be of further assistance, feel free to contact our office.

Sincerely,

Rick Illgner
Manager

RI:jah

March 16, 1982

Dr. Edward Martinko
Kansas Applied Remote Sensing (KARS) Program
University of Kansas Space Technology Center
Lawrence, Kansas 66045

Dear Dr. Martinko:

The Harvey County Planning Department is currently in the process of revising the comprehensive plan for the County. For this purpose we want to do a lot of mapping and possibly overlays. From your article in the KARS Newsletter of January 1982, it sounds like you have just the thing we need in your Geographic Information System (GIS).

We need to know more, however, about what kind of computer your system requires. Could you give us a list of all the micro-computers the GIS would work on, how big of a memory required, and whether or not a disk drive is necessary? Also we need more information on exactly what graphics capabilities are needed on a printer.

Our Department has access to several computers. Could the GIS be adapted to any of these and with how much difficulty?

- -IBM 5120 with printer (BASIC & APL languages)
- -Commodore 8032 with printer (BASIC)
- -NCR 8200 with printer (COBAL)

If none of these will do, could you please recommend some and what features to look for? We would also like more information on the cost and availability of the GIS.

In addition, we would greatly appreciate what information you have regarding LANDSAT or aerial photography data available to counties.

We thank you for your assistance in these matters and any further assistance you can offer us in our plan revision process.

Sincerely,

Monty R. Wedel

Monty R. Wedel
Planner I

MRW/kr

cc: Gene R. Kristenson, County Administrator

APPENDIX VII

COMMERCIAL CONTRACTORS THAT HAVE BENEFITED BY KARS PROGRAM PROJECTS

COMMERCIAL CONTRACTORS THAT HAVE BENEFITED BY THE KARS PROGRAM PROJECTS

	Project	Agency	Contractor	
1.	Arkansas River Vegetation Analysis (CIR Aerial Photography)	Kansas Fish and Game Commission U.S. Fish and Wildlife Service	Wilson Engineers, Inc. Salina, Kansas	$ 5,000
2.	Monitoring of Cheyenne Bottoms Waterfowl Management Area Habitat (CIR Aerial Photography)	Kansas Fish and Game Commission	Wilson Engineers, Inc. Salina, Kansas	2,000
3.	Mapping Jamestown Waterfowl Management Area Habitat (CIR Aerial Photography)	Kansas Fish and Game Commission	Wilson Engineers, Inc. Salina, Kansas	400
4.	Landsat Computer Identification of Wildlife Habitat in Kansas (Landsat Computer Compatible Tapes)	Kansas Fish and Game Commission	Bendix Corporation Ann Arbor, Michigan	5,000
5.	Soldier Creek Watershed "208" Planning Project (Color Aerial Photography)	Environmental Protection Agency	Wilson Engineers, Inc. Salina, Kansas	1,500
6.	County Line Lake, Missouri (Color Aerial Photography)	Missouri Natural Resources Department	M. J. Harden's Associates Kansas City, Missouri	800
7.	Musk Thistle Project (CIR Aerial Photography)	Kansas Department of Agriculture - Weed and Pesticide Division	Wilson Engineers, Inc. Salina, Kansas	500
8.	Sand Hills State Park (Black and White Aerial Photography)	Kansas Applied Remote Sensing Program	Wilson Engineers, Inc. Salina, Kansas	300
9.	Several KARS Projects April 1972 - March 1983	Kansas Applied Remote Sensing Program	Center for Research, Inc. Drafting and Photographic Laboratory	28,000
			TOTAL	43,500

APPENDIX VIII

PROGRAM STATISTICAL DATA

INQUIRIES AND VISITATIONS TO THE
KANSAS APPLIED REMOTE SENSING PROGRAM

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
Inquiries	60	96	96	96	108	120	120	200	200	160	230
Visitations	*320	*350	120	150	200	*300	175	175	210	225	285

*Several remote sensing meetings occurred during these years at the Space Technology Center.

NEWSLETTER DISTRIBUTION **

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
Number of Recipients	--	220	325	377	695	865	900	1,250	1,900	2,050	2,100

**Newsletters are sent only to those individuals who are involved with Kansas Applied Remote Sensing Program projects or who have expressed a need to be continually informed about remote sensing efforts. The newsletter is responsible for many of the inquiries and visitations listed above.

KARS PROGRAM STAFF

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
Faculty	3	3	3	3	2	2	3	3	3	3	3
Graduate Research Assistant	2	4	4	4	9	5	3	10	6	8	7
Staff	2	2	2	2	2	2	4	2	4	2	3
TOTAL	7	9	9	9	13	9	10	15	13	13	13

ENROLLMENT IN REMOTE SENSING COURSES OFFERED BY
THE UNIVERSITY OF KANSAS (1982)

	Course Title	Enrollment
CE 785	Terrain Analysis	20
*EE 681 and GEOL 756	Remote Sensing	20
EE 785	Pattern Recognition	20
EE 800	Optical Remote Sensing	15
EE 826	Radiometric Remote Sensing	10
EE 827	Radar Remote Sensing	9
EE 828	Advanced Microwave Remote Sensing	10
EE 829	Scattering Theory	11
*GEOG 526	Remote Sensing I	33
*GEOG 626	Practicum in Remote Sensing	2
*GEOG 627	Topics in Remote Sensing	6
*GEOG 726	Remote Sensing II	20
*GEOG 926	Seminar in Remote Sensing	6
GEOG 980	Remote Sensing of China	4
*GEOL 410	Introduction to Field Geology	35
GEOL 591	Radar Imaging	10

*Courses offered every school year

REMOTE SENSING EDUCATION AT THE UNIVERSITY OF KANSAS

The KARS Program maintains strong links with the remote sensing academic programs in the Departments of Geography and Electrical Engineering at the University of Kansas, through student and faculty appointments and collaboration in research, teaching and extension activities. The Geography courses provide a sequence of formal lecture/laboratory work, research seminars and independent work, with an emphasis on the interpretation and uses of remotely sensed data.

Remote Sensing I (Geog 526), the first course in the sequence, provides a basic working knowledge of applied remote sensing techniques in environmental analysis. Emphasis is placed on the visual interpretation and mensuration of visual, infrared and microwave sensor imagery.

Remote Sensing II (Geog 726) emphasizes quantitative image analysis, concentrating on photographic densitometry and digital image processing. A comprehensive instructional image processing software package developed at KU provides intensive practical experience and understanding of image processing concepts, procedures and algorithms. Access to KARS' and other image processing systems provides exposure to various operational hardware/software configurations.

Remote Sensing III (Geog 826) concludes the basic course sequence and deals with remote sensing input to geographic information analysis techniques. The course covers data structures and input/output techniques, but the primary emphasis is on spatial information analysis and modeling.

Seminar in Remote Sensing (Geog 926) provides advanced study of special topics: image processing and GIS software development are recent examples.

Topics in Remote Sensing (Geog 627) allows students to undertake independent work in research, education or technology transfer.

Practicum in Applied Remote Sensing (Geog 626) provides a realistic work experience in which the student designs, executes and completes a project within the KARS Program.

Seminar in Remote Sensing of China (Geog 480) offers experience in regional analysis of an area using remote sensing, emphasizing Landsat.

Aerial Photography and Photogrammetry (Geog 527) teaches the practical aspects of aerial photography, mission planning, camera operation (nine-inch cartograhic camera and medium format 70mm multi-camera cluster), basic photogrammetry and stereo plotting using a Kelsh Plotter.

The remote sensing program emphasis is on the application of remote sensing techniques within geographic and environmental studies. It has achieved a high (and unusual) degree of integration with the various subdisciplines. The recently renovated departmental facilities offer complete remote sensing teaching and research laboratories, a computer graphics laboratory, and teaching and research cartographic production laboratories. The Department also houses modern palynology, vegetation-dendrochronology, soils, geomorphology and meteorology laboratories. The China Maps and Imagery Repository in the Department provides an extensive and unique collection of maps and imagery for teaching and research. The KARS Program and the remote sensing program in geography together offer a complete range of basic and advanced image analysis and interpretation facilities for both basic and applied research instruction.

ELECTRICAL ENGINEERING AND GEOLOGY DEPARTMENTS EMPHASIZE MICROWAVE REMOTE SENSING

Courses on remote sensing systems and applications are offered by both the Department of Electrical Engineering and the Department of Geology at the University of Kansas. These courses are particularly designed for students planning to specialize in microwave systems engineering and applied geology, but they complement remote sensing coursework offered through the Department of Geography. Major emphasis in these courses is on the fundamentals of various passive and active (e.g., radar) microwave systems and their applications, although other systems are also covered. The coursework in both departments is fully integrated with research activities of the KU Remote Sensing Laboratory.

ELECTRICAL ENGINEERING

Radiometric Remote Sensing (EE 826) - Analysis of radiative transfer theory, including emission, scattering and absorption and its application in microwave remote sensing of the atmosphere and terrestrial surfaces. Operation and design of radiometer receivers and imaging considerations are discussed.

Radar Remote Sensing (EE 827) - Description and analysis of radar systems used in remote sensing including scatterometers, real-aperture imaging radar and synthetic-aperture imaging radar. This course is designed to provide an overview of the fundamentals underlying radar systems, with particular emphasis on those relevant to remote sensing radars.

Advanced Microwave Remote Sensing (EE 828) - The course consists of a survey of advanced techniques and systems used in microwave remote sensing, including altimeters, synthetic aperture radar processing techniques, and specialized scatterometers. Additionally, the course gives a state of the art review of microwave remote sensing applications in the fields of oceanography, meteorology, geology, hydrology and agriculture.

Scattering Theory (EE 829) - Theoretical models for scattering and emission from natural surfaces and volumes are derived and compared to experimental measurements. Various approaches are considered including geometric optics, physical optics, perturbation method, and the radiative transfer technique.

Additional information about the remote sensing program in the Department of Electrical Engineering and the Remote Sensing Laboratory can be obtained from Dr. Fawwaz T. Ulaby, Remote Sensing Laboratory, Center for Research, Inc., University of Kansas, Lawrence, Kansas 66045-2969; (913) 864-4832.

GEOLOGY

Remote sensing courses are offered through the Department of Geology's program in applied geology. The Department maintains a strong connection with the University's Remote Sensing Laboratory, where emphasis in research has been on an understanding of the interaction of microwave energy and the target and its effect on the recorded return signal. Utilization of radar imagery, aerial photography, and satellite imagery in solving geologic problems is encouraged in individual research.

Two courses are offered through the Department, both of which are co-taught by faculty of Geology and Electrical Engineering. These are designed to emphasize remote sensing applications for geologic studies.

Remote Sensing (Geol 756) - Deals with the principles and applications of remote sensing in the ultraviolet, infrared and microwave regions of the electro-magnetic spectrum. Topics discussed include theoretical concepts of energy emission; techniques for the detection of this energy; detection devices commonly used; and utilization of remote sensors in geologic, agricultural, hydrologic, oceanographic, and meteorologic studies.

Radar Imaging (Geol 591) - Provides an in-depth survey of system operations and aids in the development of an understanding of the influence of system and operational parameters on the return signal. Laboratory exercises (informal) are provided.