# RESEARCH APPLICATIONS PROGRAMS

Space Technology Center
The University of Kansas
Lawrence, Kansas 66045
(913) 864-4775

KARS

# Kansas Applied Remote Sensing Program

(E83-10114) THE APPLICATION OF REMOTE SENSING TO RESOURCE MANAGEMENT AND ENVIRONMENTAL QUALITY PROGRAMS IN KANSAS Annual Report, 1 Apr. 1981 - 31 Mar. 1982 (Kansas Univ.) 234 p HC A11/MF A01 CSCL 05A G3/43

N83-15757

Unclas
00114

NASA National Aeronautics and Space Administration

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

July 1982

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

by

B. G. Barr
Director
Space Technology Center
The University of Kansas

and

E. A. Martinko
Assistant Scientist
Space Technology Center
The University of Kansas

July 1982

An Annual Report of Work
Performed Under NASA Grant
No. NGL 17-004-024

(April 1, 1981 - March 31, 1982)

## ACKNOWLEDGEMENTS

The work reported in this document is the result of efforts of many people at the University of Kansas Space Technology Center and various state, county and municipal agencies, as well as NASA and other federal agencies. Acknowledgement of specific agencies by name is made in the text. Editing and illustrations were provided by Elizabeth Kipp.

KARS Program staff members who have contributed to specific projects include the following:

L. Caron
B. Domeruth
C. Griffin
C. Gunn
E. Kipp
H. Krieger
J. Merchant
J. Poracsky
P. Orlowski
J. Rosacker
E. Roth
D. Sidor
L. Terflinger
T. H. L. Williams
R. Yoos

B. G. Barr, Principal Investigator
Kansas Applied Remote Sensing Program

E. A. Martinko, Co-Investigator
Kansas Applied Remote Sensing Program

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

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 procedures. This report describes the activities of the KARS Program in pursuit of its objectives during the period April 1, 1981 through March 31, 1982.

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. An applied agricultural research and development project for Farmland Industries, Inc. was also continued.

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. The equalization of tax assessment for land in different parts of the state is the focus of another land-related project. Other projects are concerned with preserving existing environments, one with those which are necessary as habitats for wildlife, and another with an inventory of abandoned mined lands and potential hazard assessment in Kansas. Another land-related project dealt with an inventory of land use and land cover along the Missouri River.

Other projects were continued during this period and are now nearing completion or awaiting final action.

# 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 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 demonstrate the utility of remote sensing technology in data gathering for decision makers in state, regional and local agencies. Now in its tenth year, the KARS Program is developing the concepts and methodologies to utilize remote sensing procedures in dealing with significant problems in Kansas related to changing urbanization patterns, rapid irrigation growth, changing agricultural needs and environmental quality. This activity is accomplished primarily through cooperative remote sensing projects 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, 1981, through March 31, 1982 in pursuit of its key objectives:

- To apply remote sensing techniques, analysis and systems to the solution of significant decision oriented concerns of state and local officials.
- To participate cooperatively on remote sensing projects with state and local agencies in Kansas.
- To effect the transfer of applicable remote sensing technology to governmental agencies at all levels as a by-product of the demonstration projects conducted in the KARS Program.
- To assist the personnel within Kansas agencies in the evaluation of the capabilities of the rapidly changing remote sensing systems and the benefits which might be achieved through their utilization.
- To stimulate through multidisciplinary teams, the application of the products of remote sensing systems to the significant problems of resource management and environmental quality in Kansas.

- To guide, assist and stimulate faculty, staff and students in the utilization of information from Landsat and Aircraft Programs of NASA in research, education and public service activities carried out at the University of Kansas and in the State.

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.

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 Inter-agency 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.

Table 1 . SERVICES OF THE KARS PROGRAM

The KARS Program provides the following services:

- Interpretation of remote sensing data (in digital or image format) in support of land use/land cover, environmental, planning, agricultural and natural resources inventories and analyses.

- 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;

- Map production using state-of-the-art cartographic techniques including negative scribing, color separation and computer graphics. Production of printed maps in color or black and white, transparent overlays, precision scale matching;

- 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);

- Location and acquisition of remote sensing imagery, 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

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. Several 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.

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. Frequent meetings of the Kansas Interagency Task Force on Applied Remote Sensing have enhanced agency-KARS interaction significantly and are

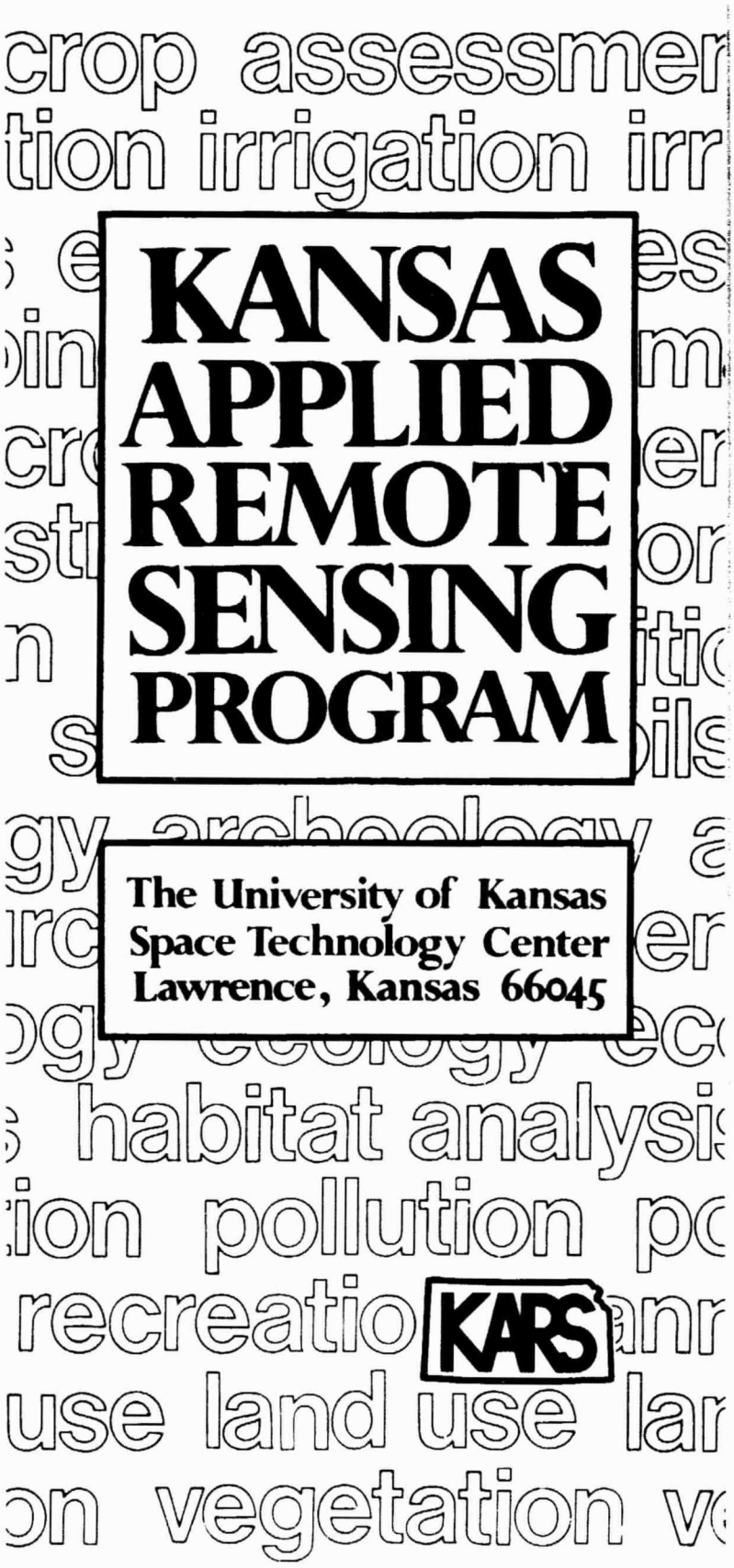



Figure 1.
The KARS Program Brochure

institutionalizing the KARS Program as a state 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).

During the past year the KARS Program organized the Kansas Interagency Task Force on Applied Remote Sensing. The Task Force, 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 was formally recognized by the Kansas Legislature during its 1982 session, and was 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, Kansas Chapter of the American Institute of Real Estate Appraisers, Upper Wakarusa Rural Clean Water Program Coordinating Committee, Kansas Soil Survey Planning Workshop, Topeka Chapter of the American Society of Appraisers, Kansas Official Council of County Commissioners, Kansas Association of Professional Soils Classifiers, and the Kansas Association of Watersheds. KARS staff authored professional papers and publications as well (Appendix V ). In addition, the KARS Program, under a contract from NASA's Earth Resources Laboratory, presented a series of one-day and five-day remote sensing short courses throughout Kansas. More than 100 representatives of Kansas agencies, industry, and public institutions attended the courses.

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

County:

ATCHISON COUNTY, KANSAS, COMMISSIONERS
CHEROKEE, 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 COMMISSIONERS
Wichita-Sedgwick County Metropolitan Area Planning Department

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 PARKS 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)
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.

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

NATURE OF PROJECTS

Table 4 indicates the range of projects in progress during FY 80-81. Note in Figure 2 that projects have been distributed widely over Kansas.

PRINCIPAL PROJECT 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, Ms. Elizabeth Kipp, Mr. Christopher Gunn, and Dr. Lee Williams comprise the senior personnel of the Program. The KARS staff is comprised of specialists having expertise in forestry, 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.

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 Alabama and an M.S. in Mechanical Engineering from the University of 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 interdisciplinary projects, including the Univeristy's BETA Program for industrial technology transfer. This program has

Table 4

KARS PROGRAM IN-PROGRESS PROJECTS
April 1981 - March 1982

| | |
|---|---|
| PROJECT: | ARKANSAS RIVER IRRIGATION MORATORIUM |
| COUNTIES INVOLVED: | Hamilton, Kearny |
| COOPERATING AGENCIES: | U.S. Geological Survey - Water Resources Division; Division of Water Resources - Kansas State Board of Agriculture |
| PROJECT: | WALNUT CREEK WATERSHED GROUNDWATER MODEL - IRRIGATED LANDS AND CROP INVENTORY |
| COUNTIES INVOLVED: | Ness, Rush, Barton |
| COOPERATING AGENCY: | Kansas Geological Survey |
| 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: | KANSAS INTERAGENCY TASK FORCE ON APPLIED REMOTE SENSING |
| COUNTIES INVOLVED: | Statewide |
| COOPERATING AGENCY: | Kansas Governor's Office; Kansas Senate; 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 : | USING LANDSAT TO SELECT A PRONGHORN ANTELOPE RELEASE SITE IN KANSAS |
| COUNTIES INVOLVED: | Gove, Lane, Logan, Scott, Sherman, Trego, Wallace |
| COOPERATING AGENCY: | Kansas Fish and Game Commission |
| PROJECT: | GEO-DATA BASE FOR TAX REASSESSMENT |
| COUNTY INVOLVED: | Finney |
| COOPERATING AGENCY: | Kansas Department of Revenue |
| PROJECT: | LAND USE/LAND COVER INVENTORY OF THE MISSOURI RIVER FLOODPLAIN |
| COUNTIES INVOLVED: | Atchison, Brown, Doniphan, Leavenworth, Wyandotte |
| COOPERATING AGENCY: | Missouri River Basin Commission |

Table 4 (contd.)

| | |
|---|---|
| PROJECT: | ABANDONED MINED LANDS INVENTORY AND HAZARD ASSESSMENT |
| COUNTIES INVOLVED: | Allen, Anderson, Atchison, Bourbon, Chautauqua, Cherokee, Clay, Cloud, Coffey, Cowley, Crawford, Doniphan, Douglas, Elk, Ellsworth, Franklin, Greenwood, Hodgeman, Jackson, Jefferson. Jewell, Labette, Leavenworth, Lincoln, Linn, Lyon, Mitchell, Montgomery, Nemaha, Neosho, Osage, Pottawatomie, Republic, Russell, Shawnee, Wabaunsee, Washington, Wilson, Woodson |
| COOPERATING AGENCIES: | U.S. Department of the Interior - Office of Surface Mining; Kansas Corporation Commission; U.S. Geological Survey; Kansas Geological Survey; University of Kansas Center for Public Affairs |
| PROJECT: | KANSAS REMOTE SENSING SHORT COURSES |
| COUNTIES INVOLVED: | Numerous counties in Kansas and several from surrounding states |
| COOPERATING AGENCIES: | National Aeronautics and Space Administration; University of Kansas, Division of Continuing Education |
| PROJECT: | APPLIED RESEARCH AND DEVELOPMENT IN AGRICULTURAL REMOTE SENSING |
| COUNTY INVOLVED: | Wyandotte |
| COOPERATING AGENCY: | Farmland Industries, Inc. |

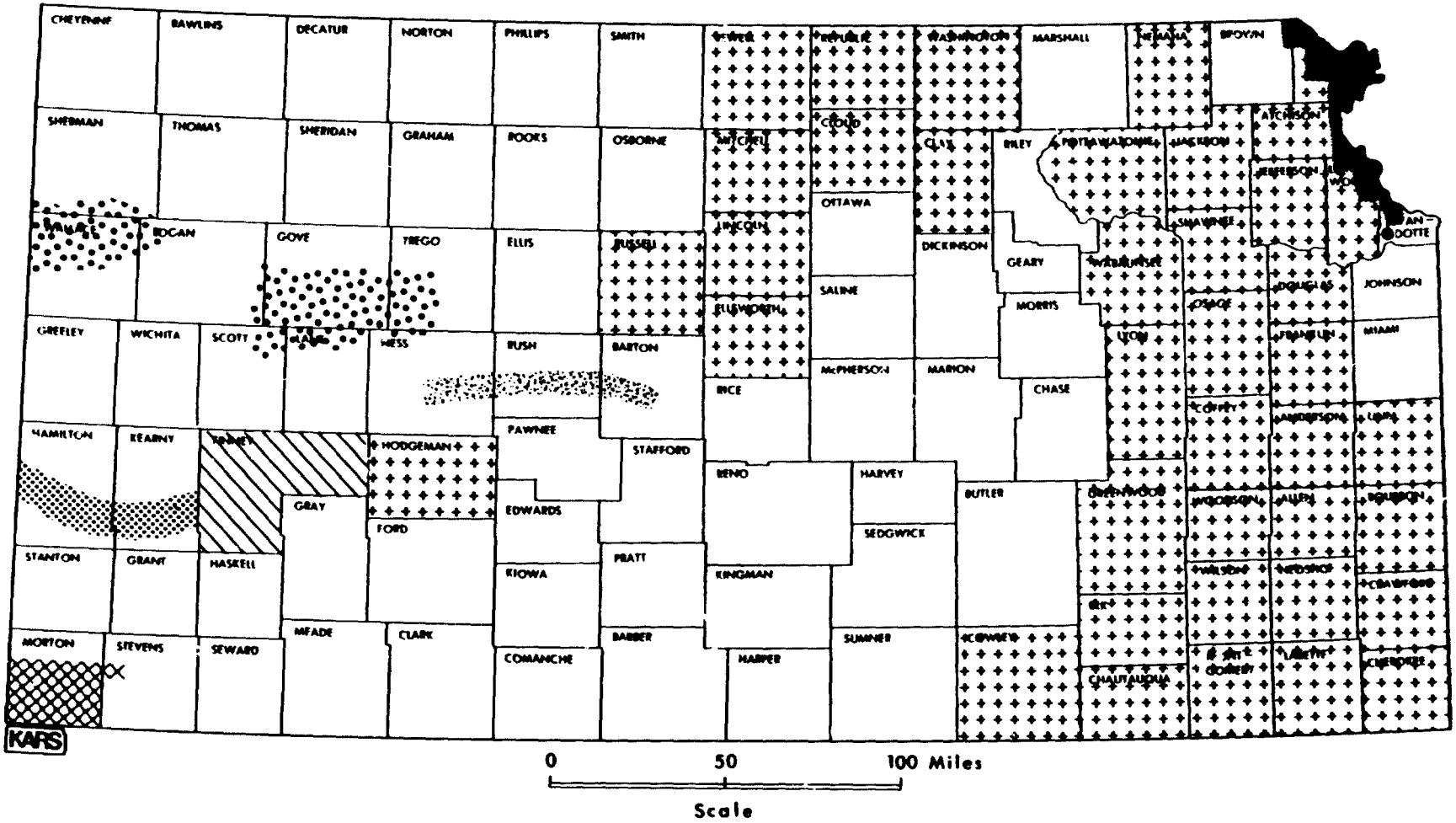





Figure 2. KARS Program Projects April 1, 1981-March 31, 1982

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 an 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 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 is intimately familiar with the functions and needs of state government and industry and with the operations of NASA. He has first-hand familiarity with public agencies and other users in the states of Kansas, Colorado, Missouri, and Texas, 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 System (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.

Elizabeth R. Kipp, Remote Sensing Specialist with the KARS Program, has a unique background in remote sensing, agriculture, ecology, and environmental studies. She holds a B.S. in plant science with emphasis on agriculture and plant ecology from the University of Delaware. Currently she is pursuing an M.A. in environmental studies with an emphasis on remote sensing and environmental resource analysis. She has been engaged in basic and applied research in remote sensing for three years, during which she has been associdated with the KARS Program. She is currently working with Kansas and federal agencies on projects involving the application of remote sensing and geographic information systems to resource problems in the areas of water resources management, land use analysis, weed inventory and evaluation, and pesticide drift detection and monitoring. She is also involved with data needs assessment for the Kansas Interagency Task Force on Applied Remote Sensing.

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. He has a B.S. degree in journalism from KU and spent four years as a newspaper reporter in the area of government affairs.

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 state and local agencies are involved in their own applications projects at no cost to the NASA grant. We continue to work with the various extension agencies in the state to gain their assistance in transferring remote sensing technology to a broader audience.

## 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 Steroscope, 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 several infrared prints and 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 several image mosaics.

The KARS Program also maintains a substantial reference library for both in-house and agency use. This material includes reports, articles, per-

iodicals, manuals, textbooks, etc., 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. 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 three remote terminals interfaced to the University of Kansas Honeywell Level 66 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. Also housed in the laboratory are an Integral Data Systems Dot Matrix Printer used for production of textual, graphic, and cartographic hard copy, and an Altek AC90SM microprocessor-controlled digitizer having a 42 x 60 inch back-lighted digitizing tablet.

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's 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.

KARS has acquired a Terak Corporation 8510/23-8600HDX microcomputer and color display system. The 8510/23 is a repackaged DEC LSI 11/23, an advanced 16-bit microcomputer that emulates the larger DEC PDP 11/34 mini-computer. The 8600HDX is a color display unit integrated with the 8510/23 that uses a highspeed Intel 8086 16-bit microprocessor to generate a color image of 640 by 480 pixels. The system runs under DEC's RT-11 single-user, multi-tasking operating system, which allows a FORTRAN applications program to access the entire 256K byte physical address space of the 11/23.

The Terak system currently has the following peripheral devices: an 8-inch double-density floppy disc drive for software interchange; a Control Data Corporation/Emulex 80-megabyte SMD disc pack drive emulating an expanded DEC RM03; a SKYMNK microprocessor-based array processor for arithmetic computation; a Kennedy 9100 10.5-inch reel-to-reel tape drives; an Altek AC90SM intelligent digitizer with 60- by 42-inch backlit tablet; an Intertec SuperBrain Z-80 microcomputer/intelligent terminal, and various terminals and printers.

KARS is in the process of acquiring the following additional devices: a high-resolution electrostatic printer/plotter for hard-copy output (capable of film recording if possible); one or more additional disc drives, and additional communications boards for the 11/23.

# 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 preparing 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 will work 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 (GIS) 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

May 1981 - May 1982

Kansas Applied Remote Sensing Program
Kansas Association of Counties
Kansas Corporation Commission
Kansas Department of Administration -
  Division of Budget
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
  Division of Water Resources
  Entomology Division
  Weed and Pesticide Division
Kansas Water Office
Kansas Legislative Research Department
Kansas Senate
Kansas Department of Economic Development

There was a consensus that state agencies that have participated with the KARS Program in demonstration projects have benefited from, and need to enhance and ensure continual access to, remote sensing/GIS technology. The Task Force felt, however, that there was a need to document the specific manner in which each agency might use such technology to better carry out its assigned mission and legally mandated obligations.

Therefore, Task Force representatives requested that KARS staff conduct an assessment of Kansas state agency data needs which might be met through application of remote sensing/GIS technology. They also asked that the study include an identification of high priority common data requirements.

During June 1981 a User Needs Survey was conducted. Information was gathered regarding (1) agency missions, (2) agency legislative mandates, (3) current and future projects and the necessary data required to conduct those projects, and (4) the frequency of data needs.

The conclusions of this study were presented at the second meeting of the Task Force held in July 1981. At least 38 statutes or specific projects in the State of Kansas that could benefit from data acquired by remote sensing/GIS technology were identified. These statutes and projects were found in 13 Kansas departments, agencies and commissions. The data needs of federal, regional and local agencies within Kansas have not yet been studied.

Regarding the common data needs of Kansas state agencies, the most recurrent interagency data requirements include a general land use/land cover inventory, irrigated lands identification and classification, and crop identification. Of the 38 different applications of remote sensing/GIS technology identified, 11 are of common interest to at least 2 agencies, and 4 are of interest to at least 6 agencies (Tables 6 and 7 ).

The Task Force recommended that the KARS Program, in conjunction with Kansas state agencies, document the benefits that could be derived by integrating remote sensing data gathering techniques into agency programs. The agency representatives also appointed a delegation to meet with Kansas Governor John Carlin to discuss the mission and objectives of the Task Force, and to request direction on alternatives for institutionalization of an operational remote sensing/GIS program in Kansas state government. Both the results of this meeting (held on September 10, 1981) and the amended user/cost-benefit

TABLE 6

DATA PRIORITIES OF KANSAS INTERAGENCY
TASK FORCE ON APPLIED REMOTE SENSING

| Data | Number of Agencies |
|---|---|
| Land Use Inventory (Maps, Statistical Data) | 12 |
| Irrigated Lands Identification and Classification | 10 |
| Crop Inventory | 10 |
| Land Use - GIS | 7 |
| Non-Point Pollution Sources Identification and Classification | 7 |
| Reservoir Turbidity/Water Quality Evaluation | 7 |
| Mined Lands Environmental Assessment | 7 |
| Surface Water Inventory | 6 |
| Land Use Monitoring Near Major Reservoirs | 6 |
| Rangeland Condition Evaluation | 5 |
| Riparian Land Use/Environmental Assessment | 5 |

TABLE 7

KANSAS AGENCIES REQUIRING DATA REGARDING IRRIGATED LANDS

| Agency | Application |
|---|---|
| Kansas Water Office | State Water Planning |
| Kansas State Board of Agriculture | |
| Division of Water Resources | Administration of Water Rights, Drilling Permits |
| Division of Entomology | Control of Insect Pests |
| Kansas Geological Survey | Evaluation of Groundwater Availability, Depletion Rates and Management Options; Modeling of Hydrologic Systems |
| Kansas Groundwater Management Districts | Establishment of Planned Depletion Policy and Local Groundwater Management Plants; Evaluation of Permits for New Wells; Public Education |
| Kansas Department of Health and Environment | Water Quality Evaluation |
| Kansas Department of Revenue | Tax Assessment |
| Kansas Fish and Game Commission | Wildlife Habitat Evaluation |
| Kansas Legislative Research Department | Special Studies for Kansas Legislature (e.g., Corporate Ownership of Irrigated Lands) |
| Kansas Corporation Commission and Public Utilities | Energy Demand Forecasting |

study were presented at the third meeting of the Task Force held December 14, 1981, at the State Capitol in Topeka. The committee reported that Governor Carlin viewed very positively the advantages of applying remote sensing/GIS technology to state agencies' needs. He recommended that the agencies work to identify funds in their respective budgets which might be earmarked for remote sensing. Senator Fred Kerr is exploring alternative legislation to provide funds for the KARS Program during the interim period until state agencies' budgets can be adjusted to accommodate such funding.

On January 20, 1982, Senators Fred A. Kerr (Pratt, KS) and Jane M. Eldredge (Lawrence, KS) introduced Senate Concurrent Resolution No. 1644 into the Kansas Senate (Appendix VI). The resolution charges the Kansas Interagency Task Force on Applied Remote Sensing with evaluating the ways in which the Kansas Applied Remote Sensing (KARS) Program "can be most efficiently and effectively maintained," and directs the Task Force to present an initial report to the Governor and Legislature regarding this matter on or before December 31, 1982.

The resolution was chief among the topics discussed at the January meeting of the Task Force held again at the State Capitol in Topeka. Other major items on the agenda were:

- A discussion of legislative and executive alternatives for providing baseline funding for an operational KARS Program; and
- A report by Dr. Edward Martinko and Raney Gilliland, Kansas Legislative Research, regarding the Governor's recommendation, in his FY1983 Budget, that a fee fund be established to aid agencies in working contractually with the KARS Program. Such a fund should help facilitate transfer of contractual funds from the agencies to the KARS Program.

In April 1982 the Kansas Interagency Task Force on Applied Remote Sensing received formal recognition and direction from the Kansas Legislature as 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.

Resolution 1644 states, in part, "That it is in the interest of hte 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 has directed that "the task force shall exist until December 31, 1983, and shall reports 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. 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.
- 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.
- 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 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.

The Task Force will meet again in May 1982. All agencies were requested to have permanent representatives appointed (re: Resolution 1644) prior to the May 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 agenct project priorities for 1982-1983. Summaries of the Task Force meetings for the year can be found in Appendix VII.

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.

# A SURVEY OF KANSAS STATE AGENCY DATA NEEDS AND COST BENEFIT ANALYSIS OF DATA GATHERING BY REMOTE SENSING MEANS AND CONVENTIONAL METHODS

ABSTRACT

There are at least 38 statutes or specific projects in the State of Kansas which could utilize data acquired by remote sensing/geographic information system (GIS) technology. These statutes and projects have been identified from thirteen different Kansas departments, agencies or commissions (see Table 8). (The data needs of federal, regional and local agencies within Kansas have not been studied.) At this time, there is no coordinated data collection, analysis or management of these data needs in the State of Kansas. Every agency has its own method of gathering these data (if they can obtain them at all), resulting in many cases, in duplication of time, effort and funding. Each of these data needs could utilize information derived from remote sensing/GIS technology in a unified effort, thus resulting in a reduction of time spent on data gathering and analysis. Table 10 details specific cost comparisons between the utilization of conventional data gathering methods and that of remote sensing/GIS technology. The table is organized to reflect the costs that one agency would bear for obtaining data for one project. It was found that a cost savings of 30% to 96% could be realized by a single agency for one project if the data were gathered using remote sensing/GIS technology rather than present techniques.

INTRODUCTION

On Thursday, May 7 and Thursday, July 9, 1981 the Kansas Applied Remote Sensing (KARS) Program convened the first two meetings of the Kansas Interagency Task Force on Applied Remote Sensing at the University of Kansas Space Technology Center in Lawrence. The Task Force has been established to (1) provide policy direction for the KARS Program, (2) define Program goals and priorities, (3) enhance interagency communication, coordination and cooperation on remote sensing and utilization of geographic information systems (GIS), (4) provide feedback to the KARS Program regarding agency needs and concerns, (5) evaluate the Program's performance and requirements, and (6) assess alternatives for greater and more operational utilization of remote sensing/GIS technology on a state-wide basis. While recognizing that state agencies with which the KARS Program has worked have benefited from and need to enhance and ensure continual access to the application of remote sensing/GIS technology, the Kansas Interagency Task Force on Applied Remote Sensing requested during the course of these first two meetings that

the KARS Program document, in a systematic fashion, the specific manner in which state agencies could use such technology to better accomplish their assigned missions and legally mandated obligations and the cost benefits that could be derived by using remote sensing data gathering techniques rather than conventional means of data collection.

## METHODOLOGY

Information regarding agency data needs and cost comparisons between remote sensing and conventional data gathering techniques were collected during surveys conducted between June 1 and August 5, 1981 through telephone and personal interviews. Assistance was provided by the following agency representatives within Kansas:

Guy Gibson
David Pope
Emmet Dusharm
Kansas State Board of Agriculture
Division of Water Resources

Donald F. Kostecki
John Gottschamer
Kansas Water Office

William W. Hambleton, Director
Manoutch Heidari
Kansas Geological Survey

Robert C. Walters
Kansas Department of Revenue

Freeman E. Biery, Director
Kansas State Board of Agriculture
Division of Weeds and Pesticides

Rick Illgner, President
Kansas Groundwater Management District Managers Association

Don Snethen
Kansas Department of Health and Environment

Wayne Herndon
Kansas Park and Resources Authority

Ramon Powers
Raney Gilliland
Legislative Research Department

R. C. Loux
Kansas Corporation Commission

William Hanzlick, Director
Verlyn Ebert
Kansas Fish and Game Commission

H. Dean Garwood, Director
Tom Sims
Dale Lambley
Kansas State Board of Agriculture
Division of Entomology

Kevin Carr
Kansas Department of Economic Development

KARS Program staff members were responsible for contacting these agency personnel, compiling the data and summarizing the results of the survey.

## SUMMARY OF RESULTS

The common data needs of Kansas State agencies are summarized in Table 8. The most recurrent interagency data requirements include a general land use/land cover inventory, irrigated lands identification and classification, and crop identification. A description of these data requirements is included in Table 9.

Specific cost comparisons for eight projects both in Kansas and in other states are compiled in Table 10. The table lists the specific project and the time, detail, scale and total dollar figure for gathering the project's data by using both conventional means and remote sensing/GIS technology. The percentage of savings obtainable by using remote sensing/GIS methods are also included. In each case, remote sensing/GIS technology was found to provide the user with a substantial amount of savings. These savings range from 30% to 96% over conventional data gathering techniques. Where dollar figures were not available for conventional data gathering techniques, the use of remote sensing data is considered beneficial when it would be supplying data which the agency needs but which heretofore have been unavailable in terms of completeness and/or timeliness. The prime benefit derived from improved information is the ability to make improved decisions -- those which affect buying, selling, investing or setting government economic programs -- with increased accuracy, in a more timely manner or with more certainty.

**Table 8.** COMMON DATA NEEDS OF KANSAS STATE AGENCIES

#1. This data requirement is a necessity for this agency.

#2. This agency could probably use this type of data.

#3. This agency could possibly use this type of data.

AGENCY

| DATA REQUIREMENT | KANSAS CORPORATION COMMISSION | KANSAS DEPARTMENT OF HEALTH AND ENVIRONMENT | KANSAS DEPARTMENT OF REVENUE | KANSAS FISH AND GAME COMMISSION | KANSAS GEOLOGICAL SURVEY | KANSAS GROUNDWATER MANAGEMENT DISTRICT MANAGERS ASSOCIATION | KANSAS PARK AND RESOURCES AUTHORITY | KANSAS STATE BOARD OF AGRICULTURE-DIVISION OF ENTOMOLOGY | KANSAS STATE BOARD OF AGRICULTURE-DIVISION OF WATER RESOURCES | KANSAS STATE BOARD OF AGRICULTURE-DIVISION OF WEEDS AND PESTICIDES | KANSAS WATER OFFICE | LEGISLATIVE RESEARCH DEPARTMENT | | | TOTALS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Land Use/Land Cover Inventory | X | X | | X | | | | X | | X | X | X | | | 7 |
| 2. Geographic Information System to Define Homogeneous Physical/Land Use Regions | | | X | | | | | | | | | | | | 1 |
| 3. Land Use/Land Cover and Physical Features Inventory for Recreational Planning and Trails Development | | | | | | | X | | | | | | | | 1 |
| 4. Land Use/Land Cover Data in Geographic Information System as Input to Geo-Based Natural Resource Models | | | | | | X | | | | | | | | | 1 |
| 5. Identification of Irrigated Lands | | X | X | X | X | X | | X | X | | X | X | | | 9 |
| 6. Classification of Irrigated Lands | | | X | X | X | X | | X | X | | X | | | | 7 |
| 7. Crop Identification | | | X | | X | X | | X | | X | | X | | | 6 |
| 8. Crop Condition Monitoring | | | | | | | | X | | | | | | | 1 |
| 9. Surface Water Inventory | | X | | X | | | | | | | X | | | | 3 |
| 10. Water Body Condition Assessment | | X | | | | | | | | | X | | | | 2 |
| 11. Thermal Discharge in Water Bodies | X | | | | | | | | | | | | | | 1 |
| 12. Reservoir Siltation | | | | | | | X | | | | X | | | | 2 |
| 13. Reservoir Shoreline and Shallow Water Vegetation | | | | | | | | | | | X | | | | 1 |
| 14. Floodplain Delineation | | | | | | | | | | | X | | | | 1 |
| 15. Streambank Erosion and Channel Meandering | | | | | | | | | | | X | | | | 1 |
| 16. Dam Inventory Update | | | | | | | | | X | | | | | | 1 |

#1. This data requirement is a necessity for this agency.

#2. This agency could probably use this type of data.

#3. This agency could possibly use this type of data.

| DATA REQUIREMENT | KANSAS CORPORATION COMMISSION | KANSAS DEPARTMENT OF HEALTH AND ENVIRONMENT | KANSAS DEPARTMENT OF REVENUE | KANSAS FISH AND GAME COMMISSION | KANSAS GEOLOGICAL SURVEY | KANSAS GROUNDWATER MANAGEMENT DISTRICT MANAGERS ASSOCIATION | KANSAS PARK AND RESOURCES AUTHORITY | KANSAS STATE BOARD OF AGRICULTURE-DIVISION OF ENTOMOLOGY | KANSAS STATE BOARD OF AGRICULTURE-DIVISION OF WATER RESOURCES | KANSAS STATE BOARD OF AGRICULTURE-DIVISION OF WEEDS AND PESTICIDES | KANSAS WATER RESOURCES OFFICE | LEGISLATIVE RESEARCH DEPARTMENT | | TOTALS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 17. Mapping Access and Major Transportation Routes in The Vicinity of Major Rivers | | | | | | | X | | | | | | | 1 |
| 18. Inventory of Natural Vegetation and Physical Features Along Major Rivers | | | | | | | X | | | | | | | 1 |
| 19. Private, Commercial and Recreational Development Around Reservoirs | | | | | | | X | | | | | | | 1 |
| 20. Mapping Areas of Visible Pollution | | | | | | | X | | | | | | | 1 |
| 21. Pesticide Drift | | | | | | | | X | | X | | | | 2 |
| 22. Non-point Pollution Sources Evaluation | | | | | | | | | | | | X | | 1 |
| 23. Environmental Impacts Associated With Proposed or Existing Power Generating Facilities (e.g. Vegetation Stress) | X | | | | | | | | | | | | | 1 |
| 24. Criteria for Hazardous Waste and Sanitary Landfills | | X | | | X | | | | | | | | | 2 |
| 25. Noxious Weed Location and Acreage Determination | | | | | | | | | | X | | | | 1 |
| 26. Identification of Mined Lands and Environmental Impact Assessment | | X | | | | | | | | | | X | | 2 |
| 27. Vegetation Mapping of Mined Land Wildlife Area | | | | X | | | | | | | | | | 1 |
| 28. Endangered Species Habitat | | | | | | | | X | | | | | | 1 |
| 29. Antelope Habitat Update | | | | X | | | | | | | | | | 1 |
| 30. Rangeland Condition | | | | | | | | X | | | | | | 1 |
| 31. Rangeland Burning Monitoring | | | | X | | | | | | X | | | | 2 |
| 32. | | | | | | | | | | | | | | |

AGENCY

Table 9. DESCRIPTION OF DATA REQUIREMENTS

1) Land Use/Land Cover Inventory: a remotely sensed survey of surficial natural resources and the delineation of land use.

2) Geographic Information System to Define Homogeneous Physical/Land Use Regions: a remotely sensed survey of land use employed in combination with ancillary data such as soils surveys, census records, topographic and thematic maps and similar resources in order to determine land regions which are homogeneous in nature.

3) Land Use/Land Cover and Physical Features Inventory for Recreational Planning and Trails Development: as in (1) above but with the specific use of planning recreation areas.

4) Land Use/Land Cover Data in Geographic Information System as Input to Geo-Based Natural Resources Models: as in (2) above but with the specific use of being used in combination with natural resource management design.

5) Identification of Irrigated Lands: the delineation of areas which are under irrigation (i.e., irrigated vs. non-irrigated lands).

6) Classification of Irrigated Lands: the determination of the type of crops which are under irrigation (irrigated corn vs. irrigated wheat)

7) Crop Identification: determination of the types of crops under cultivation (i.e., corn vs. soybeans).

8) Crop Condition Monitoring: inspection of crop status for signs of vigor or stress.

9) Surface Water Inventory: a survey of surface water bodies through remote sensing which could include location and acreage determination.

10) Water Body Condition Assessment: the determination of the status of surface water bodies in terms of the degree of siltation and/or eutrophication.

11) Thermal Discharge in Water Bodies: the delineation of heat differentials due to thermal discharge in surface water bodies.

12) Reservoir Siltation: as in (10) but specifically for reservoir siltation levels.

13) Reservoir Shoreline and Shallow Water Vegetation: the delineation of vegetation covering reservoir shorelines and beneath shallow water.

14) Floodplain Delineation: determination of floodplain location and including areal measurements.

15) Streambank Erosion and Channel Meandering: the determination of the location and areal measurement of eroding streambanks and channel meanders.

16) Dam Inventory Update: the determination of dam location.

17) Mapping Access and Major Transportation Routes in the Vicinity of Major Rivers: the delineation of roads near major rivers.

18) Inventory of Natural Vegetation and Physical Features Along Major Rivers: a survey of natural vegetation and features such as roads, bridges and dams along major rivers.

19) Private, Commercial and Recreational Development Around Reservoirs: a determination of the location, areal coverage and type of development occuring around reservoirs.

20) Mapping Areas of Visible Pollution: the delineation of areas which exhibit pollution such as open dumping, siltation and eutrophication

21) Pesticide Drift: the delineation of areas where pesticide has drifted onto non-target areas..

22) Non-Point Pollution Sources Evalution: the determination of areas which could be contributing to pollution problems.

23) Environmental Impacts Associated With Proposed or Existing Power Generating Facilities: determination of environmental impacts on local and regional land use, wildlife habitat and vegetation stress that may be associated with power generating facilities.

24) Criteria for Hazardous Waste and Sanitary Landfills: determination of criteria such as surface drainage, floodplains and geomorphology to aid in the location of hazardous waste and sanitary landfills.

25) Noxious Location and Acreage Determination: the identification and statistical inventory of noxious weed infestations.

26) Identification of Mined Lands and Environmental Impact Assessment: a survey of mined lands and determination of environmental impacts such as vegetation stress, the extent of revegetation, surface drainage and topographic relief.

27) Vegetation Mapping of Mined Land Wildlife Area: the delineation, classification and areal measurement of vegetation within the Mined Land Wildlife Area.

28) Endangered Species Habitat: an inventory of land use, land cover and habitat condition in endangered species habitat areas.

29) Antelope Habitat Update: as in (28) but specifically for antelope.

30) Rangeland Condition: a survey of the status of rangeland including an inventory of barren areas, vegetation identification and classification and areal measurements.

31) Rangeland Burning Monitoring: the delineation and areal measurement of rangeland areas which have undergone burning.

Table 10

COST COMPARISONS BETWEEN REMOTE SENSING AND CONVENTIONAL DATA GATHERING TECHNIQUES

1. Kansas Statewide Land Use Map Update (exclusive of printing costs)

| | Conventional | | Landsat/GIS - Manual Analysis | |
|---|---|---|---|---|
| | Kansas (KS Dept. of Economic Development) | Tennessee* | Kansas | Tennessee* |
| TIME | These data are considered by this agency to be unattainable using conventional methods. | 11.5 man-years | 6 months | 1 week |
| DETAIL | | 9 categories | 12 categories | 9 categories |
| SCALE | | not given | 1:1,000,000 | not given |
| TOTAL | | $223,000 | $18,831 | $50,000 |
| % SAVINGS† | | | | 78% |

| | Conventional | | Landsat/GIS - Digital Analysis | |
|---|---|---|---|---|
| | Kansas (KS Fish & Game Commission) | Mississippi** | Kansas | Mississippi** |
| TIME | 21 man-years | not given | 4 man-years | not given |
| DETAIL | 6 categories | 6 categories | 6 categories | 6 categories |
| SCALE | 1:24,000 | 1:24,000 | 1:24,000 | 1:24,000 |
| TOTAL | $787,500 | $894,900 | $200,000-250,000 | $137,000 |
| PER COUNTY | $7,500 | | $10,000 - 15,000 to start, but would be less for other counties with a probable savings of at least $1000/county over the $7500 estimate per county by conventional methods | |
| % SAVINGS | | | 72% - 79% | 85% |

*Information provided by Paul J. O'Farrell, Systems Analyst, Tennessee Department of Conservation, Nashville, TN.

**Based on Joyce, A. T. January, 1979. Final Report on the Natural Resources Inventory System ASVT Project. NASA Technical Report #58211. NASA - Earth Resources Laboratory, Bay St. Louis, MS.

†Percent savings of remote sensing/GIS technology over conventional data gathering techniques.

2. Antelope Habitat Survey:

| | Conventional - Kansas Fish & Game Commission | Landsat - Manual |
|---|---|---|
| TIME | 140 man days | 6 months |
| DETAIL | 2 categories (over 4 years) | 2 categories (over 5 years) |
| SCALE | 1:250,000 | 1:250,000 |
| TOTAL | $19,750 | $13,766 - based on 1981 figures |
| % SAVINGS | | 30% |

3. Irrigated Lands Identification - for western 1/3 of Kansas

Conventional

These data are presently only available for small areas of the state; cost comparison figures are unavailable at this time.

Landsat - Digital

TIME: 6 months

DETAIL: 2 categories

SCALE: 1:24,000

TOTAL: $30,587 ($91,761 for entire state)

4. Crop Identification - for entire state

Conventional

These data are presently gathered through statistical sampling procedures; cost-comparison figures are unavailable at this time.

Landsat - Digital

TIME: 4 man years

DETAIL: 6 categories

SCALE: 1:24,000

TOTAL PER COUNTY: $10,000 - $15,000 for the first county, with surrounding counties at a greatly reduced rate.

5. Mapping of East Texas Forestlands*

| | Aerial Photos | Landsat |
|---|---|---|
| TIME | 10.7 man years | 4 man months |
| AREA | 11 million acres | 11 million acres |
| COST | $294,000 | $10,298 |
| % SAVINGS | | 96% |

6. Southwestern Illinois Metropolitan and Regional Planning Commission*

| | Ground Survey | Aerial Photos | Landsat |
|---|---|---|---|
| TIME | 8 years | 18 months | 6 months |
| DETAIL | 40 categories | 5 categories | 16 categories |
| AREA | 1,788 sq. mi. | 1,788 sq. mi. | 3,792 sq. mi. |
| TOTAL | $106,201 | $36,049 | $15,975 |
| % SAVINGS | | 66% | 85% - 56% |

7. Floodplain Study of the Cumberland River Through Nashville*

| | Corps of Engineers | Geographic Information System of Tennessee |
|---|---|---|
| TOTAL | $200,000 | $132,000 |
| % SAVINGS | | 34% |

8. Inventory of the State of Washington's Forests***

| | Conventional | Landsat |
|---|---|---|
| TIME | 2 years | 1 year |
| TOTAL | $2,000,000 | $200,000 |
| % SAVINGS | | 90% |

***From: The Kansas City Times. July 9, 1981. "Eyes in Orbit Search Missouri's Ozarks for Sign of Minerals." pg. B-8.

KARS Program Computer Development

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's 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 system represents a major upgrade of KARS's capacity for digital image analysis and information processing. Until recently, KARS was limited to 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, which are heavy users of computer resources. The desktop computer, an Intertec SuperBrain with a Z-80 eight-bit microprocessor, while useful for some KARS activities, had insufficient computing speed and storage for statewide image analysis applications.

Since the early 1970's, the majority of satellite image processing systems have been built around large mini-computers. Popular mini-computer models for this purpose have included Digital Equipment Corporation's (DEC) larger PDP-11 models, such as the 11/44, 11/55 and 11/70; the Hewlett-Packard HP-3000; Sperry-Varian V-series computers; "number-crunching" minis from Prime and Harris, and 32-bit "super-minis" such as the DEC VAX series and the Perkin-Elmer 8/32 and its descendents. 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.

Other institutions have used large centralized mainframe computers for Landsat analysis. Those which have done this successfully have tended to have a large computer dedicated for image processing applications, however. A dedicated computer generally 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.

Both high-end and 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's strategy, therefore, has been to use state-of-the-art microcomputer technology to develop a system optimized in terms of cost-effectiveness and suitability for Landsat-oriented computing. KARS was particularly interested in the software package ELAS (Earth Resources Laboratory Applications Software) written at NASA's Earth Resources Laboratory at Bay St. Louis, Miss. 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.

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 3 ).

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 point-per-inch resolution will provide hard-copy graphics output.

Color video display and other functions are provided by a Terak 8510/ε-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

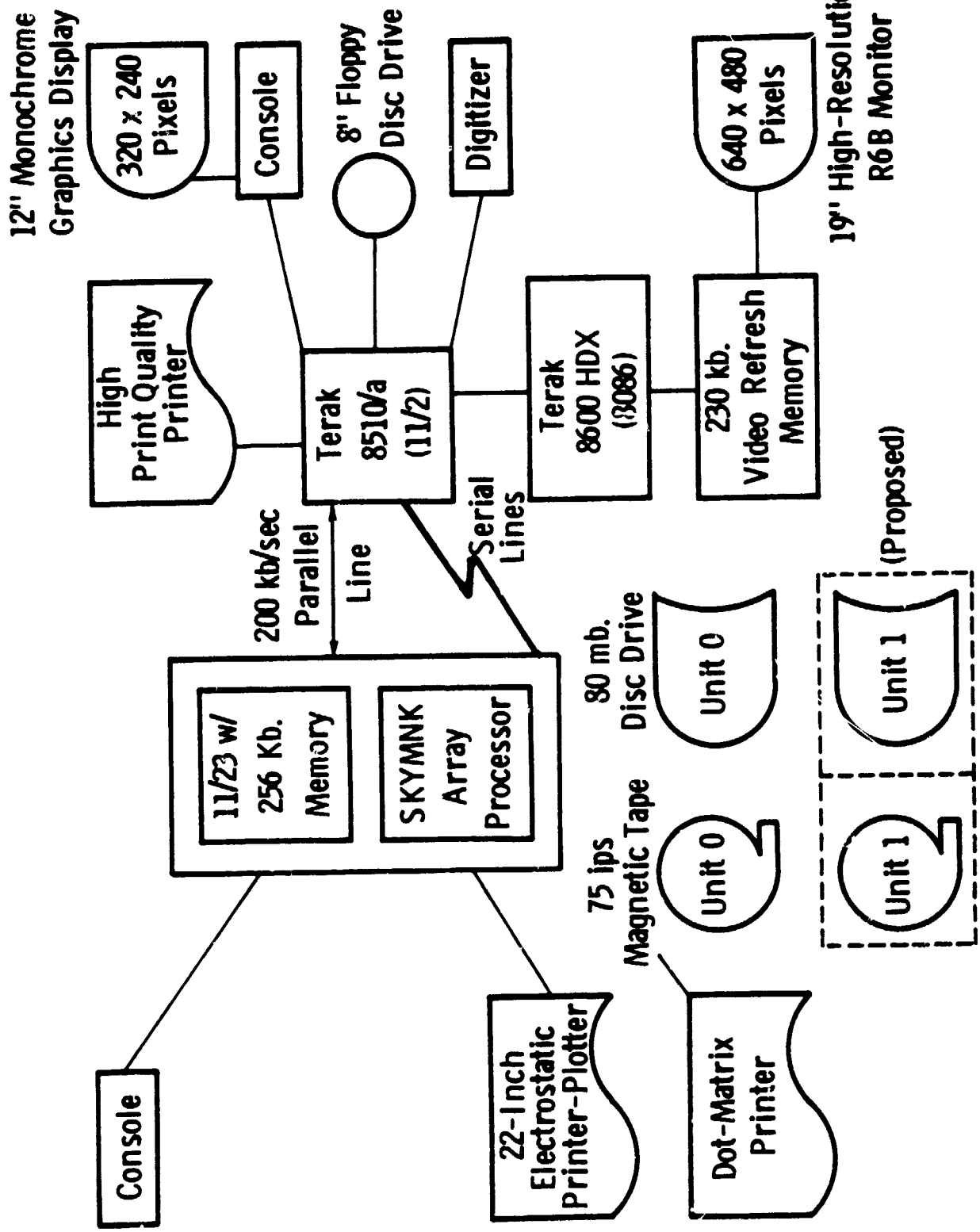



Figure 3. The KARS Program Low-Cost Stand-Alone Image Processing and Geographic Information System

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 by using the RSX-11M operating system. 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.

KARS implementation of ELAS uses the RT-11 operating system. As a single-user, multi-tasking operating system, RT-11 has less intrinsic overhead than RSX-11M and should prove more suitable for resource-intensive activities such as image processing. In addition, RT-11 allows programs to manage more than 56K bytes of memory. These memory management techniques, including "virtual arrays" and "virtual overlays," are not particularly straightforward. However, they should allow RT-11 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 oper-

ations will be performed by the TRW pipeline CPU in the SKYMNK arithmetic unit; data transfers will be performed by intelligent device controllers that user 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 Altec AC90SM digitizer that was already on site, is slightly less than $100,000.

# III. KARS PROJECT ACTIVITIES

April 1, 1981-March 31, 1982

## Agricultural and Rural Development

Arkansas River Irrigation Moratorium

Kansas water law is based on the doctrine of "first in time, first in right." All appropriations of water, either surface water or groundwater, must first be applied for and granted as a "water right" by the Chief Engineer of the Division of Water Resources (DWR) of the Kansas Department of Agriculture. Should a conflict arise between two users of the same water, the water law doctrine would give priority to the user who had been granted his water right first.

During the 1970's, there has been a continual decrease in streamflow in the Arkansas River downstream of the Colorado-Kansas state line. The streamflow at Syracuse, located in central Hamilton County, Kansas about 12 miles from the state Line (Figure 4 ) decreased from an annual average of 232 cubic feet per second in the period 1951-69 to only 85 cubic feet per second during the 1970-79 period. Accompanying this reduced streamflow has been a die-off of woody vegetation along extensive reaches of the river. This decreased streamflow has meant that a number of water appropriators who have been granted a water right to specific volumes of water are not able to obtain sufficient amounts of water from the river to fully exercise their right.

Recent growth in the use of groundwater for irrigation has been taking place throughout all of Kansas and has been particularly pronounced in the southwestern part of the state. A measurable decline of water levels in the aquifer adjacent to the Arkansas River has accompanied this irrigation growth. In January 1979 water levels in Hamilton County and western Kearny County averaged 4 feet lower than January levels in 1970. Water levels near the river channel in parts of eastern Kearny County declined more than 25 feet during the same period.

For several years now the availability of water for diversion at the head gates of irrigation canals has been inadequate to meet legal water right commitments and to satisfy crop demands. In addition, annual precipitation at Syracuse, Kansas during 1970-79 averaged 2.4 inches below the long-term, 80-year mean of 16.5 inches. The corresponding decrease in effective precipitation during the growing season has produced an unprecedented demand on the surface and groundwater resources in the area. In an attempt

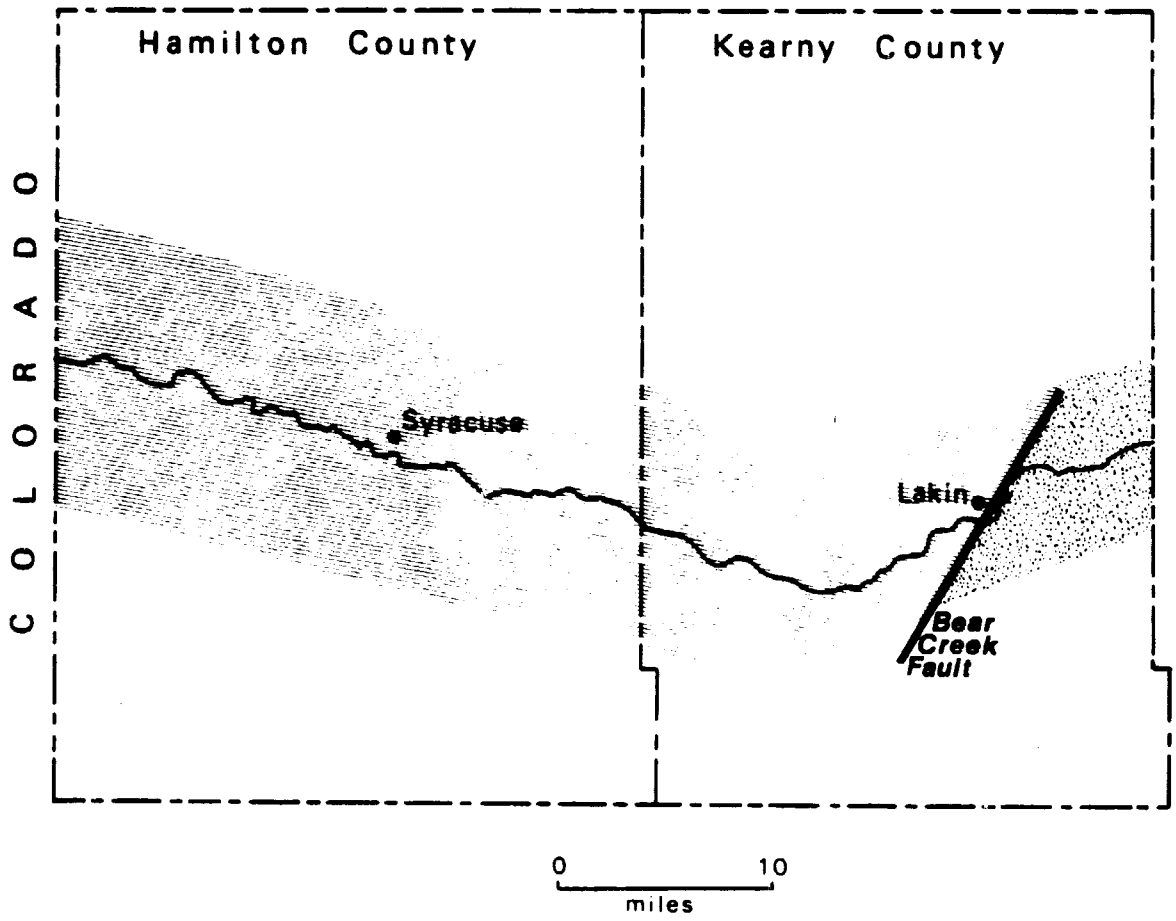



Figure 4.
Arkansas River Moratorium Study Area

to prevent excess stress on the hydrologic system beyond its natural capacity to recover, the Chief Engineer of the Kansas Board of Agriculture, Division of Water Resources (DWR) in January, 1977 placed a moratorium on approval of applications for groundwater and surface water in a 480 square-mile area along the Arkansas River in Hamilton and Kearny Counties.

At the present time there are more than 50 applications pending in the moratorium area. These applications have neither been approved nor denied, and the moratorium has continued because available information is insufficient to allow a sound judgment regarding the extent to which additional development of the water resources would impair water used under existing rights. At the time the moratorium was declared, no scientific evaluation of the interaction of groundwater and surface water in the area had been done. The Division of Water Resources, therefore, needs a means by which to assess future hydrologic conditions in the area in response to additional development of groundwater, different rates of incoming streamflow from Colorado, and different climatological possibilities.

To obtain the scientific information necessary to make decisions about the situation, the United States Geological Survey (USGS) was commissioned to conduct a comprehensive study of the surface-water and ground-water resources of the Arkansas River Valley between the Colorado-Kansas state line and the Finney-Kearny County line. Conducted from the Geological Survey's Garden City, Kansas office, the study began in July, 1977, and is scheduled to continue through September, 1982.

Specific objectives of the study are to: 1) determine the extent of interaction between ground-water, surface-water and climatic factors, 2) evaluate the effects of ground-water withdrawals on stream flow and 3) develop a digital-computer model of the exchange of water between the surface and subsurface. Once the computer model has been calibrated to simulate the sequence of observed responses to a history of hydrologic events, it can be used to predict the effects of various combinations of recharge rate and withdrawals.

The study area has been divided into two sections with the Bear Creek Fault in central Kearny County representing the dividing line (Figure 4 ). The geology of the study area east of the fault is much more complex than west of the fault and a different model will be required for each area. As

a result, the modeling is being done in two phases. The development of a model for the western two-thirds of the study area, extending eastward from the Colorado-Kansas state line through Hamilton County and into central Kearny County, constitutes the first phase. The model development for the eastern one-third of the study area, extending eastward from the Bear Creek Fault in central Kearny County to the Kearny-Finney County line, constitutes the second phase.

In conjunction with the USGS study the KARS Program was asked to provide land use and land cover information for the entire study area. Remote sensing data were chosen as the source of this information because they would be the most direct and efficient source of such information, they would reduce the amount of field work required, and they would be compatible with the model being developed.

Large scale (1:10,000) color infrared aerial photography acquired in July 1978 served as the principal source of land use/land cover data. Landsat multispectral scanner images (Band 5; 1:500,000 scale) acquired during May and August 1978 were used to assist in identification of irrigated cropland and to supplement the aerial photography in areas having incomplete photo coverage.

All image interpretation was accomplished at the original image scale and subsequently registered to a 1:63,360 base map of the study area. A final map was produced in color on stable-base Kwik-Proof material and delivered to the USGS.

The KARS map was initially utilized by the USGS hydrologists to locate stream channels, canals and water bodies in the project area, to determine where stress is placed on the groundwater supply (e.g., irrigation), to evaluate the effects of such stresses on riparian vegetation, and to locate a network of stream gauging and monitoring stations.

Data extracted from the map were used in the development of the Phase 1 area model and are currently being used in the development of the Phase 2 area model being constructed by USGS. The Phase 1 model, covering the 110,000 acres in the western two-thirds of the study area, has been completed. The KARS-provided map was used to define areas of recharge and to assign values to areas known to contain a specific vegetation type (phreatophytes). In addition, 31,000 acres of irrigated cropland were identified from the KARS

map and were input to the model in the form of well-pumpage figures and streamflow diversions.

After the model was calibrated (to correctly simulate historic sequences of observed responses to hydrologic events), it was used by USGS to evaluate the probable effects of various rates of groundwater pumpage, fluctuations in precipitation, and variations in surface water flow from Colorado.

Estimates were made by the USGS of where the groundwater went (discharge) and where the sources of the groundwater were (recharge) during the period 1975-1979. A difference was found of 81,000 acre feet of discharge and the 74,000 acre feet of recharge, and thus represents the volume of groundwater decline - some 7,000 acre feet - during the period. Identification of each factor in a quantitative fashion allows projections to be made of the potential impact of a change in one or more of the factors.

In this manner the USGS was able to state that:

> "Model results suggest that the water-level decline and streamflow shortage during 1970-79 were affected more directly by departures from historic (1951-65) rates of incoming streamflow than by either the smaller than average amounts of precipitation or the increased pumpage during the 1970's. Results also indicate that water-level declines and streamflow reduction would stabilize or reverse during 1980-82 if one of the following conditions prevailed:
>
> (1) monthly precipitation increased to 25% greater than the normal for 3 years,
> (2) pumpage decreased to 50% of 1979 rate, or
> (3) incoming streamflow increased to the 1951-1969 rate."

The report, entitled ANALYSIS AND COMPUTER SIMULATION OF STREAM-AQUIFER HYDROLOGY, ARKANSAS RIVER VALLEY, SOUTHWESTERN KANSAS, was released as an Open-File Report in August 1981. It will eventually be published as a USGS Water Supply Paper with the Phase 2 report.

The results of these studies will be used by the Kansas State Board of Agriculture's Division of Water Resources (DWR) to decide whether to lift the moratorium or make it permanent, and to decide on future appropriation of water rights and regulation of water use in the project area. DWR personnel have estimated that a final decision will not be made for 1-2 years. That decision must await the completion of the Phase 2 report and a lengthy evaluation process by DWR that will include both internal study of the reports and public hearings. Until that time the moratorium will remain in effect.

Inventory and Evaluation of Rangeland in the Cimarron National Grassland, Kansas

It has been demonstrated that data acquired by Landsat, particularly when integrated with data acquired from collateral sources, offer range managers potentially valuable information. Yet such data are not now widely utilized. An applied research project designed to identify and demonstrate the manner in which a range resource information system founded upon Landsat data may be employed by local level range managers was initiated in 1980. The components, structure and applications of such an information system are being defined by the potential users (range managers) working in concert with KARS remote sensing specialists. The work focuses on the Cimarron National Grassland of southwestern Kansas.

Cimarron National Grassland (CNG) encompasses approximately 107,140 acres in the extreme southwestern corner of Kansas (Figure 5 ). Most of CNG lies along the Cimarron River in Morton County, Kansas, though isolated tracts are scattered throughout Morton and neighboring Stevens Counties.

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.

The Forest Service has made substantial progress in re-establishing grassland and riparian vegetation. In general, well-managed silty and loamy hardland soils support short-grass prairie, while sandy soils are covered with mid to tall grasses and forbs. Open stands of cottonwood, willow and tamarack 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.

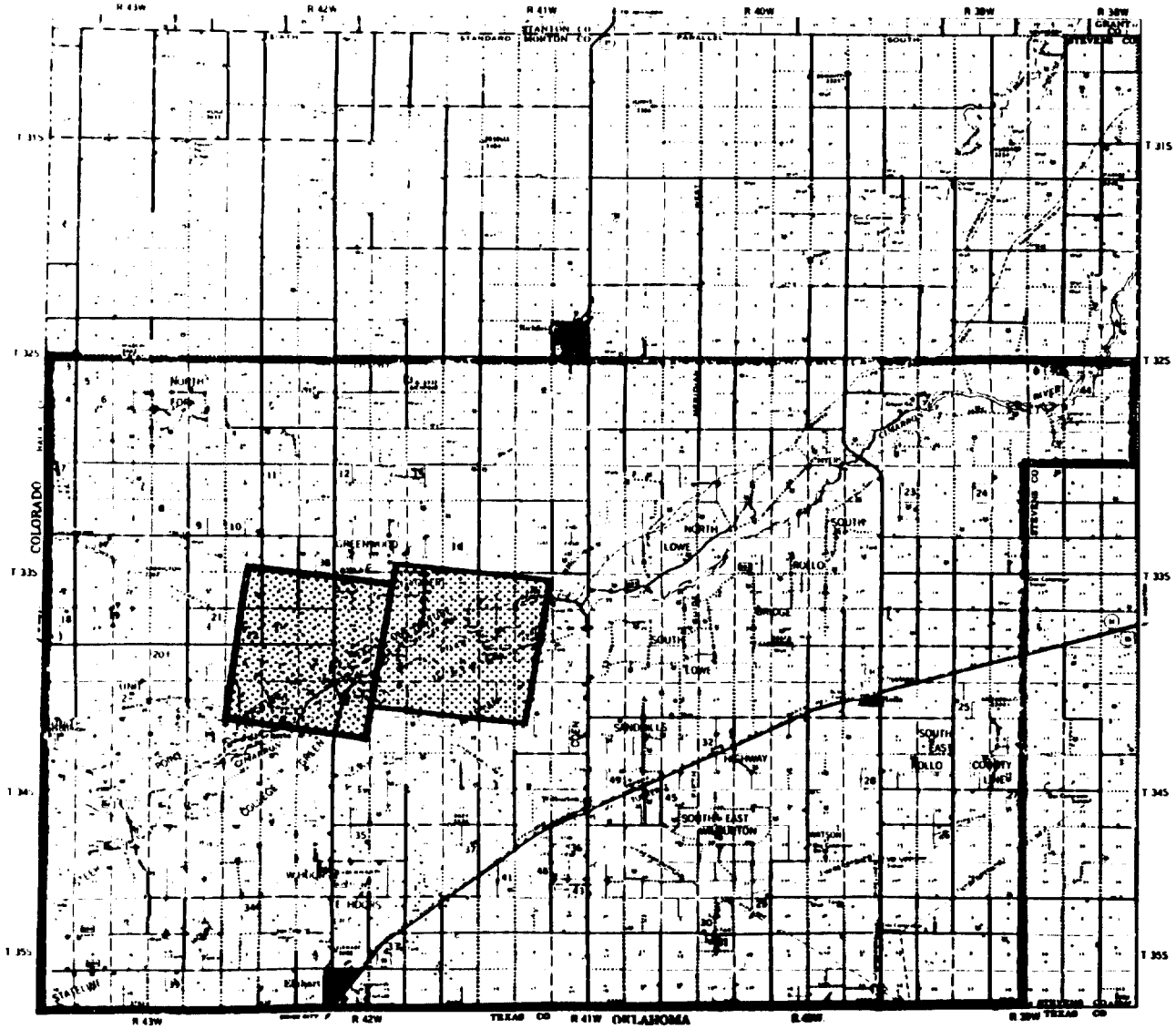
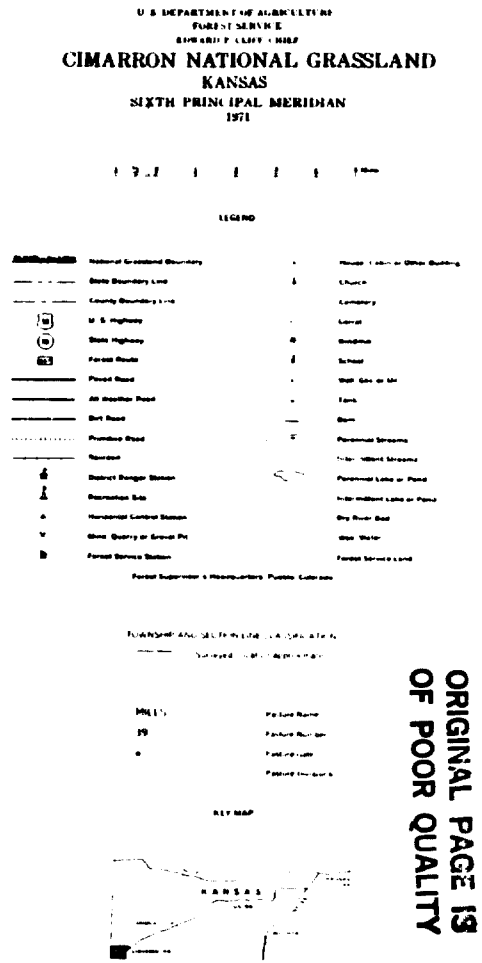



Figure 5. Map of the Cimarron National Grassland. Pilot study area is shaded. (Source: U.S. Forest Service)



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 5800-6000 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.

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 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 techniques are time consuming and costly and often provide insufficient information to optimally manage CNG.

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). In addition, the components, structure and potential applications of a rangeland resources information system are being defined. The research is directed towards providing the local level range manager with information which will facilitate better, more timely and/or more cost effective management decisions.

The multispectral, multitemporal data and large areal coverage afforded by Landsat make it a valuable complement to aerial photography. A number of

investigators have demonstrated that computer processed Landsat MSS digital data can be effectively employed to inventory range cover types and estimate biomass. The objective of our initial work was to adapt existing cover classification techniques to the CNG environment in order to enable Forest Service range managers to evaluate the viability, accuracy, format, cover classification and potential utility of Landsat-derived information for facilitating better range management.

Two test sites, of approximately 15,840 acres each, were selected for study (Figure 5 ). Landsat coverage for the 1980 growing season was reviewed and a scene identified for analysis on the basis of acceptable cloud cover, data quality and date. The phenology of important native species of grass, sage and yucca was considered in choosing the date of coverage.

Landsat MSS digital data, acquired 15 July 1980 (Scene ID 22001-16444), were computer processed on the KARS digital image processing system. An unsupervised cluster analysis technique employing a maximum likelihood classification algorithm was used to produce initial twenty-category maps of the two study sites. These maps portrayed spectrally similar regions. The twenty spectral classes were systematically collapsed into nine-category land cover maps of the study sites (Figure 6 ). Cover types were defined with the aid of aerial photography, existing topographic and resource maps, soils surveys and field data collected in August 1980. Forest Service personnel aided KARS Program staff in field data collection and in acquisition of USDA Agricultural Stabilization and Conservation Service medium scale (1:63,360) color aerial photography flown in July 1980.

Vegetative biomass was estimated and mapped using a band ratio technique. The best approximation of biomass appeared to be produced by ratioing MSS bands 5 and 7. Other vegetation indices tested, such as the Transformed Vegetation Index (alternately employing MSS bands 6 and 7) developed at Texas A&M University, were qualitatively judged by Forest Service and KARS Program personnel to be less representative of existing grassland condition.

In April 1981 KARS Program staff met with CNG Forest Service District Ranger Don Mecklenburg to review results of the Landsat analysis. A systematic post-classification field check conducted by KARS staff indicated that the vegetation cover classification and mapping was approximately 85% correct. The CNG Forest Service District Ranger concurred with the accuracy assessment of the land cover maps and with the utility of the format and classification scheme employed.

Figure 6. Land Cover classification of Cimarron National Grassland Pilot Study site. Each character represents approximately 1.1 acres .

Key

G - range grasses, greater than 75% cover, no sage
g - range grasses, 50-75% cover, no sage
* - range grasses, greater than 75% cover with open tree canopy near river, little or no sage
# - woodland with grass understory, greater than 70% cover, no sage
~ - soil with sparse stubble or weed cover
. - bare soil
S - sagebrush, greater than 75% cover
s - sagebrush and yucca, 50-75% cover
- scattered sagebrush and yucca with grass, less than 50% sage/yucca 50-75% ground cover

The initial attempt to map vegetative biomass was evaluated only qualitatively. Aerial photographs, field observations and the personal daily experience of Forest Service personnel were employed to judge the relative viability of several maps prepared using vegetation indices which have produced good results in other Great Plains locales. Substantially more work will be required in order to quantitatively establish the relationship between Landsat MSS-based vegetation indices and CNG grassland production (in lbs/acre). However, the initial work was judged by Forest Service personnel to be a reasonable representation of relative biomass conditions.

The maps, statistical information and analysis procedures utilized were also reviewed by ten Forest Service range managers representing National Grasslands in nearby southeastern Colorado and northwestern New Mexico, and the Forest Service regional service center in Pueblo, Colorado. There was unanimous agreement that the CNG pilot study has demonstrated that useful information regarding land cover types and, potentially, vegetative biomass can be acquired through computer processing of Landsat MSS digital data. All noted that such data would be highly valuable in rangeland management and would significantly aid in better decision-making regarding such issues as weed control, reseeding, pasture rotation and allowable grazing intensities. The accuracy and spatial detail of the products were considered sufficient for operational use at the local level and, in most cases, are better information than that presently available to rangeland managers. There was substantial interest in evaluating and quantifying the capabilities of Landsat for annual or seasonal monitoring of grassland condition and for detection of change.

The CNG Landsat pilot project is designed to address informational needs defined by potential data users. Range managers who have aided in planning and in reviewing project results have identified specific management decisions which could be facilitated by information such as that provided in the pilot study. These include:

- Establishment of annual stocking rates and grazing rotations,
- Allotment of grazing permits,
- Identification of areas requiring sagebrush and yucca control,
- Identification of areas requiring revegetation,
- 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.

While Landsat-derived data can contribute substantially to range resource management, clearly there are additional data, unobtainable from remote sensing, which bear on issues such as those cited above. Consequently, the KARS Program is exploring means to integrate, and utilize in concert, data available from conventional sources as well as data which may be acquired via remote sensing. The desirable components, structure and resolution of a prototype geographic information system for range management have, this year, been defined by the KARS Program and Forest Service range managers (Table 11).

Current efforts, founded upon the results of the pilot study, are being directed at:

1. refining and improving the accuracy of vegetative cover classification by incorporating vegetation phenology, range site preferences, and soils/site associations in Landsat data analysis algorithms,
2. establishing quantitative relationships between Landsat vegetation indices and CNG biomass, and
3. integrating the results of such work with ancillary data in a prototype micro-computer-based geographic information system.

It is anticipated that an expansion of the CNG work to encompass more of the CNG area will produce data which will aid the Forest Service and members of the Morton County Grazing Association in making 1983 range management decisions.

The pilot study has also attracted the attention of other agencies concerned with range management (e.g., Kansas Fish and Game Commission, U.S. Soil Conservation Service, Sunflower Resource Conservation and Development Project). KARS staff are now working with these agencies to initiate funded range management projects in other areas of the State.

Table 11. RANGE RESOURCE INFORMATION SYSTEM

| Data Element* | Data Sources** |
|---|---|
| Land cover/land use | Landsat MSS CCTs<br>Aerial photography |
| Biomass | Landsat MSS CCTs |
| Land Treatment, Management | U.S. Forest Service |
| Soils (type, suitability, vulnerability) | USDA/SCS<br>Morton County Soil Survey |
| Topography (slope, aspect) | USGS topographic maps<br>Digital terrain tapes |
| Ownership | Land ownership maps |
| Grazing (intensity, spatial distribution, rotations) | Grazing records (U.S. Forest Service, Morton County Grazing Association) |
| Wildlife | Kansas Fish and Game Commission, U.S. Forest Service |
| Climate | NOAA climatic records<br>Kansas State Agricultural Experiment Station meteorological data |
| Petroleum, Gas, Minerals | Kansas Geological Survey<br>U.S. Forest Service |

*Data base resolution = 10 acres

**All data supported by field surveys

## Walnut Creek Watershed Groundwater Model - Irrigated Lands and Crop Inventory

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 7). 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. The Kansas Applied Remote Sensing (KARS) Program, in cooperation with KGS, engaged in a project designed to assess the utility of Landsat data for estimating groundwater withdrawals.

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 are 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. Previous work by KARS has shown that irrigated

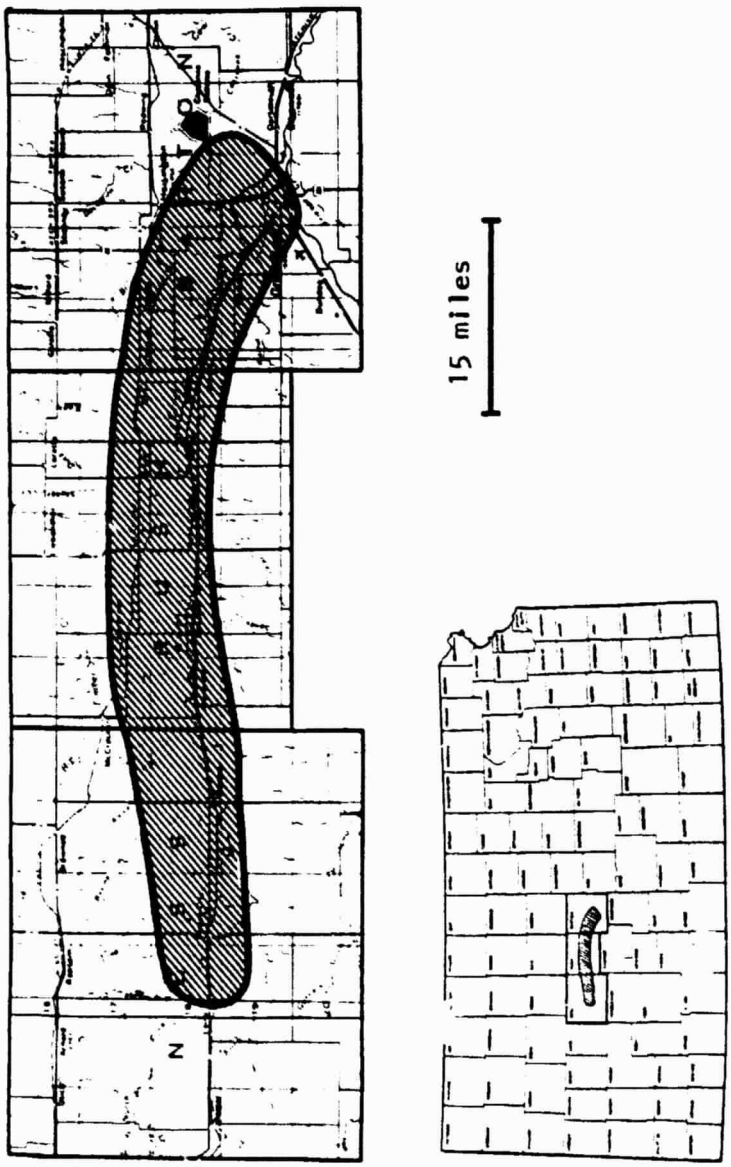



Figure 7. Walnut Creek Valley, central Kansas

fields in western Kansas generally have a more vigorous crop cover than similar unirrigated fields. This difference in crop vigor should be reflected in the tonal characteristics of the two types of field, especially in the red spectral band of Landsat imagery, which is sensitive to the low red reflectance of healthy vegetation. From a consideration of the crop calendars of the major crops in the area, a period between April and October was chosen for the study of irrigated areas.

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 (April/May), mid-season (July/August), and late season (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, thus enabling accurate identification of each crop.

A 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, using the criteria that vigorous irrigated crops appear black on the imagery whereas the unirrigated crops appear in gray tones. Because in the early part of the growing season (April/May) wheat fields are green, early season imagery was, therefore, needed to identify irrigated wheat. By mid-season (July/August) corn and sorghum (which are not emergent in May) have a dense ground cover; hence mid-season imagery was required to identify irrigated corn and sorghum. Because alfalfa is periodically harvested and is in a vigorous growth stage throughout much of the growing season, fields appearing irrigated in two or more parts of the growing season were interpreted as irrigated alfalfa.

Since all the possible patterns of irrigation for a given growing season were recorded on a single overlay, a color-coding scheme was used to identify crop types. Each "color" type was digitized on the KARS' Altec AC90SM digitizer and the data stored on floppy disc files on the KARS' Intertec SuperBrain Z-80 microcomputer. In order to reduce the number of data points generated for each field, the digitizer was put into gride mode for this operation. The grid was oriented such that each section was divided into 256

cells; that is, the grid for each section was 16 by 16. Thus, each irrigated field was represented by the X-Y coordinates of the cells that made up its boundary.

Three operations were performed on the digitized fields. First, a program EDITPTS (edit points) was executed on the SuperBrain to guarantee that all field boundaries were closed and to delete duplicate polygons (fields digitized twice by mistake). Then, the edited files were transmitted by telephone to the University's central computer system, a Honeywell Level 66 DPS-3E. The files were then plotted on a CalComp drum plotter (Figure 8 ) and the plots checked against the original interpretation for accuracy. Any errors were corrected.

Finally a program AREAGRID was implemented on the SuperBrain to fill the polygon boundaries and compute the areas in each quarter section that were irrigated. The quarter section boundaries were superimposed on the filled polygons and areas computed. The resulting areas were transmitted to the central Honeywell and made available to KGS. KGS has since transferred the data to their new computer, a Data General Eclipse MV8000.

Preliminary data for several sample sections indicate that the Landsat-based estimation technique is providing consistent results. A comparison of the Landsat-based estimates and the two other data 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. Because the water use reports are based on incomplete records, this is precisely what would be expected.

To date, 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. 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 as well as in other critical management areas.

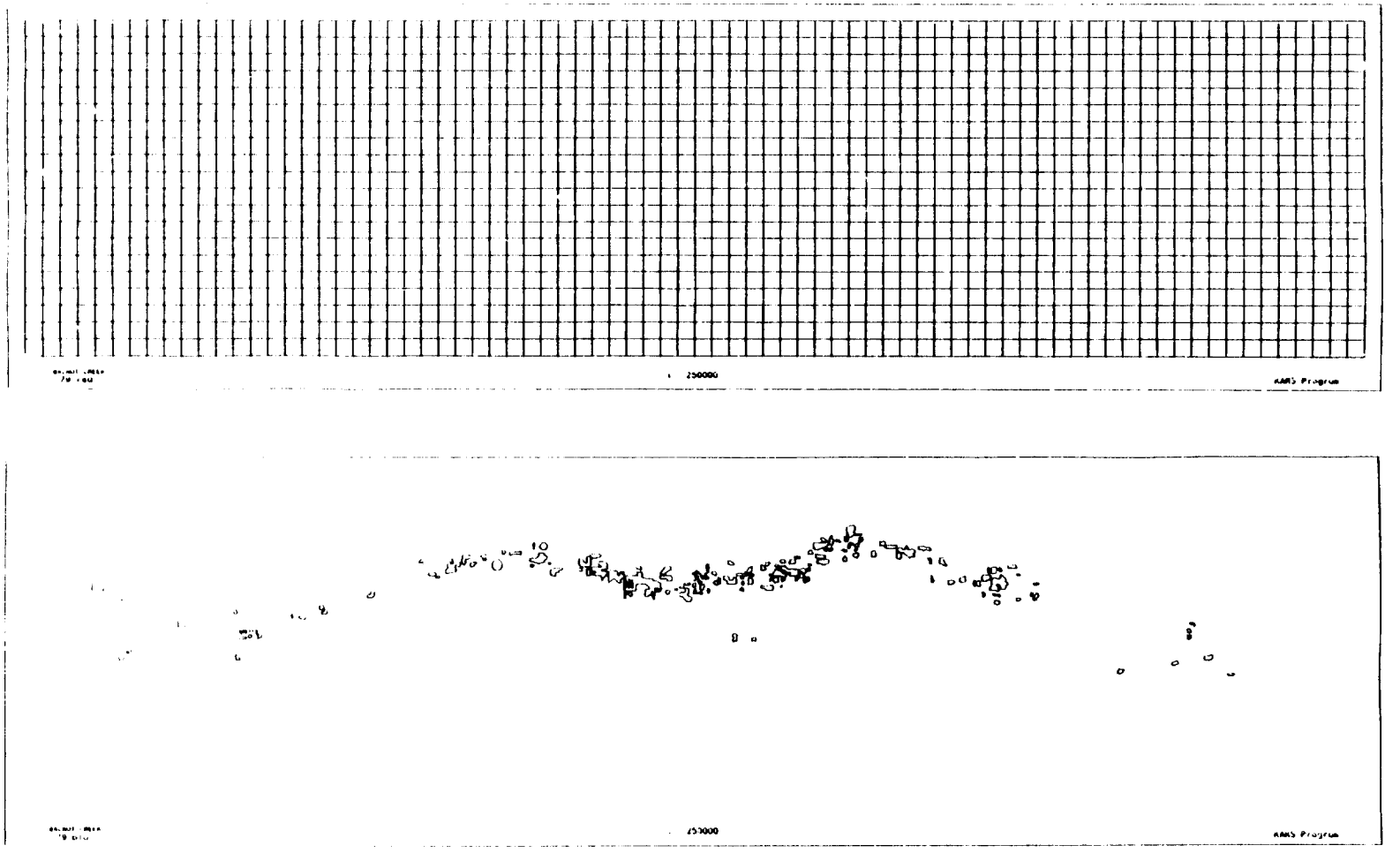






Figure 8. Two of the computer plots used to verify the digitized data with the original compilations. The upper plot represents the one-square mile section line grid of the study area; the lower plot is the area identified as being irrigated in the middle part of the growing season (July/August) and represents the irrigated corn and sorghum in the valley.

Wildlife Habitat and Environmental Quality

## Using Landsat to Select a Pronghorn Antelope Release Site in Kansas

Kansas represents the extreme eastern edge of pronghorn antelope (Antilocapra americana) 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. The decline of this species 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 the state. Antelope trapped in Montana were released in Sherman and Wallace counties in 1964. More antelope were trapped and released in 1966 and 1967 in other counties, but these latter herds were unsuccessful. Meanwhile, the population in Sherman and Wallace counties increased from 37 (1962) to over 1,100 (1980).

In selecting potential release sites for additional pronghorn transplants, KF&G personnel previously had looked for areas featuring large tracts of uninterrupted rangeland. In 1977, the Commission contracted the KARS Program to evaluate the possibility of using remotely sensed data in determining pronghorn habitat conditions for five areas.

A preliminary analysis of the habitat sites was completed using the KARS 1973 Landsat-derived Kansas Land Use Patterns map prepared by KARS in 1974 and KF&G field data. On the basis of this analysis one site was selected for a release (Flint Hills region in Chase County), and a second site (Morton County) was eliminated from further consideration.

The remaining sites were subjected to additional evaluation on the premise that areas where conversion of rangeland to cropland is occurring rapidly would be undesirable release sites. The three sites were 1) the Gove County Area, 2) the Clark County Area, and 3) the Ellsworth County area.

Landsat images were acquired in a 1:500,000 black and white print format. Imagery between May and September of the years 1972 through 1976 was used to evaluate agriculture encroachment onto rangeland for each area. Four Landsat images were interpreted for each year. Based upon the information resulting from this effort, the Clark County area was selected by KF&G for a second release site, because average annual loss of rangeland over the 1972-1976 time frame was only 1%.

Of particular importance were the data on the Gove County area. Based upon its location and land use the KF&G had anticipated that this area would be selected as a release site. KARS' analysis, 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 KF&G 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, Terry Funk, Big Game Biologist with the Northwest Fish and Game Regional Office in Hays, reports that 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. The following are considered to be important habitat parameters in Kansas:

- Food - especially winter wheat and forbs
- Topography - slopes of 5% or less
- Man-made barriers - restrict pronghorn movement
- Size of range - 10,000 acres or more preferred
- Wooded draws - for calving
- Dry climates - spring rains may enhance susceptibility to pneumonia in newborn calves
- Water availability - through forbs, stock tanks, etc.

Previous work has been based on the premise that the size of the range available was the single most important factor bearing on the success of pronghorns. However, recent studies have brought forth the importance of winter wheat in the diet of Kansas pronghorns. In fact, one study of pronghorns in the Sherman/Wallace area found 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 KF&G decided to investigate not only the relative abundance, but also the interspersion of this crop in both the Sherman/Wallace and Gove/Trego areas (Figure 9). This study was conducted for 1973 and 1980, so that the amount and distribution of winter wheat could be compared between two study areas, over an eight-year period.

1973. Black and white Landsat MSS Band 5 images at a scale of 1:250,000 were interpreted for spring and late summer of 1973. In addition to classifying cropland and rangeland, a winter wheat/alfalfa class was also identified on the spring imagery. These crops are actively growing in the spring of the year and appear as dark gray-to-black tones on the images.

A model was then used to determine the amount of interspersion of various components defined by superimposing a 160-acre grid over the study areas (see Figure 10). This model basically considers each 160-acre cell sequentially, in relation to the vegetation of its neighboring cells. Relative weights are assigned to the various edge combinations, based on their importance to pronghorn antelope. For example, a range/winter wheat-alfalfa edge has a higher value than a range/other crop edge.

The model was performed manually for both study areas. A juxtaposition index was determined for each cell in the sample and an average derived for the entire study area. Final results indicated that, although the two study areas appear to be drastically different, the relative amount and distribution of winter wheat throughout both areas is similar.

1980. Landsat MSS images were more difficult to obtain for the 1980 season because of cloud cover. Therefore, high altitude black and white aerial photography was utilized for both study areas, supplemented with 35mm section-centered color aerial photography. The increased resolution of the aerial photography resulted in improved interpretation overall. For example, more acres of rangeland were interpreted for both study areas in 1980 than in 1973. Part of this discrepancy is undoubtedly due to the increased accuracy of interpretation in 1980, although some of it may be accounted for by a reversion of cropland to range.

Preliminary results of the study are summarized in Tables 12-14. An analysis of these results is in process, and should be completed during the next two months. The results of this study should provide new insight into the relative importance of winter wheat/alfalfa availability in relation

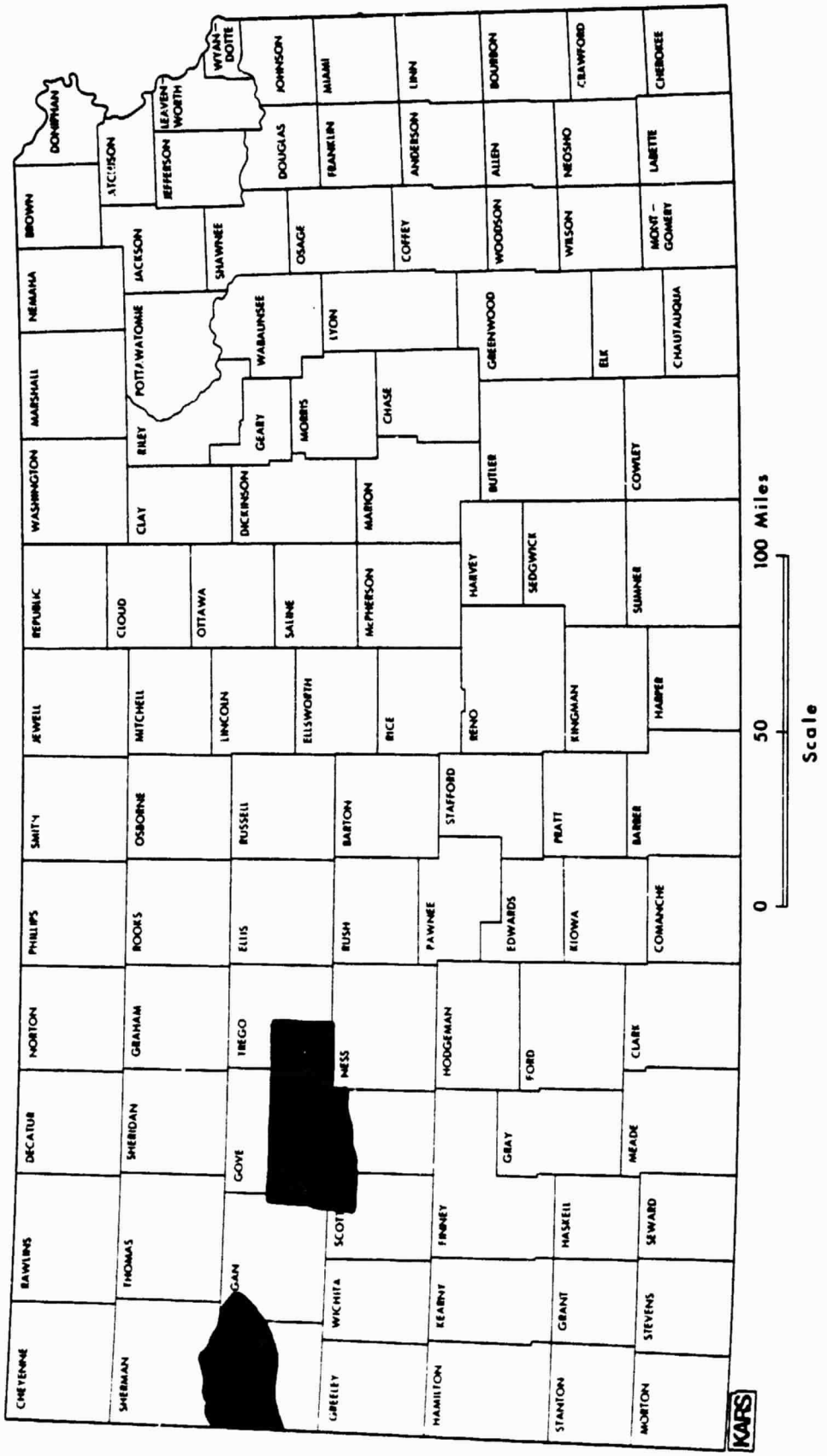
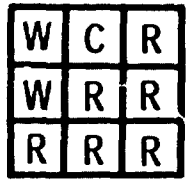
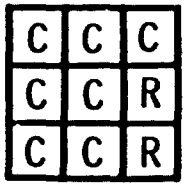



Figure 9. Study Areas for the Pronghorn Antelope Release Sites

## MEASURING FOR JUXTAPOSITION




| Edge Type | Quantity* | Quantity | Total |
|---|---|---|---|
| R/R | 7 | 0.50 | 3.50 |
| R/W | 3 | 0.40 | 1.20 |
| R/C | 2 | 0.05 | 0.10 |
| | | JX Index = | 4.80 |




| Edge Type | Quantity* | Quantity | Total |
|---|---|---|---|
| R/C | 3 | 0.05 | 0.15 |
| C/C | 9 | 0.00 | 0.00 |
| | | JX Index = | 0.15 |

*Diagonal Edges Count as 1.
Vertical/Horizontal Edges Count as 2.

Figure 10. Juxtaposition Index for Pronghorn Antelope Habitat

to the size of the rangeland. This perspective may influence future management decisions made by KF&G regarding their efforts to increase pronghorn antelope populations in Kansas.

Table 12
Acreage Estimates

| | Sherman/Wallace | | Gove/Trego | |
|---|---|---|---|---|
| | 1973 | 1980 | 1973 | 1980 |
| Rangeland | 191,680 (49%) | 209,440 (54%) | 296,920 (35%) | 309,760 (42%) |
| Cropland | 195,040 (50%) | 179,520 (46%) | 472,320 (63%) | 427,680 (58%) |
| Other | 960 (17%) | 320 | 320 ( 1%) | 480 |
| Total | 387,680 | 389,280 | 742,560 | 737,920 |

Table 13
Number of Quarter Sections
Containing Winter Wheat/Alfalfa

| Sherman/Wallace | | Gove/Trego | |
|---|---|---|---|
| 1973 | 1980 | 1973 | 1980 |
| 597 | 556 | 1127 | 819 |
| ( 24.6%) | ( 22.9%) | ( 24.3%) | ( 17.8%) |

Table 14
Juxtaposition Index Values

| | Sherman/Wallace | Gove/Trego |
|---|---|---|
| 1973 | 2.32 | 2.01 |
| 1980 | 3.18 | 2.23 |

Urban and Regional Planning

Geo-Data Base for Tax Reassessment

The Division of Property Valuation of the Kansas Department of Revenue is charged with the responsibility of providing for uniform and equal taxation of all property throughout the state. However, a situation of unequal tax burdens appears to exist statewide as a result of differences in property assessment by local appraisal offices. Since early 1980 the KARS Program has been discussing with the Division of Property Valuation, Kansas Department of Revenue the possible systematic use of environmental data, acquired by both remote sensing devices and from more traditional sources, in the property valuation and tax assessment process. These data would provide means for identifying areas of equal resource value.

A useful tool for property valuation personnel in Kansas would be a map of the state that identifies regions of relative homogeneity as measured by a pre-determined set of valuation factors. Such a map would provide an objective basis for establishing property values on a regional basis. As a first-look demonstration of a technique for determining homogeneous regions, the KARS staff prepared a regionalization of the state based on average annual precipitation, average annual growing season and the USDA Soil Conservation Sservice's distribution of major soil groups.

The range of factors initially identified - rainfall, length of growing season, land use patterns, cropping practices, soil types and topography was wide enough, and the estimated final resolution fine enough (in the neighborhood of tens of acres or smaller) to suggest that the use of computer technology would be required to successfully complete such an undertaking and to facilitate the necessary continual updating and modifying of the data. Such applications of computer technology, known as Geographic Information Systems (GIS), are relatively common.

In late 1981, the KARS Program undertook the development of a project to demonstrate the concept of a Geographic Information System. Geo-referenced data from a test site, Finney County, Kansas, were recorded and analyzed for the demonstration. A microcomputer, dot matrix printer and a modem were employed to construct and operate the GIS. The microcomputer used was an Intertec SuperBrain with 64K bytes of random access memory. The SuperBrain is a small desk-top computer that includes a Z-80 microprocessor,

a keyboard, CRT screen and 2 floppy disc drives. It requires about twice the table-top space of a normal electric typewriter. This computer was used for manual data entry, program development, manipulations and analysis of the data by the software, and as the source of the output data sent to the printer.

The printer used was an Integral Data Systems Model 440 Paper Tiger dot matrix printer, utilizing 8½-inch wide fan-fold, pin-feed paper. The Paper Tiger was operated in normal alphanumeric mode to produce program listings, data listings, statistical output, and to provide titling and labeling for the maps. In the enhanced graphics mode, the printer was used to produce mapped output in the form of grid-cell areal pattern maps.

The modem was used to allow the transfer of existing data files from the University's Honeywell computer to floppy disc files on the SuperBrain.

Finney County, Kansas (Figure 11), was chosen as the demonstration area because it is heavily and diversely developed agriculturally and provided a moderately complex environment in which to demonstrate and evaluate GIS technology. In addition, two geographically referenced data sets were available for the county from a previous study by the KARS Program for the Kansas Legislative Research Department. Since the data from the previous study pertained to 1976, it was used as the base year for all the data in the system.

Soils, topography, land ownership and irrigated lands were included in the data base. These data were compiled form a number of sources. Soil data were taken from the latest edition of the Soil Survey of Finney County produced by the Soil Conservation Service. The dominant soil type within each quarter section was recorded. Soil types were then combined into categories including suitability for irrigated agriculture, suitability for dryland agriculture and sandy soils. High and low elevations were recorded for each quarter section. These were interpolated from USGS seven minute Topographic Quadrangles. Ownership and irrigated lands data for Finney County were available in digital format from the previous KARS Program project. Land ownership was originally obtained from the Kansas Legislative Research Department. Quarter sections were indicated as being privately owned, or being held by one of four types of corporate ownership.

Irrigation data were originally obtained by visual interpretation of Landsat Band 5 black and white images from May and August of 1976. The

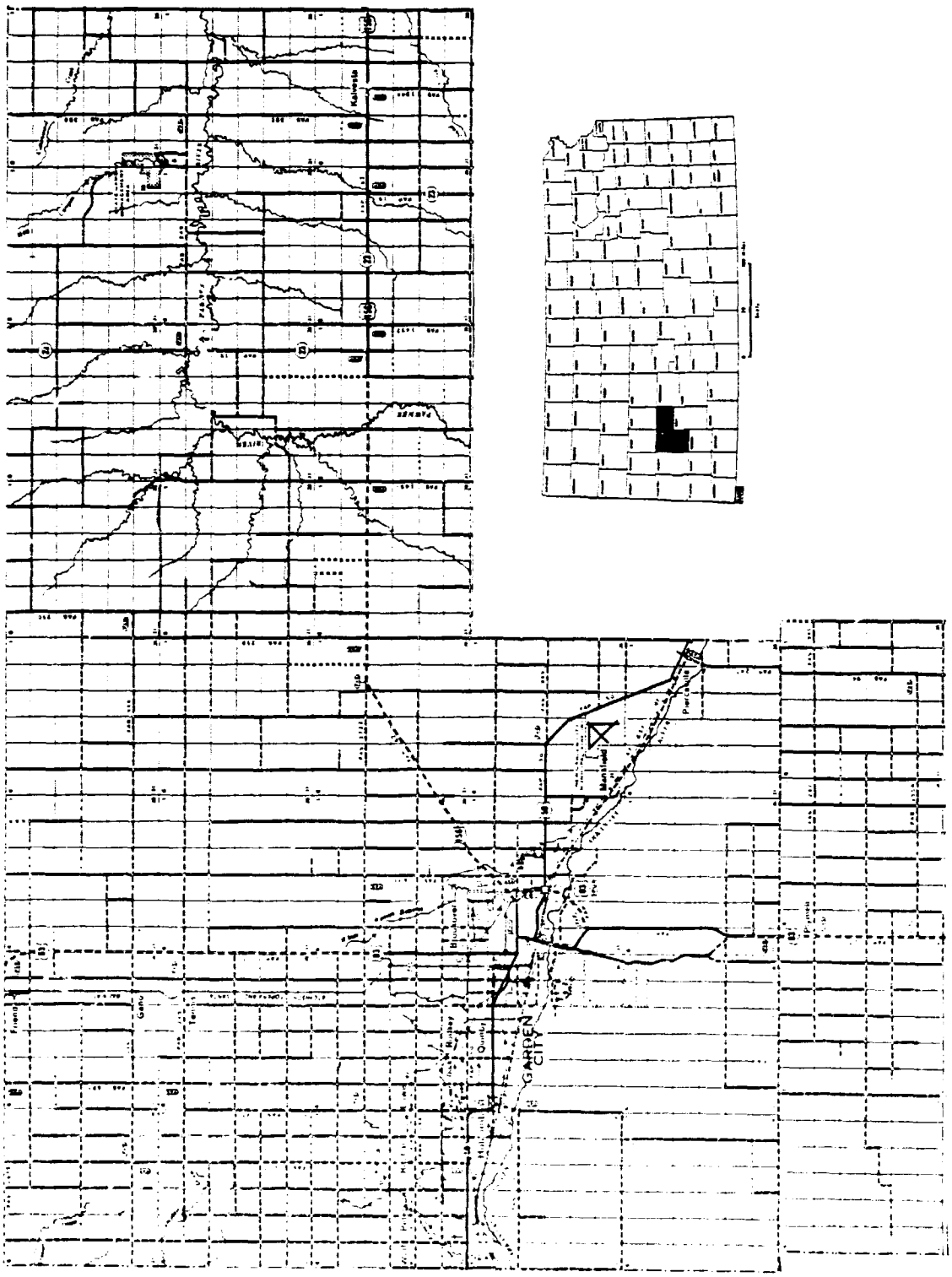



Figure 11. Finney County, Kansas

data were grouped into six classes, representing approximate acreages of irrigation within each quarter section. These data types were four of a number of factors that the Department of Revenue considered indicators of property value.

The output format allowed specific relationships regarding the study area to be examined both spatially, using maps, and quantitatively, using statistics. Using four data sets, significant relationships were illustrated between environmental factors. A list of the maps produced is shown in Table 15.

The "Corporate-Owned Irrigated Lands, 1976" map and statistics (Figure 12) showed that 9.5% of the total county was owned by corporations. These corporations irrigated 341 quarter sections, or 69% of their land holdings while privately held land irrigated 1763 quarter sections, or 37.5%. Thus, irrigation for corporate-owned land was nearly twice that of privately-owned land.

The "Irrigation Suitability of Non-Irrigated Lands" map (Figure 13) displays one factor, suitability of soils to irrigation, which may influence the spread of irrigation in Finney County. The category "all others" on this map represents irrigated land. The map shows 1,229 quarter sections with soils of Class 1 irrigated capability, highly suited to irrigation, and 762 quarter sections with soils having a Class 2 irrigated capability, well suited to irrigation. Thus, 65% of the non-irrigated lands bear soils that are well-suited or would present few limitations to irrigation. However, many of these areas were located neither near the Arkansas River nor overlying the Ogallala Aquifer, the two main sources of irrigation water in Finney County. Therefore, the potential for the spread of irrigation in these areas is decreased.

To demonstrate the flexibility of scale in the Geographic Information System, large-scale maps at a ten-acre resolution were produced for four test sections, one square mile each. An example of such a map is shown in Figure 14.

Although the Finney County demonstration was a relatively simplistic example of a GIS, the GIS technique was exemplified. By systematically categorizing each data type into groups, homogeneous areas were defined. Overlaying several types of data divided these homogeneous areas to more refined areas. By simply assigning values to groups within data sets a system of equal property valuation could easily be designed.

Table 15

FINNEY COUNTY MAPS



County Maps at 160 Acre Resolution:

Irrigated Lands, 1976
Suitability of Land for Dryland Agriculture
Suitability of Land for Irrigated Agriculture
Sandy and Non-sandy Soils
Land Ownership, 1976
Corporate Ownership by Type, 1976
Irrigation Suitability of Irrigated Lands
Irrigation Suitability of Non-Irrigated Lands
Dryland Suitability of Irrigated Lands
Dryland Suitability of Non-Irrigated Lands
Irrigation on Sandy and Non-Sandy Soils
Irrigation Suitability of Sandy Soils
Dryland Suitability of Sandy Soils
Corporate Owned/Irrigated Lands, 1976
Irrigation Suitability of Corporate Owned Lands
Dryland Suitability of Corporate Owned Lands

Section Maps at 10 Acre Resolution:

Sandy Soils
Dryland Capabilities of Soils
Irrigated Capabilities of Soils
Selected Land Uses
Local Elevation Differences (Within 10 acre Tracts)
Irrigation Suitability of Irrigated Lands
Irrigation Suitability of Dry Croplands
Dry Cropland Capabilities of Dry Cropland
Dry Cropland Capabilities of Range
Irrigation Suitability of Rangeland
Local Elevation Differences of Cropped Lands
Local Elevation Differences on Rangeland
Cropland on Sandy Soils
Irrigated/Dry Cropland on Sandy Soils
Irrigation Suitabilty of Sandy Soils

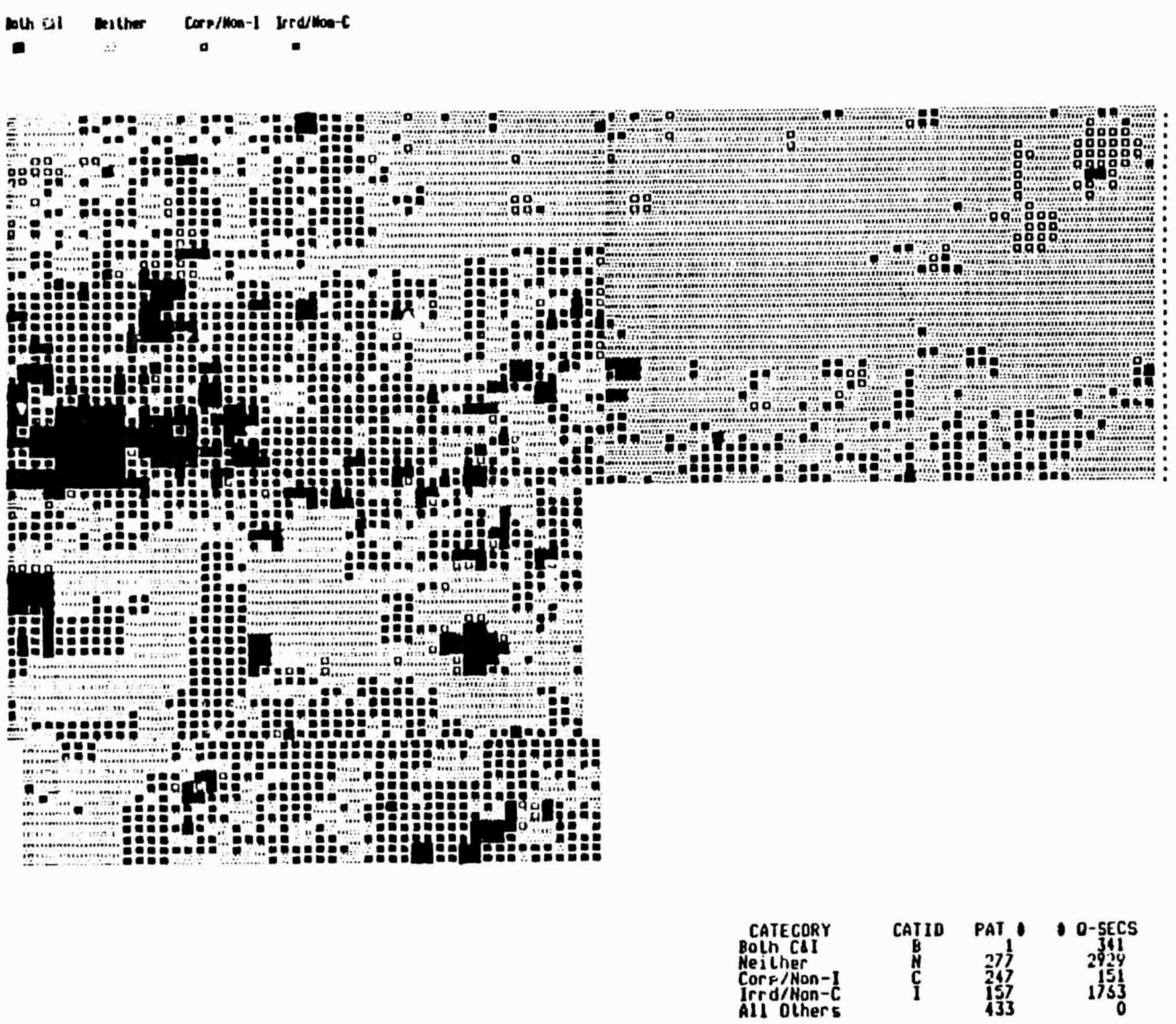
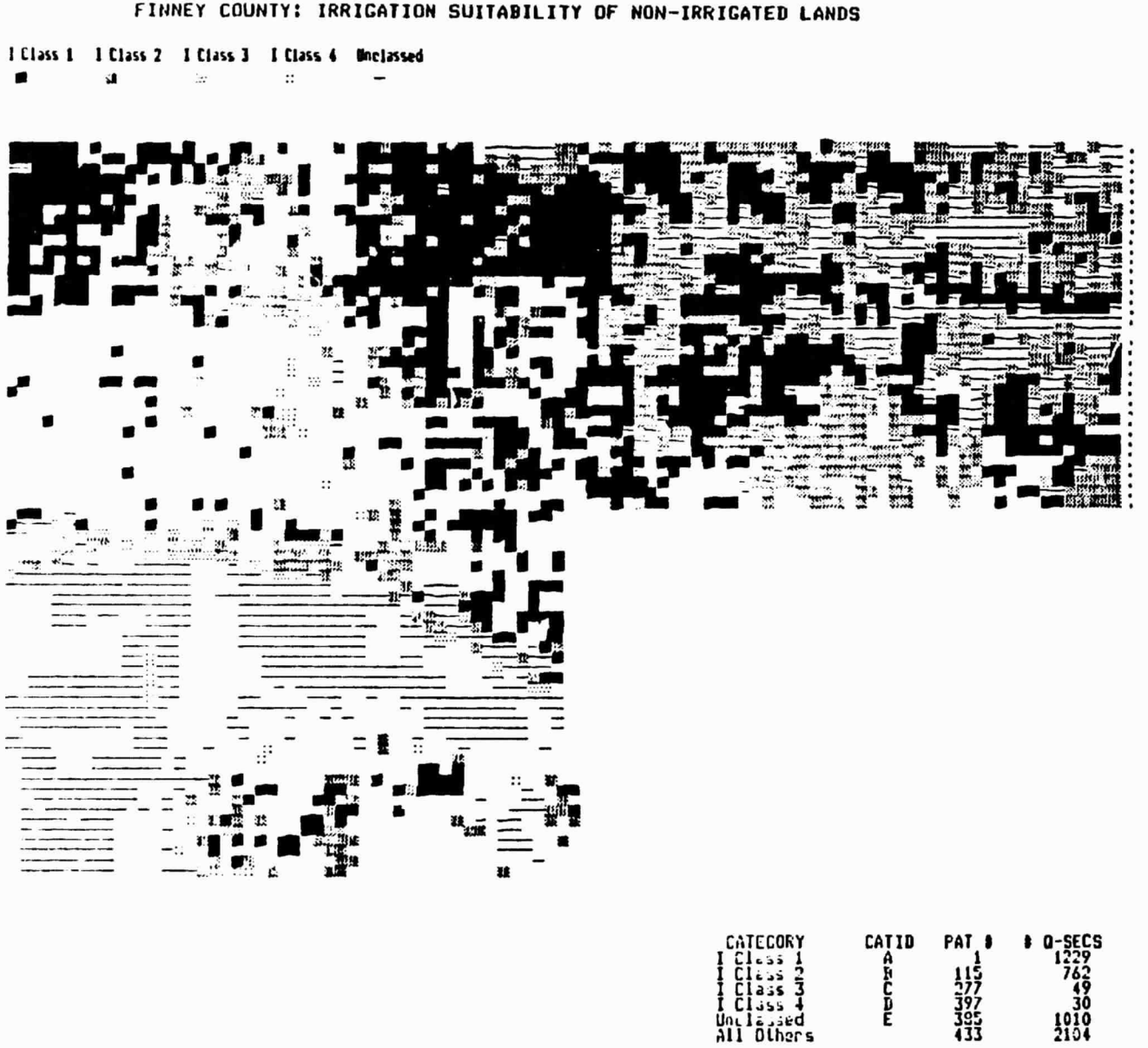


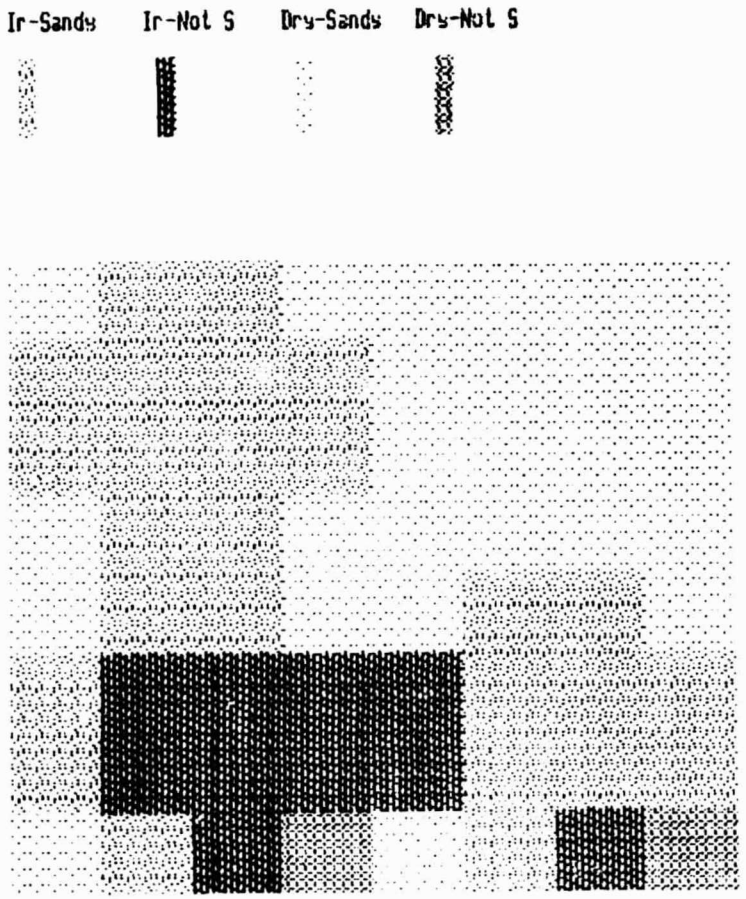

Figure 12. Corporate-Owned/Irrigated Lands, Finney County, Kansas, 1976




| CATEGORY | CATID | PAT # | # Q-SECS |
|---|---|---|---|
| I Class 1 | A | 1 | 1229 |
| I Class 2 | B | 115 | 762 |
| I Class 3 | C | 277 | 49 |
| I Class 4 | D | 397 | 30 |
| Unclassed | E | 395 | 1010 |
| All Others | | 433 | 2104 |

Figure 13. Irrigation Suitability of Non-Irrigated Lands

IRRIGATED/DRY CROPLAND ON SANDY/NOT SANDY SOILS IN A SINGLE SECTION




| CATEGORY | 10 acres |
|---|---|
| Ir-Sandy | 26 |
| Ir-Not S | 10 |
| Dry-Sandy | 26 |
| Dry-Not S | 2 |
| All Others | 0 |

Figure 14. Irrigated Cropland on Sandy/Not Sandy Soils in a Single Section

The flexibility of the system will allow the Department of Revenue to combine sets of data pertinent to tax assessment in order to achieve a comprehensive and conclusive analysis of an area.

The Property Valuation Division, Kansas Department of Revenue has favorably reviewed the results of the Finney County demonstration GIS. Although the pressure to complete a statewide reappraisal of land has temporarily diminished, the Department of Revenue is encouraging the exploration and development of applicable Geographic Information Systems techniques.

The KARS Program will pursue research on the microcomputer-based GIS technology. The Finney County project has attracted the attention of a number of groups interested in making similar applications of geo-referenced data. Several inquiries have been received, including contacts from: the Harvey County, Kansas Planning Department; the Department of Geography, University of Utah; the Department of Geography, the University of Akron, Ohio; EROS Data Center; the Planning Department of the City of Kent, Washington; and the Butte-Silver Bow Department of Public Works, Butte, Montana.

# IV. OTHER KARS ACTIVITIES

Kansas Remote Sensing Short Courses

During March and April, 1981, the University of Kansas Applied Remote Sensing (KARS) Program conducted a one day short course in remote sensing in four cities across the state of Kansas. This course, entitled "Remote Sensing: An Overview," was funded by the National Aeronautics and Space Administration (NASA) contract NAS 13-166. It was designed to encourage the use and understanding of state-of-the-art remote sensing techniques, especially Landsat and digital processing, by personnel in state and local agencies, colleges, and universities in the state of Kansas.

The primary objectives of the course were to encourage and improve the teaching of remote sensing techniques within Kansas institutions of higher education, and to increase the usage of remote sensing data by local and state governmental personnel. Further objectives were to provide an overview of remote sensing, to demonstrate the applications of Landsat data, and to stimulate interest in developing additional Landsat applications.

Topics covered by the course included the following:

(1) An overview of remote sensing introducing:
   a. The electromagnetic spectrum;
   b. Remote sensing platforms including aircraft, the Landsat Satellite and the Space Shuttle;
   c. Remote sensing systems including cameras, scanners and radars.

(2) The interpretation and use of remote sensing data including manual interpretation, digital analysis, collateral data (e.g., maps, field data, soil surveys).

(3) Remote sensing applications in:
   a Pianning -- including land use and land cover studies and urban development studies;
   b. Agricultural -- including crop inventories, yield prediction and irrigated land inventories;
   c. Natural resources -- including wildlife habitat studies, surface mining, surface water mapping, and geological exploration;
   d. Environmental quality -- including water pollution, thermal problems, waste disposal site location, etc.

(4) Sources of remote sensing data.

Lectures were liberally illustrated with slides, imagery prints, maps and graphics. Handouts were distributed to all participants which detailed sources of remote sensing imagery, information, publications, audiovisual and educational materials, newsletters and information regarding the Kansas Applied Remote Sensing Program.

The course was presented four times in, respectively:

| | | |
|---|---|---|
| Overland Park, Kansas | KU Regents Center | March 31, 1981 |
| Topeka, Kansas | Washburn University | April 2, 1981 |
| Salina, Kansas | Kansas Technical Institute | April 7, 1981 |
| Pratt, Kansas | Kansas Fish & Game Commission Headquarters | April 8, 1981 |

A total of 82 persons attended the course. They represented many different disciplines including hydrology, engineering, planning, and wildlife conservation. Attending the course were university faculty (professors of landscape architecture, physical science, and regional planning), and individuals from various federal, state and local agencies, including the USDA Crop and Livestock Reporting Service, U.S. Environmental Protection Agency, U.S. Soil Conservation Service, and the Kansas Fish and Game Commission.

Two 5-day sessions of a more comprehensive remote sensing course, entitled "Fundamentals of Applied Remote Sensing," were held at the Space Technology Center, Lawrence, Kansas, June 1-5 and July 13-17, 1981. The course offered training and hands-on experience in both visual image interpretation and numerical analysis of Landsat data. Table 16 outlines the major topics covered during the course.

Each course participant received a packet of materials including information on sources of remote sensing data, remote sensing literature and newsletters, course notes, maps and various imagery of a study area on the western edge of Lawrence.

Imagery included a black and white stereo pair of photographs, a black and white photo mosaic, a high-altitude CIR photograph, four bands of black and white Landsat imagery and an enlargement of the study area portion of the false color composite Landsat image generated from three of the black and white Landsat images. All of the imagery was utilized in various exercises concerning remote sensing analysis of the Lawrence study area.

A field trip to the study area was used to assist the participants in their interpretations and to enhance their appreciation and understanding of

Table 16
Outline of Topics Covered
in the Five Day Course

Monday - Aerial Photographic Interpretation

*Characteristics of aerial photography.
*Measurement on aerial photographs (including Exercise).
*Stereoscopy (including Exercise).
*Fundamentals of black and white photo interpretation (including Exercise).
*Films, filters and spectral reflectance.
*Land Use Mapping (including Exercise).

Tuesday

A. Non-Photo Imaging Systems

*Radar.
*Scanners.
*Applications (including radar, thermal and MSS).
*Characteristics of Landsat.
*Applications of Landsat.
*Visual Interpretation of Landsat (including Exercise).

B. Field Trip

*Remote Sensing related field observations and data collections.
*Study area familiarization.

Wednesday - Introduction to Digital Processing

*The nature of Landsat digital data.
*Gray shade portrayals of Landsat data contrast stretch and Histogram normalization (including Exercise).
*Statistical classification using an unsupervised classifier (including Exercise).

Thursday - More Digital Processing

*Combining similar categories of data.
*Identification and naming of classes (including Exercise).
*Cleaning and smoothing operations.

Friday

A. Summary and Critique of Digital Processing

B. Geographic Information Systems

*Analysis using multiple geo-referenced data sets.
*Digitizing (Demonstration).
*Characteristics of GIS's.
*Applications of GIS's.

how the various types and scales of remote sensing data measure and record information about the earth's surface.

A major emphasis in the five-day courses was digital image analysis of Landsat data. Constituting approximately one-half of the total course, the digital analysis portion of the course keyed in on a 24 square mile area to the West of Lawrence. Previous exercises in the course had introduced the participants to the study area via three sets of photographic data, two sets of Landsat visual imagery, a topographic map and a field trip. In the digital analysis portion of the course each participant was introduced to digital analysis through a combination of lectures and hands-on experience.

Utilizing an image analysis package designed and implemented by KARS personnel, the course participants worked through several sessions of interactive analysis of a 120 x 120 pixel set of 4 bands of Landsat data. Working at matrix printer terminals, they performed numerical analyses of the data, generated maps, identified categories of data, performed combinations of categories and identified land use/cover classes. Although many of the participants had never even operated a computer terminal before, the tutorial nature of the KARS interactive program allowed them to quickly and rather easily perform the required operations and to make decisions relative to such things as the number of categories to identify, discrimination and combination of categories, and types of mapped output. For most people in the course, the experience with the digital analysis proved to be both interesting and rewarding.

A total of 28 persons attended the two courses. Participants included faculty and staff from the University of Kansas, Kansas State University, Ft. Hays State University, Pittsburgh State University, St. Mary of the Plains College, Montana State University, and the University of Missouri, and personnel from various agencies including the Kansas Fish and Game Commission, Kansas Geological Survey, Kansas Department of Health and Environment, Missouri Department of Natural Resources, USDA Soil Conservation Service (SCS), Environmental Protection Agency, National Park Service, and several firms including Basin Electric Power Cooperative, Southwestern Bell Telephone Company and the Federal Crop Insurance Corporation. A questionnaire completed by participants at the end of each course provided valuable feedback on the courses and an overall very favorable evaluation.

C-2

Land Use/Land Cover Inventory of the Missouri River Floodplain*

On October 28, 1980 the Missouri River Basin Commission (MRBC) initiated the Missouri River Floodplain Study for the 752 mile long, 1.5 million acre Floodplain of the Missouri River from Ponca, Nebraska, to the river's mouth near St. Louis, Missouri (Figure 15). The major goals of the study are to: (1) develop a comprehensive floodplain data base by examining relevant activities which affect land use and contribute to flood hazard problems; (2) develop projections which will indicate the future magnitude of encroachments and escalation of the flood hazard situation if nothing is done; and (3) develop a program that provides guidance to the states in implementation of a coordinated approach to floodplain management.

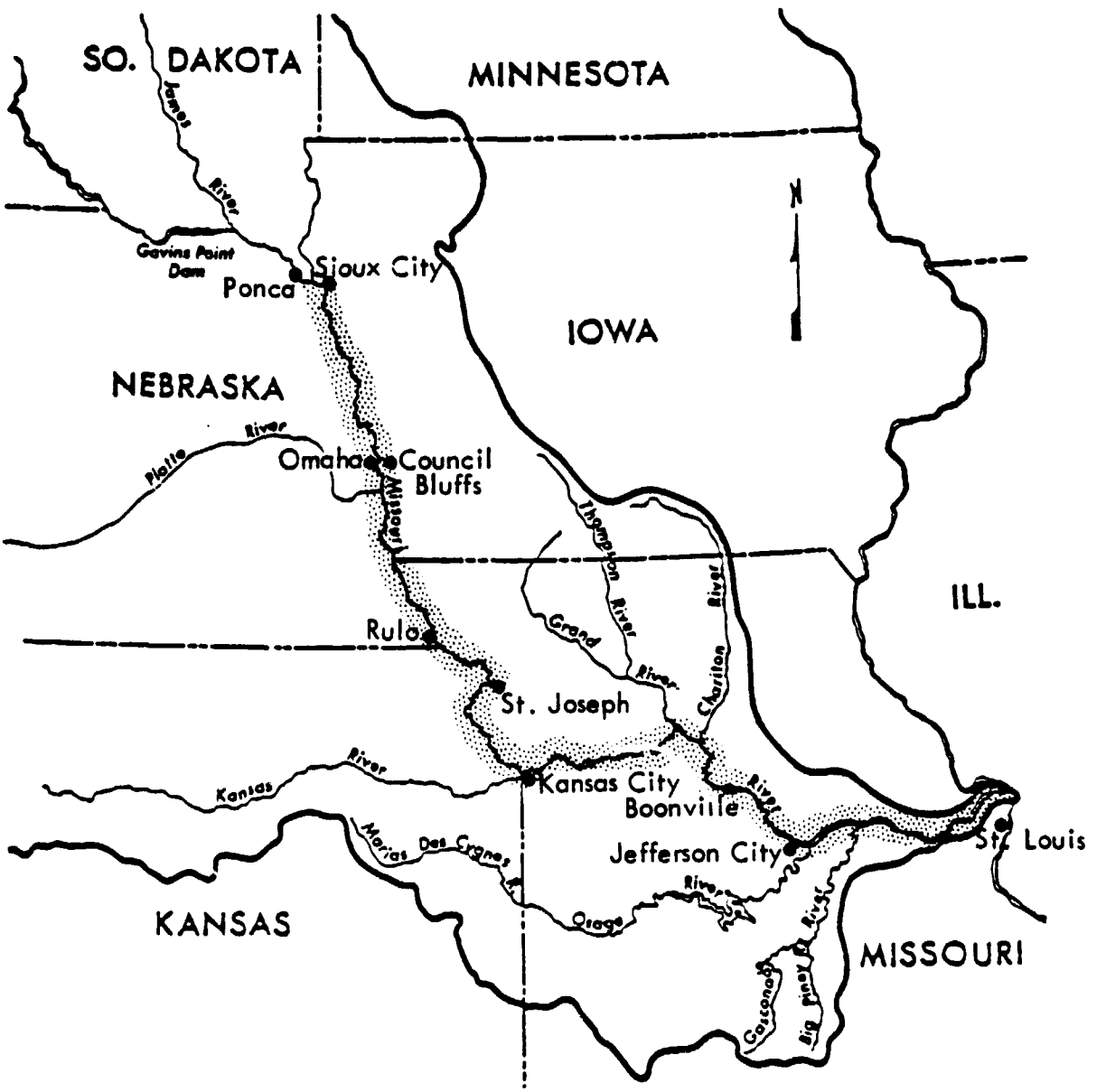
In May 1981 the University of Kansas Applied Remote Sensing (KARS) Program was commissioned by the MRBC to prepare a set of land use/land cover maps for the study area and to measure the area within each land use/land cover polygon delineated. The maps and associated acreage statistics will be used by MRBC staff to assist in defining (1) the location of land uses or encroachments that may be potentially hazardous during flooding episodes, (2) the location of sensitive environmental areas, (3) the spatial interrelationships and possible conflicts among different land use and land cover classes, and (4) possible conflicts of existing and proposed land uses with current floodplain management programs.

The study area was specifically defined as the floodplain of the Missouri River extending from Ponca, NE to St. Louis, MO. The limit of the study area was determined by MRBC to be the bluffs along the floodplain. The area mapped included a distance of 752 river miles and an area of approximately 1.5 million acres. Metropolitan areas contained within the study area included Sioux City and Council Bluffs, Iowa; Omaha, Nebraska City and Rulo, Nebraska; and St. Joseph, Kansas City, Jefferson City, and St. Charles, Missouri. Floodplain land uses ranged from farming operations to heavy industry, with most of the commercial and industrial activities concentrated in urban areas. Natural vegetation was characterized by cottonwood, willow, and emergent species of riparian and wetland vegetation.

*Funding for this project was provided by the Missouri River Basin Commission

Figure 15

# MISSOURI RIVER FLOOD PLAIN STUDY AREA



Land use and land cover were interpreted from aerial photography using conventional photointerpretation techniques. Primary data sources included 1:12,000 color aerial photographs acquisitioned by the U.S. Army Corps of Engineers (CoE) in 1979. This imagery provided coverage of the main river channel as well as parts of the adjacent floodplain. A second major source was USDA/Agricultural Stabilization and Conservation Service (ASCS) 35mm color aerial slides, which provided coverage of the outer reaches of the floodplain. Additional information sources included field notes, 1:24,000 U.S. Geological Survey (USGS) topographic maps, high altitude color infrared aerial photography and selected published material. Ancillary data were provided to the KARS Program by the Environmental Protection Agency (EPA) and CoE and were added to the land use/land cover maps.

Prior to the initiation of image interpretation, the length of the study area from Ponca, NE to St. Louis, MO was driven and observed by KARS Program staff members. Transects through the study area were made to provide a representative sample of current land use and land cover classes and conditions within the project area. Agency personnel familiar with particular reaches of the river within their agency's jurisdiction suggested sites which were particularly characteristic of specific land use/land cover types and associations.

The land use/land cover classification scheme employed in this project was based on the standard classification system of the U.S. Geological Survey. However, the classification of the Department of Interior's Fish and Wildlife Service was also used in part. The level of classification and the inclusion and exclusion of particular classes were determined by mutual agreement of MRBC and the KARS Program. Decisions were based on MRBC requirements and a preliminary analysis by the KARS Program of the capacity for accurately distinguishing the desired cover classes using the CoE aerial photography. The final classification scheme is show in Table 17.

The maps were compiled by projecting the 1:12,000 CoE photography onto the 1:24,000 USGS topographic sheets. Land use and land cover were mapped in pencil directly onto mylar overlaying the USGS topo sheets.

The Kansas City District of the CoE provided flood hazard information in the form of maps depicting floodway, 100-, and 500-year flood hazard lines. Sites of water treatment facilities, waste water treatment facilities and landfills were provided by the EPA. Both of these information types were recorded directly onto the KARS maps in addition to the land use and land cover data.

# Table 17

Land Use and Land Cover Classification System

1. URBAN OR BUILT-UP

- 11 Residential
  - 11.1 Single
  - 11.2 Mobile Home
  - 11.3 Multi-family
- 12 Commercial
- 13 Industrial
- 14 Transportation
  - 14.1 Agricultural Storage
  - 14.2 Airports
  - 14.2 River Terminals[1]
  - 14.3 Land-based Terminal
  - 14.4 Interstate Highways
  - 14.5 Railyards
- 15 Utilities
  - 15.1 Power Plants
  - 15.2 Water Supply[1]
- 16 Waste Water Treatment
- 17 Solid Waste Disposal Facilities (landfills)
- 18 Institutional
- 19 Park and Recreation Facilities (boundaries by MRBC)

2. AGRICULTURAL

- 21 Cropland
  - 21.1 Center-pivot irrigation
- 22 Specialty Crops (Orchards)
- 23 Confined Feeding Operations
- 24 Grassland/Pasture/Hayland

3. FOREST

- 31 Flood Plain Woodland
  - 31.1 Over 75 percent cover
  - 31.2 25-74 percent cover
  - 31.3 Recently cleared
- 32 Shrubland

4. OPEN WATER WETLANDS

- 41 Missouri River Main Channel
- 42 Missouri River Side Channels and Backwaters
  - 42.1 Mudflats associated with side channels
- 43 Tributary Rivers (miles or acres) and Streams
  - 43.1 Mudflats associated with tributary rivers and streams
- 44 Intermittent Streams and Water Courses
- 45 Lakes (greater than 20 acres)
  - 45.1 Mudflats associated with lakes
- 46 Ponds (open water)
  - 46.1 Mudflats associated with ponds

5. SANDBARS AND VEGETATED WETLANDS

- 51 Sandbars (unconsolidated shores)
- 52 Emergent (perennial)
- 53 Shrub/Forest

6. BARREN

- 61 Mines, Quarries, Gravel Pits, etc
- 62 Sand Dunes
- 63 Other

[1] Obtained by MRBC using corollary data sources.

Upon completion of the photointerpretation, acreage calculations and final inking were initiated. An Altek AC90SM digitizer was employed to compute the acreage of each land use/land cover polygon, as well as the area of the Missouri River occurring on each map. The lengths of tributaries and streams were computed in miles. The areas of lakes and ponds were computed in acres. Areal statistics for each polygon were noted in pencil on mylar map overlays.

Land use/land cover polygon boundaries and classification numbers and 100-year and 500-year flood hazard lines were inked on Kimoto 1.5mm diamat thin mylar sheets registered to the 1:24,000 USGS topographic quadrangles.

Because the maps were intended to overlay the USGS maps, information on the topographic map was not duplicated on the mylar overlay. An example of a portion of a final inked map is shown in Figure 16 .

The set of 130 inked mylar map overlays prepared for this project will be incorporated into an atlas which will be a product of the Missouri River Floodplain Study. In addition to the information provided by the KARS Program, the atlas will also contain information on state and federally owned properties, historic sites, the locations of boat ramps which access the Missouri River, and information regarding levees. Copies of the atlas will be provided to the state agencies in each of the five states involved (Iowa, Kansas, Missouri, Nebraska and South Dakota) and to the federal agencies which participated in the study. The atlas will be used to facilitate land use planning decisions by the participating agencies.

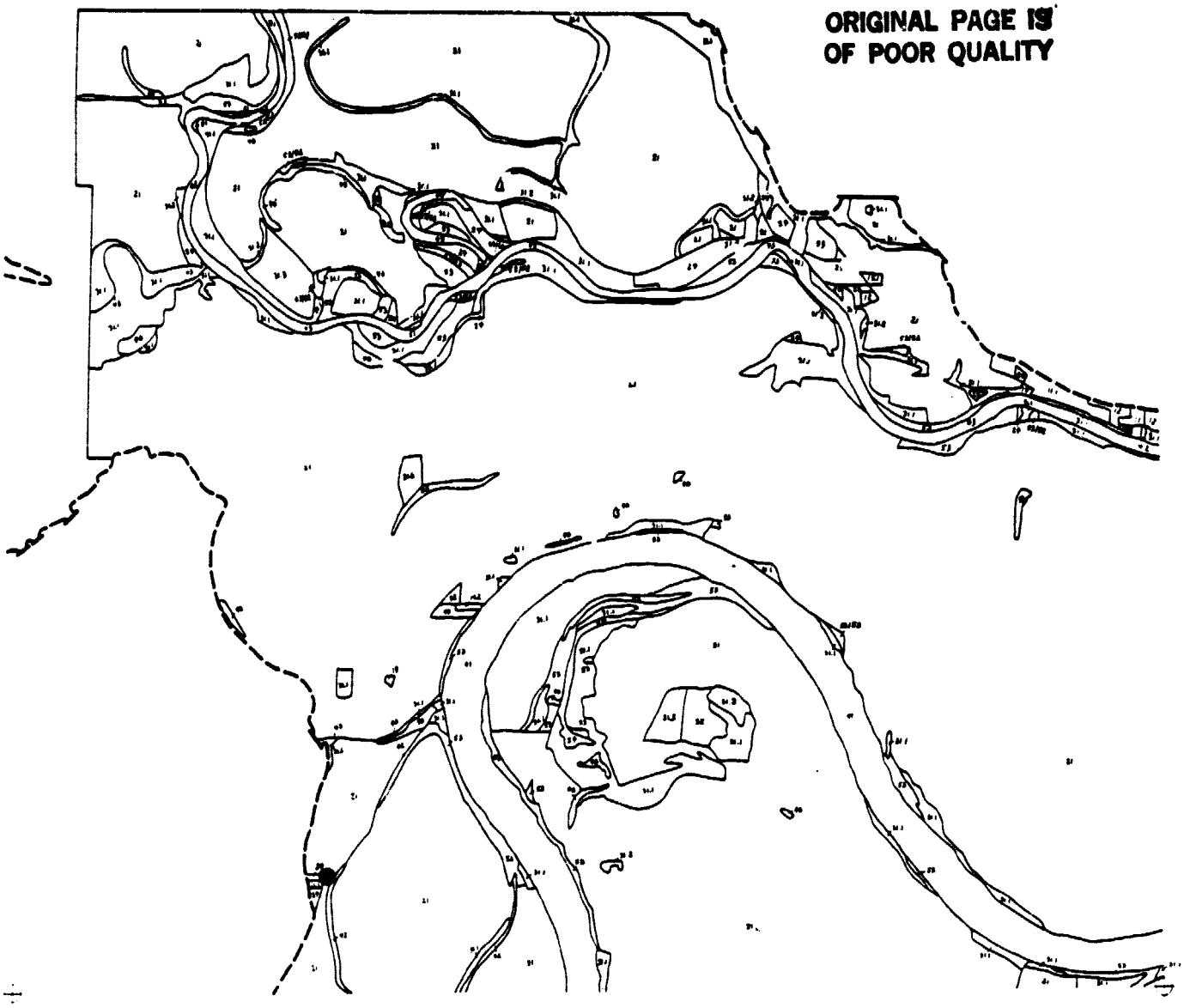



Figure 16. Land Use and Land Cover Classification of Brunswick West, Missouri

KARS Kansas Applied Remote Sensing Program
Space Technology Center
University of Kansas

BRUNSWICK WEST, MO

Land Use and Land Cover Classification System

1. URBAN OR BUILT-UP

- 11 Residential
  - 11.1 Single
  - 11.2 Mobile Home
  - 11.3 Multi-family
- 12 Commercial
- 13 Industrial
  - 13.1 Agricultural Storage
- 14 Transportation
  - 14.1 Airports
  - 14.2 River Terminals[1]
  - 14.3 Land-based Terminal
  - 14.4 Interstate Highways
  - 14.5 Railyards
- 15 Utilities
  - 15.1 Power Plants
  - 15.2 Water Supply[1]
- 16 Waste Water Treatment
- 17 Solid Waste Disposal Facilities (landfills)
- 18 Institutional
- 19 Park and Recreation Facilities (boundaries by MRBC)

2. AGRICULTURAL

- 21 Cropland
  - 21.1 Center-pivot irrigation
- 22 Specialty Crops (Orchards)
- 23 Confined Feeding Operations
- 24 Grassland/Pasture/Hayland

3. FOREST

- 31 Flood Plain Woodland
  - 31.1 Over 75 percent cover
  - 31.2 25-74 percent cover
  - 31.3 Recently cleared
- 32 Shrubland

4. OPEN WATER WETLANDS

- 41 Missouri River Main Channel
- 42 Missouri River Side Channels and Backwater
  - 42.1 Mudflats associated with side channels
- 43 Tributary Rivers (miles or acres) and Streams
  - 43.1 Mudflats associated with tributary rivers and streams
- 44 Intermittent Streams and Water Courses
- 45 Lakes (greater than 20 acres)
  - 45.1 Mudflats associated with lakes
- 46 Ponds (open water)
  - 46.1 Mudflats associated with ponds

5. SANDBARS AND VEGETATED WETLANDS

- 51 Sandbars (unconsolidated shores)
- 52 Emergent (perennial)
- 53 Shrub/Forest

6. BARREN

- 61 Mines, Quarries, Gravel Pits, etc
- 62 Sand Dunes
- 63 Other

[1]Obtained by MRBC using corollary data sources.

## Applied Research and Development in Agricultural Remote Sensing*

Farmland Industries, Inc. is the regional agricultural cooperative serving 500,000 farmers and ranchers through 2,250 local cooperative associations in 15 Midwest and Southwest states including Kansas, and has been an active member of the Geosat Committee. In Spring 1980 Farmland Industries, Inc. expressed an interest in the acquisition and experimental use of remote sensing technology for selected agricultural applications on their Research and Demonstration Farm located near Bonner Springs, Kansas. After preliminary discussions between Farmland officials and personnel of the University of Kansas Applied Remote Sensing (KARS) Program, Farmland engaged the KARS Program to conduct a series of three experimental aerial photographic missions over the Research and Demonstration Farm with coordination and assistance provided by Farmland research staff. The KARS Program subsequently acquired the aerial photography in July, August and October, 1980.

In an effort to assess the potential use of remote sensing data by Farmland for selected applications in agriculture, the KARS Program formally began work in November, 1980 after the completion of the aerial photographic flights. After several meetings with Farmland personnel to discuss their needs, the following objectives for this work were identified:

(1) To evaluate film type, scale and timing appropriate for acquiring light aircraft photography over the Farmland Research and Demonstration Farm.

(2) To determine the relationships and significant differences among various crop treatments using both visual and quantitative interpretation techniques.

(3) To provide literature review services, photographic prints and interim reports as needed.

Taken together, the data derived through the completion of these tasks formed the initial basis for assessing remote sensing needs, and designing demonstration and cocperative projects.

---

*Funding for this project was provided by Farmland Industries, Inc.

A literature search covering applications of remote sensing in agriculture was conducted during February. A bibliography of satellite remote sensing was delivered to Farmland in February along with a summary paper covering selected uses of aerial photography in agriculture. On March 5, an extensive bibliography covering a more complete listing of aerial photographic applications was sent to Farmland.

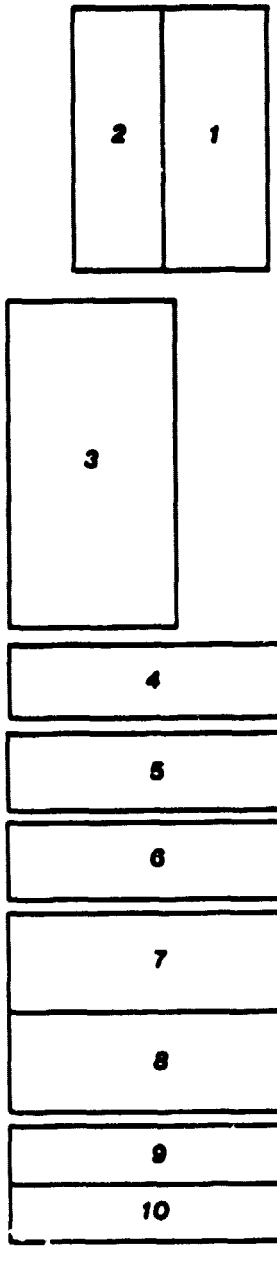
Three aerial photographic missions were flown over Farmland's Research and Demonstration Farm near Bonner Springs, Kansas, using the Space Technology Center's 70mm format Hasselblad camera cluster. Three film types (color, black and white infrared, and color infrared) were flown at scales of 1:40,000, 1:20,000, 1:10,000, 1:5,000 and 1:2,000 in three successive flights, one each in July, August and September, 1980.

The missions were designed to test the capabilities of various film/filter/scale combinations for providing information regarding tillage practices, crop varieties and herbicide treatments. Since a wide variety of crops (including wheat, alfalfa, corn, forage and grain sorghum, soybeans and sunflowers) were grown on the Research and Demonstration Farm under a range of different conditions, these experiments were designed to aid in defining aerial photographic requirements and interpretation techniques useful for discriminating between a broad spectrum of agricultural phenomena.

An unsupervised visual interpretation of tones and textures was undertaken for one crop experiment for each date of imagery acquisition using the color and color infrared photography. The experiment interpreted was selected randomly from the array of the 1:2,000 scale July photography. The general category of the area considered was termed the "experiment." The next subclass corresponding to rows within the experiment was termed "plots." The smallest class considered was the "treatment."

The experiment chosen for visual interpretation was number 13 (Corn-No-Till Herbicide) as designated on the map of the Research and Demonstration Farm (Figure 17). The plots were numbered #1 - #4 from North to South. Treatments within the plots consisted of 4 rows of crops; there were 68 rows and therefore 17 treatments per plot.

Figure 17. Map of Crop Experiments
at
Farmland Industries
Research and Demonstration Farm




KEY

1 Double Cropping: Grain Sorghum
2 Double Cropping: Soybeans
3 Soybean Herbicide
4 Soybean Inoculants
5 Sunflower Soil Fertility
6 Alcohol Production from Grain Sorghum
7, 8 Soybean Herbicide vs Row Spacing: 28" and 7"
9, 10 Soybean Cultivar vs Row Spacing: Solid Seeded and 28"
11 No-Till Herbicide: Soybeans
12 No-Till Herbicide: Grain Sorghum
13 No-Till Herbicide: Corn

N

Since it was found that tonal variation was nearly as wide within the same film types from date to date as it was between film types and that tonal intensity posed greater interpretation problems than the change from film to film, it was decided to interpret by date rather than by film type.

Classification of the treatments was performed solely on the basis of color (tone) and texture. Due to tonal changes for each of the dates and films, several different classes for each date and each film were devised. Whenever possible an attempt was made to classify a single treatment as a single category, but the marked variation within some treatments prevented this in some cases.

To select a classification of any given treatment, a principle color was noted. Then the intensity of color was assessed. There appeared to be tonal trends from date to date within the same film type. For instance, the July color infrared photography demonstrated a dominance of pink in the tonal description. In August, a substantial amount of brown changed the pinks toward a truer red color in most of the treatments. By October, the browns almost completely dominated.

A similar trend was noted in the color photography. Greens in July were followed by an increase in yellow content in the August imagery, with the experiment dominated by browns in October. With an increase in the tonal variety occurring in the August photography (both color and color infrared) came an increase in: 1) number of categories, and 2) number of treatments split into separate categories.

The second basis for classification, texture, was determined largely by assessing regularity of row integrity. If the rows within a treatment were regular and distinguishable, they were classified as MT, Moderate Texture. A fuzzy appearance within a treatment caused classification of the areas as FT, Fine Texture. Lesser degrees of fuzziness were classified as MFT, Moderate to Fine Texture. Coarse Texture, CT, was determined by the disruption or discontinuity of rows within each treatment. Areas of bare soil within rows typified Coarse Textured classification while areas of sparse vegetation were classified as Moderate to Coarse Texture, MCT.

No trends were discernible within the context of texture, except for what appeared to be a weed infestation in treatments 1, 2, 3 and 4 in the third plot.

Codes were established with which to identify occurrences within each treatment. The codes ranged from 4 to 6 characters, each character representing a combination of either tone or texture (Table 18).

A color densitometer was utilized in order to quantitatively evaluate the color characteristics of two experiments by date and film type. The 1:2,000 scale photography was used since it was at this scale that individual treatment areas could be most clearly demarcated for densitometric measurements. Densitometry was performed on the color and color infrared photography of all three dates for Experiment 12, using a Macbeth densitometer. One reading was taken for each of four filters, panchromatic, red, green and blue, at six randomly selected spots within each treatment. A total of 5184 measurements were obtained for the experiment.

The measurements obtained from the densitometric interpretation were encoded and entered into computer files. In addition, support field data, supplied by Farmland, was encoded and entered into computer files. In July, 1981, these data were analyzed using statistical packages from the University of Kansas computer system in order to evaluate correlations between the measurements obtained from the aerial photography for providing accessory crop data.

Correlation coefficients were computed between plot yield and density values, and the results ranked. Highly significant correlations ($\alpha < .001$) were obtained for the August infrared reflectance, August red reflectance and July infrared reflectance. Thus, the August color infrared film, particularly the red and infrared bands provided the single best film/date combination for yield studies.

Although good correlations were observed between yield and the above-noted density values, it is possible that they were caused by indirect linkage of the particular reflectance values with yield via a third variable, such as another reflectance value or perhaps the weed control rating. In order to evaluate this possibility, a series of partial correlation coefficients were computed and a preliminary path analysis performed.

All the density values had highly significant correlations with yield and the two weed control ratings, whereas the correlations between the density values were less significant, except for the August red reflectance.

Table 18

Sample Codes Used for the Visual Analysis of Tone and Texture

July, 1980 Photography

| CODE | DESCRIPTION |
|---|---|
| LPFT | Light Pink, Fine Texture |
| LPMFT | Light Pink, Moderate to Fine Texture |
| LPMT | Light Pink, Moderate Texture |
| LPMCT | Light Pink, Moderate to Coarse Texture |
| LPCY | Light Pink, Coarse Texture |
| WPFT | White to Pink. Fine Texture |
| WPMFT | White to Pink, Moderate to Fine Texture |
| WPMT | White to Pink, Moderate Texture |
| WPFT | Medium Pink, Fine Texture |
| MPMFT | Medium Pink, Moderate to Fine Texture |
| MPMT | Medium Pink, Moderate Texture |
| MPCT | Medium Pink, Coarse Texture |
| DPMFT | Dark Pink, Medium to Fine Texture |

It was found that the August reflectance values were not linked via one another to yield. The August infrared reflectance was correlated with yield via its link with the weed control ratings, and had a direct correlation with the weed rating. The July infrared reflectance and its corresponding weed control rating showed that the infrared reflectance was correlated directly with the weed control rating and only indirectly with yield via the weed rating. No direct link between August red reflectance and either yield or weed control rating was found, but the combined effect of yield and weed control rating gave a strong correlation with August red reflectance.

Correlation coefficients were computed between yield and all the density differences values, and the results ranked. Highly significant correlations ($\alpha < .001$) were obtained for a number of density differences. However, among the high correlations, the dominant date was August and the dominant density differences were those that involved the infrared and red bands. The highest correlations were found for the red/infrared, green/red and green/infrared August ratios. These correlation values were higher than the correlations observed between single density values and yield, suggesting that density differences were superior indicators of yield than single density values.

In order to determine the direct and indirect linkages between the density difference values, single density values, and yield and weed control, a series of partial correlation coefficients were computed. A strong correlation existed between the red/infrared August reflectance ratio and yield and was due to the effects of both the red and infrared reflectance rather than being primarily due to only one of them. The same result was found for the red/infrared ratio and weed control rating. The red/infrared August reflectance ratio was directly linked with the weed control rating, and indirectly linked to yield. A strong correlation was found between the August green/red reflectance ratio and both yield and weed rating, and was due to the effects of both the green and red reflectances, rather than being primarily due to only one of them. The August green/red reflectance ratio was primarily linked to the weed control rating, and indirectly linked to yield via this rating. This result, which was derived from the color infrared film, was corroborated by the equivalent density difference on the color film.

A high correlation was found between the green/infrared August reflectance ratio with yield as a result of both colors; the main link was with the weed rating; the link with yield was largely indirect. However, the linkage was not as well-defined as in the previous cases.

The results of this study showed that color infrared photography was preferable to color photography for both yield and weed control evaluation. The infrared band was the single most useful band, although a combination of two bands, primarily the infrared and red, gave the optimum results. This conclusion was also corroborated by the results of the visual interpretations and digital analyses performed on Experiment 13. For both the experiments studied, the best date was August, although this varied with different environmental circumstances.

The densitometer analyses of the two experiments studied yielded significant results and indicated a potential use of light aircraft vertical aerial photography in yield and weed studies of agricultural crops.

The visual and densitometric quality of the photography obtained demonstrated that high quality aerial photography can be obtained in an operationally practicable format (70mm) using light aircraft. Based on the demonstration photography obtained, Farmland Industries can therefore make a decision concerning the further development of an aerial photography capability to serve its farmer members.

## Abandoned Mined Lands Inventory and Hazard Assessment*

Under the Surface Mining Control and Reclamation Act of 1977 (Public Law 95-87), the Office of Surface Mining Reclamation and Enforcement (OSM) has responsibility for the identification and reclamation of abandoned coal mines and lands or waters affected by coal mining processes. Lands and water eligible for reclamation under this act are those which were mined or affected by mining and abandoned prior to August 3, 1977, and for which there is no continuing reclamation responsibility under state or federal laws.

The state of Kansas is part of OSM Region IV, which also includes Texas, Oklahoma, Arkansas, Missouri, and Iowa. Although Kansas currently produces a relatively small quantity of coal, it was a leading coal producer during the late 1800's and early 1900's. Mining has taken place in 39 of the 105 counties in Kansas, predominantly in the eastern and southeastern portions of the state (Figure 18). Prior to the enactment of the Kansas Mined Reclamation and Conservation Law of 1968, 90 percent of the land which has been disturbed by surface-mining activities was left unreclaimed. When the law went into effect on January 1, 1969, approximately 40,000 acres of abandoned or "orphan" mine land existed in the state. Coal mining in Kansas falls under the jurisdiction of the Kansas Corporation Commission (KCC) and the Kansas Mine Board.

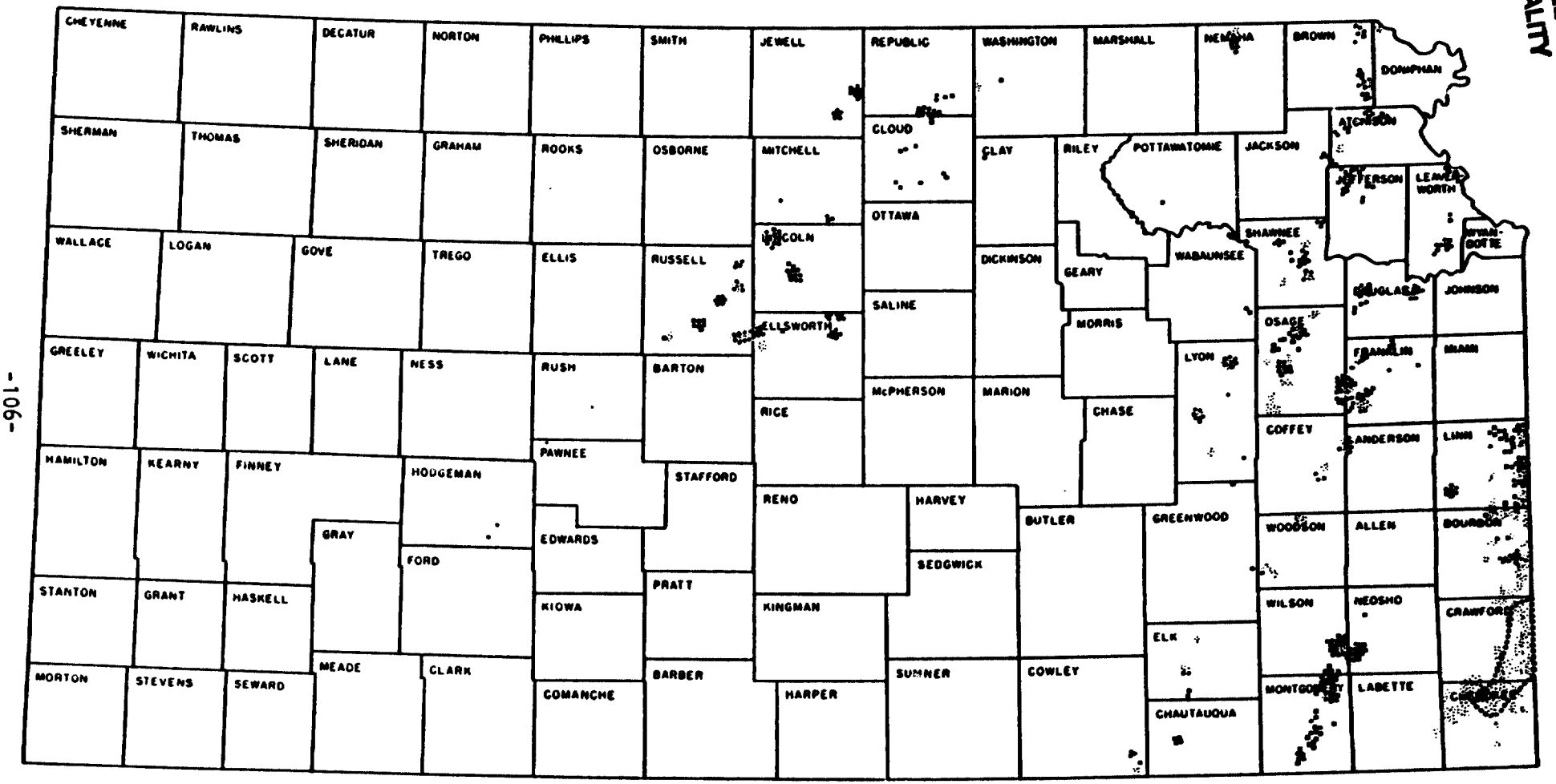
To assist in the identification, selection and reclamation of these areas, OSM is developing, through cooperative agreements with agencies in each of the coal-mining states, a national inventory of abandoned coal mine lands (AML). The purpose of the AML Inventory in Kansas is to locate, survey, and document health, safety, and environmental problems associated with abandoned coal mines throughout the state. Data collected in the Inventory can be used by OSM and the state in determining plans, priorities, budgets, schedules, and appropriate techniques for reclaiming the abandoned coal mines in Kansas.

The AML Inventory is being conducted in phases, each providing a more detailed data base than the previous phase. Phase I entailed a bibliographic search of existing documentation on AML locations and problems. Phase II entailed actual data collection on those AML areas that present problems

*Funding for this project was provided by the Office of Surface Mining under contract number C5101036.

# Figure 18

## ABANDONED COAL MINES IN KANSAS




Source: Kansas Geological Survey, Bulletins 32, 46, 52(3), 63, 64(4), 90(3), 96(2), 114(2), and 134(5).

*Map prepared by Rolfe Mandel and Laura Peracsky, Center for Public Affairs, University of Kansas.*

**Legend**

■ Shaft Mines

------ Area within this Boundary Contains 232 Shaft Mines

● Drift and Slope Mines

Strip Mines

of health, safety and general welfare. Phase III was designed as a more thorough update and refinement of the Phase II data collection effort. To assist in identifying data improvements for the Phase III studies, the concept of five "Prototype" Studies, one within each of the five OSM regions in the U.S., was developed. Conducted concurrently with Phase II, the Prototype Studies were intended to evaluate any weaknesses of the inventories and to identify specific data shortcomings.

The Phase I Study of the AML Inventory for Kansas was performed by the Kansas Geological Survey (KGS). The KARS Program and the Institute for Social and Environmental Studies of the Center for Public Affairs (CPA) at the University of Kansas have been working with the KCC in connection with the AML Inventory, and in March, 1980 entered into a contractual agreement with OSM to conduct the Phase II Inventory. The CPA has been engaged in environmental analysis and public policy projects since 1970. The complementary capabilities of KARS and CPA are well suited to this multifaceted environmental analysis study.

Existing medium-scale and high altitude color infrared photography was also used to identify potential problem areas; to perform a preliminary analysis of drainage, revegetation, erosion and sedimentation; and to identify the location of the mine sites relative to nearby public use areas that might be affected by the potential problems. The aerial photography was then used to stratify each area into similar units as a basis for fieldwork. During the actual fieldwork the aerial photographs proved invaluable in planning access to the data collection sites and as an aid to navigating in the site areas.

Interviews with federal, state, regional, and county agency personnel were conducted to obtain general information about the locations of AML problem areas in the state. In addition, local officials and area residents were interviewed to identify the types of problems that are perceived locally to be the most serious. This information eventually will be used to rank the problem areas for reclamation.

Field personnel visited the abandoned mine sites to verify the presence of problems identified in the literature, aerial photographs, and/or interviews. The problem areas were photographed and a detailed summary of the nature and severity of the problem(s) was prepared for each site. Soils and water data were collected at sites that posed environmental problems.

The AML Inventory was completed for Kansas in March 1981. Eighty-four problem areas were identified within the coal region of Bourbon, Cherokee, Crawford, Labette, Linn, and Osage counties. These problem areas make up a total of 11,491 acres, including 9,927 acres of land and 1,564 acres of water.

The final output of the AML Inventory includes the maps and materials listed below.

1. A set of 1:250,000-scale base maps and transparent overlays showing the boundaries of the AML planning units in the state. The planning units were delineated according to the boundaries of minor drainage basins.
2. A set of 7½" USGS quaurangles (1:24,000) showing the exact locations of the problem areas.
3. Standard data forms for the problem areas. Ground and aerial photographs are attached to the forms.

The Office of Surface Mining is currently computerizing the problem-area data forms in order to provide rapid and selective retrieval of the information.

Concurrent with the AML Inventory, OSM sought a prototype study of abandoned mined lands for Region IV. The Office of Surface Mining contracted with CPA and KARS to conduct the study. The primary goal of the Prototype Study is to assist OSM and the states in Region IV to improve the quality and utility of the AML Inventory. Objectives directed at meeting this goal are as follows:

(1) To solve data-collection problems arising from the AML Inventory and to test selected analysis and data-collection techniques potentially useful in state AML programs.

(2) To identify or eliminate additional variables for measuring AML impacts and costs or to link impacts to mine sites to facilitate ranking and selection of AML projects.

(3) To identify which additional variables are necessary (in terms of time, costs, and effectiveness) for identifying and characterizing AML impacts.

(4) To promote the successful results of the study as they become available and provide assistance to the states and OSM regional staff in adopting (or adapting) the findings.

The specific tasks of the Prototype Study are included among seven major research components. The interdisciplinary team of researchers addressed questions related to 1) mine spoil characteristics, 2) erosion-sedimentation problems, 3) revegetation problems, 4) water quality problems, 5) socioeconomic impacts of abandoned mined lands and AML reclamation, 6) reclamation alternatives, and 7) research methodologies for abandoned mined lands. Tasks within any one research component often overlapped or coincided with tasks in another research component because of the interrelationships between AML problems. For example, it was impossible to assess erosion and sedimentation problems without considering revegetation problems and mine-spoil conditions.

Although coal mining activities have extended over a considerable portion of the eastern half of Kansas, the majority of the abandoned mines and consequent AML problem areas are in the extreme southeastern portion of the state. As a result, the Prototype Study focused on a 110 square mile area within Crawford and Cherokee Counties (Figure 19). This area includes examples of all the AML problems common to Region IV. Furthermore, USGS, the Kansas Department of Health and Environment, and KGS recently investigated AML problems, especially mine-related water pollution, within the study area. As a result, some baseline data, including low-altitude aerial photography, were already available for the study area.

In addition to making the Prototype Study available in final report form, CPA and KARS provided direct technical assistance to persons working in state and federal AML programs in Region IV. For example, project staff visited abandoned mined lands in Texas and Oklahoma to demonstrate spoil-sampling procedures developed in the Prototype Study. The KARS Program and CPA also conducted a "Workshop on the Use of Remote Sensing in Abandoned Mine Lands Analysis and Reclamation," July 27-29, 1981. One-and-one-half days of workshop were conducted at the Space Technology Center and one day was spent in the field in southeastern Kansas visiting sites that were studied on aerial photography.

In addition, a sequence of two half-day mini-courses will be conducted during the 1982 National Symposium on Surface Mining Hydrology, Sedimentology and Reclamation, to be held in Lexington, Kentucky in December, 1982. The courses will cover the availability, cost and acquisition of a range of remote sensing image types, and their practical applications to surface

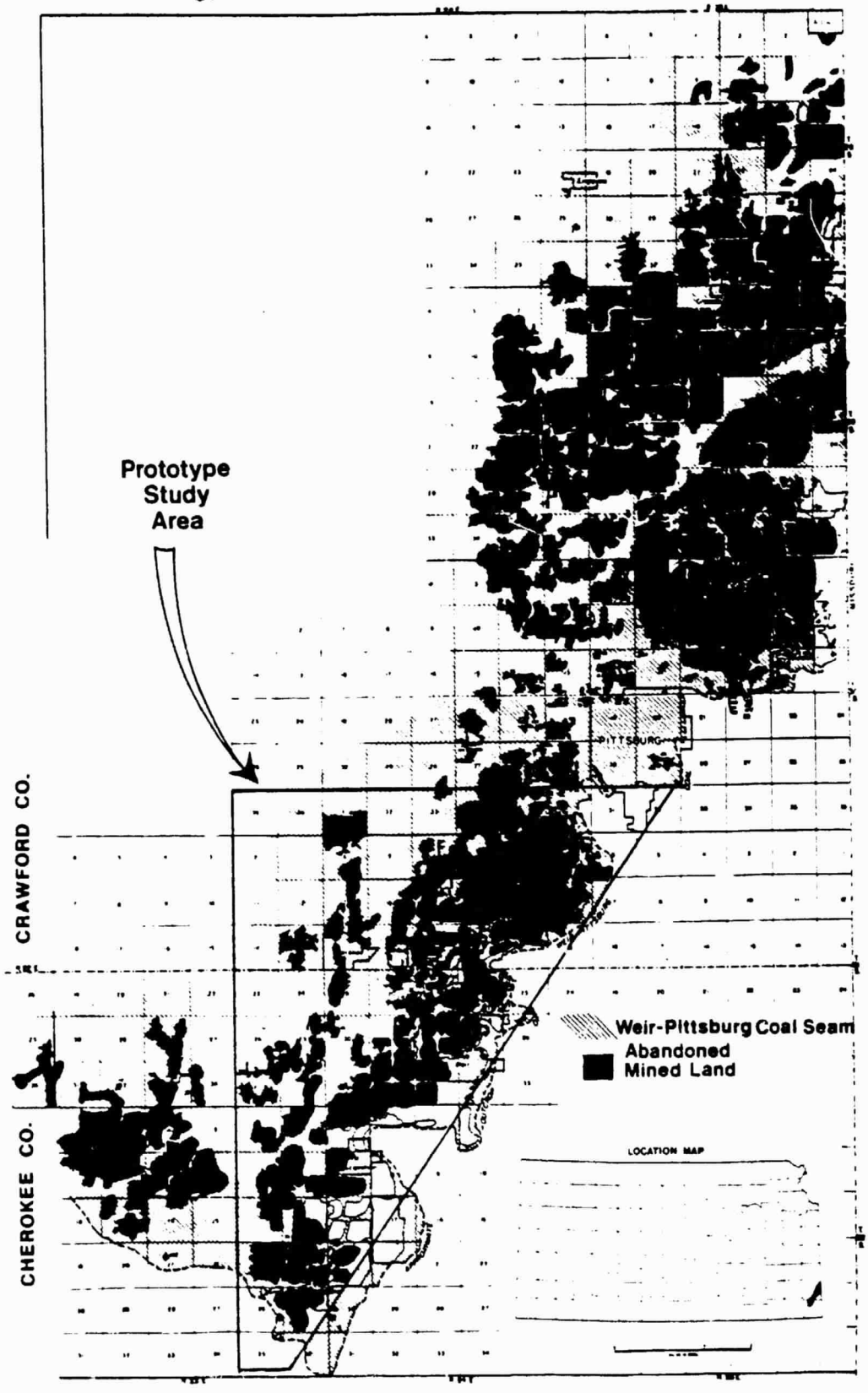



Figure 19. Major Abandoned Mined Land Areas of Southeast Kansas

coal mine land analysis. Emphasis will be placed on evaluating abandoned coal mine lands, but the material will be applicable to studies of active mine sites.

The first course will cover the characteristics, interpretation and uses of ASCS historical photography, ASCS annual 35mm color photography, high-altitude infrared color aerial photography and Landsat satellite imagery. An example of the Landsat imagery to be used is shown in Figure 20. The use of medium format light aircraft photography for detailed site monitoring will be introduced.

The second course will cover calculation and mensuration of photo scale, area, height and volume, and selection of appropriate imagery. Procedures for planning and flying light aircraft photography will be presented, including consideration of camera, film, resolution, scale, flying height, aircraft, flight line layput and cost estimation.

The information from the Prototype Study will be used by Kansas and other states for the purpose of inventorying, assessing, and reclaiming abandoned mined lands. The Center and the KARS Program will continue to provide technical assistance to persons interested in utilizing the information.

The State Reclamation Plan for Abandoned Mine Lands Study was conducted by CPA under the direction of the Kansas Mined Land Conservation and Reclamation Board (MLCRB). The plan provided social, economic, and environmental information for areas in Kansas impacted by abandoned mined lands. The plan also utilized existing data from the AML Inventory to identify the abandoned coal mines that pose health, safety, and/or environmental problems, and proposed reclamation schemes and schedules.

This reclamation plan was developed in response to Title IV of the Surface Mining Control and Reclamation Act of 1977. The statute established a reclamation fee to generate revenue from coal production to be used in reclaiming lands and water left in an unreclaimed state prior to the August 3, 1977 enactment date. Beginning October 1, 1977, the fee has been generating $.35 per ton of coal produced in Kansas; total reclamation fees collected by OSM in the state, as of March 31, 1981, amount to $1,136,806. Upon federal approval of the State Reclamation Plan, the state AML program of the MLCRB will be eligible to administer 50 percent of the revenue col-

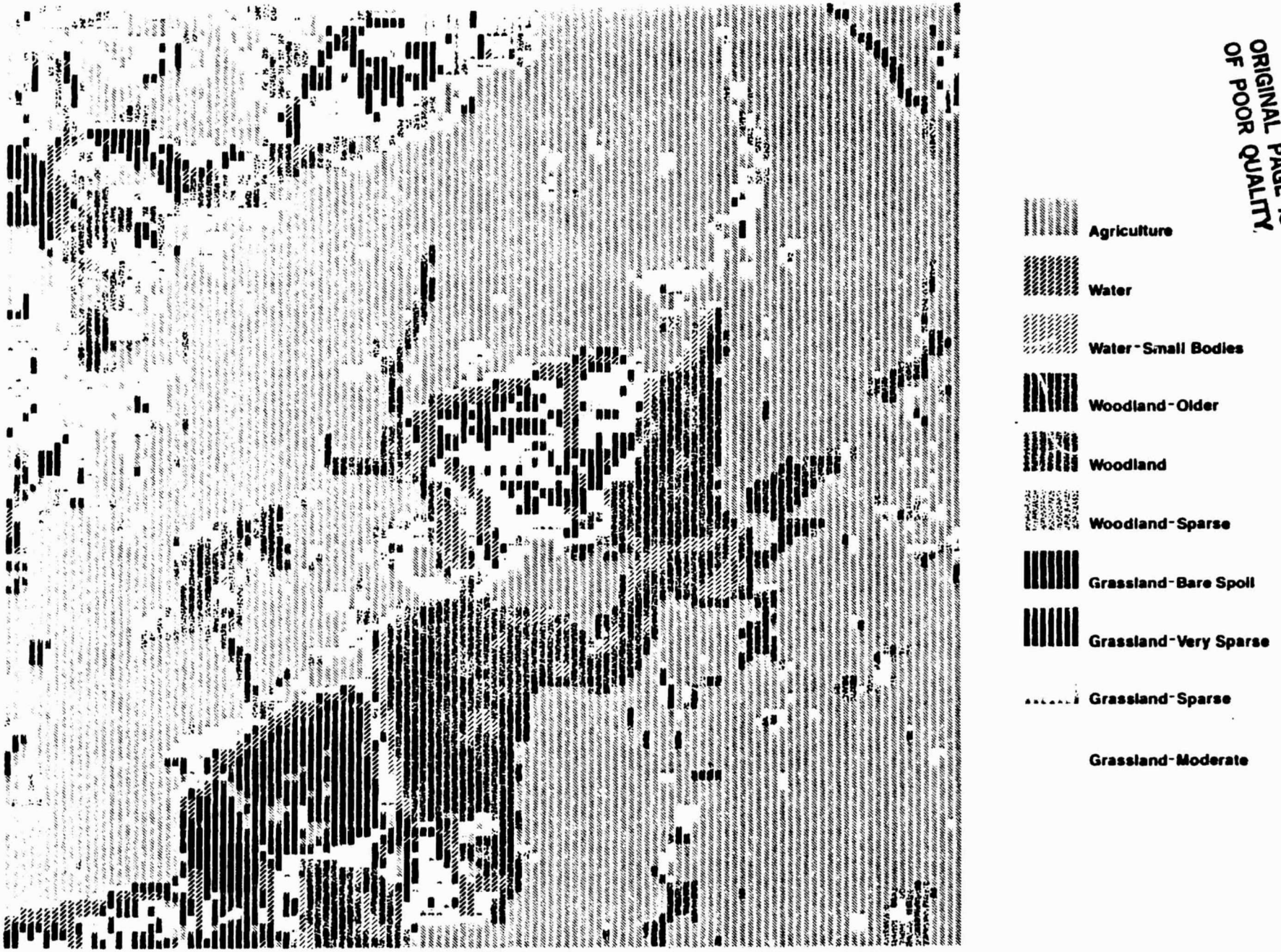



Figure 20. This digital classification of Landsat imagery acquired on October 8, 1980 of the West Mineral Study site in southeast Kansas will be used in the mini-courses to illustrate a typical image type available to AML planners.

lected in Kansas during the 15-year period ending August 3, 1992. It is anticipated that the State will be eligible for an estimated $250,000 annually. In addition, the state AML program expects to undertake reclamation projects financed entirely from the federal 50 percent "share" through cooperative agreements with OSM.

The State Reclamation Plan was completed in August 1981 and was presented at public hearings in Pittsburg, Fort Scott, and Topeka. The plan was approved by the MLCRB on September 15 and is currently being reviewed by OSM.

# APPENDIX I

# KARS PROJECTS

## KANSAS APPLIED REMOTE SENSING PROGRAM
April, 1972 to March, 1982

| Project Number | Project Title | Cooperating Agency | Type of Governmental Organization | | | | | | Data Source | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Federal | State | Regional | County | Municipal | Private | 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<br>Missouri Department of Natural Resources | | X | | | | | X | | | | X |
| 3. | Kansas City, Kansas Flooding Disaster | Mayor's Office, Kansas City, Kansas<br>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<br>U.S. Department of Agriculture - Soil Conservation Service | X | | X | | | | X | | | | |
| 6. | Land Use Map of Cherokee County, Kansas | Cherokee County Commissioners<br>Kansas Department of Economic Development<br>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<br>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<br>U.S. Fish & Wildlife Service Kansas City Area Office<br>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<br>Concordia, Kansas Chamber of Commerce<br>Four Rivers Resource Conservation and Development District<br>Kansas State Park and Resources Authority<br>U.S. Department of Agriculture-Soil Conservation Service | X | X | X | X | X | | | | | | X |
| 14. | County Line Lake Missouri Project | Governor's Office Missouri<br>Missouri Department of Natural Resources | | X | | | | | | | | | X |

| Project Number | Project Title | Cooperating Agencies | Type of Governmental Organization | | | | | | Data Source | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Federal | State | Regional | County | Municipal | Private | Landsat | Skylab | High Altitude | Medium Altitude | Low Altitude |
| 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<br>Kansas Department of Health & Environment<br>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 | U.S.D.A.-Soil Conservation Service<br>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<br>Weed and Pesticide Division<br>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<br>Sumner County Commission | | | X | X | | | | X | | | |
| 23. | Law Enforcement Planning for the Republican National Convention | Kansas City, Kansas Police Department<br>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 | | | | |
| 25. | 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<br>U.S.D.A. 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 | | | | | | Data Source | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Federal | State | Regional | County | Municipal | Private | Landsat | Skylab | High Altitude | Medium Altitude | Low Altitude |
| 30. | Soldier Creek Watershed 208 Planning | U.S.D.A.-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<br>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 | U.S. Department of Agriculture 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 | | | | | | Data Source | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Federal | State | Regional | County | Municipal | Private | 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 | U.S. Department of the Interior - 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 | U.S. Department of Agriculture - Forest Service | X | | | | | | X | | | X | X |
| 49. | Resources Management Geo-Data Base for Kansas Indian Owned Lands | U.S. Department of the Interior - 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 |

# APPENDIX II

## KARS NEWSLETTER(S)

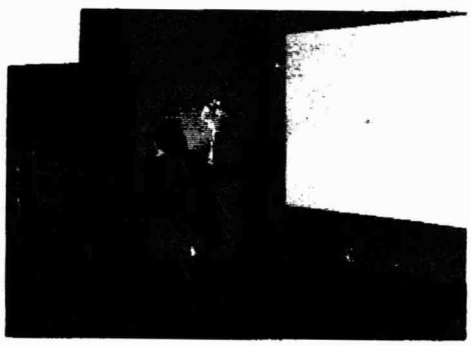
Kansas Applied Remote Sensing

KARS

Newsletter

The University of Kansas | April 1981 | Volume 10, Number 2

## KANSAS LEGISLATORS BRIEFED ON LANDSAT/KARS PROGRAM



Professor B. G. Barr presents an overview of the KARS Program for State legislators.

On March 18, 1981 Prof. B. G. Barr, KARS Program Director, and Dr. Edward A. Martinko, Associate Director, were privileged to review, for three committees of the Kansas Legislature, the Landsat program and the KARS Program's technical assistance and technology transfer activities with Kansas agencies. The KARS Program has been funded by NASA since 1972 to aid Kansas agencies in employing satellite and aerial remote sensing technology. Loyola M. Caron, Staff Associate, Natural Resource Information Systems Project, National Conference of State Legislatures, also participated in the briefings providing a summation of the utilization of Landsat data by states other than Kansas.

The presentations were made before, respectively, the Kansas Senate Committee on Energy and Natural Resources, the Kansas Senate Committee on Agriculture and Small Business, and the Kansas House Committee on Agriculture and Livestock. Approximately 80 legislators, aides, and state agency representatives attended the briefings.

(continued on page 3)

## KANSAS INTERAGENCY TASK FORCE ON APPLIED REMOTE SENSING

The Kansas Applied Remote Sensing (KARS) Program, on Thursday, May 7, 1981, convened the first meeting of the Kansas Interagency Task Force on Applied Remote Sensing at the University of Kansas Space Technology Center in Lawrence. The Task Force has been established to (1) provide policy direction for the KARS Program, (2) define Program goals and priorities, (3) enhance interagency communication, coordination and cooperation on remote sensing and utilization of geographic information systems, (4) provide feedback to the KARS Program regarding agency needs and concerns, (5) evaluate the Program's performance and requirements, and (6) assess alternatives for greater and more operational utilization of remote sensing/geographic information systems technology on a state-wide basis.

Attending the initial Task Force meeting were:

Donald Kostecki
Kansas Water Resources Board

William Hambleton, Director
Kansas Geological Survey

Ray Menendez
Kansas Department of Revenue

Robert Burcke
Kansas Department of Revenue

Freeman E. Biery
Kansas State Board of Agriculture
Weed & Pesticide Division

Rick Illgner, Manager
Southwest Kansas Groundwater Management District #3
President, Kansas Groundwater Management District Managers Association

(continued on page 2)

...TASK FORCE (Contd)
Michael Butler
Kansas Department of Health & Environment

Wayne Herndon
Kansas Park & Resources Authority

Ramon Powers
Kansas Legislative Research Department

Raney Gilliland
Kansas Legislative Research Department



R. C. (Pete) Loux, Chairman
Kansas Corporation Commission

Bill Hanzlick, Director
Kansas Fish and Game Commission

Dean Garwood
Kansas State Board of Agriculture
Entomology Division

B. G. Barr, Director
University of Kansas Space Technology Center
KARS Program

Edward A. Martinko, Associate Director
KARS Program

James W. Merchant
Senior Remote Sensing Applications Specialist
KARS Program

Following a brief review of the KARS Program and remote sensing/geographic information system applications in Kansas, the Task Force considered a number of issues including (1) the objectives and composition of the Task Force, (2) the need for a systematic evaluation of state agency data needs which might be met through application of remote sensing/geographic information system (GIS) technology, (3) the common requirements of many agencies for similar data (e.g., land use/land cover), (4) the advantages inherent in coordination of data collection efforts, and (5) alternatives for enhancing access to and application of remote sensing/GIS technology.

## NEW BROCHURES DESCRIBE KARS PROGRAM AND KU SPACE TECHNOLOGY CENTER

A new brochure describing the facilities and research programs of the University of Kansas Space Technology Center has recently been published.

The KARS Program, an applied research arm of the Space Technology Center, also offers a brochure describing its facilities, services and major research and applications areas. Both brochures may be obtained free of charge from Anne Kahle, KARS Program, KU Space Technology Center, Lawrence, KS 66045 (913-864-4775, KANS-A-N 564-4775).

The Task Force formulated a number of recommendations including:

1. Task Force composition -- An invitation to participate on the Task Force will be extended to state agencies which might potentially be able to use remote sensing/GIS technology. These will include, but not be limited to:
   - Kansas Fish and Game Commission
   - Kansas Water Resources Board
   - Kansas Geological Survey
   - Kansas Department of Health and Environment
   - Kansas Park and Resources Authority
   - Kansas Groundwater Management Districts
   - Kansas State Board of Agriculture
     - Division of Water Resources
     - Weed & Pesticide Division
     - Entomology Division
   - Kansas Department of Revenue
   - Kansas Corporation Commission
   - Kansas Department of Administration
     - Division of Budget
   - Kansas Department of Economic Development
   - Kansas Department of Transportation
   - Kansas League of Municipalities
   - The KARS Program will coordinate Task Force activities and provide liason with NASA, NOAA, NCSL, NGA, the Five Agency Project, and other states. Liason will also be maintained with the Legislative Research Department, the Kansas Governor's Office, and private industry.

   It was recommended that, in the future, an invitation be extended to federal (SCS, ASCS, USGS, WPRS, EPA), local and regional agencies to attend and participate in the Task Force meetings.

2. Systematic Study of User Needs -- The KARS Program will conduct an evaluation of Kansas state agencies' data needs which might be better met through application of remote sensing/GIS technology. The study will include an assessment of the potential for cost savings. Task Force representatives will assist KARS staff in carrying out this work. Results of the study will be presented at the next meeting of the Task Force.

3. July meeting -- The Task Force will meet at the University of Kansas Space Technology Center on July 9, 1981 (9:00 A.M.) to review the results of the User Needs Study and to discuss alternatives which will allow the KARS Program to more effectively meet data requirements identified.

Additional details regarding the Kansas Interagency Task Force on Applied Remote Sensing may be obtained from Ed Martinko or Jim Merchant.

...LEGISLATORS (Contd)

On February 28, 1981 Senators Fred A. Kerr and Jane Eldredge visited the University of Kansas Space Technology Center for a tour of KARS Program facilities and a demonstration of KARS' capabilities for meeting data needs of state agencies.

Senator Fred A. Kerr (right) discusses applications of natural resource information systems with Ed Martinko, KARS Project Coordinator, (left) and Loyola Caron, Staff Associate, NCSL/NRIS Project.

## SENATOR FRED A. KERR JOINS NCSL/NRIS TASK FORCE

Kansas Senator Fred A. Kerr has been invited to join the National Conference of State Legislatures' Natural Resource Information Systems (NCSL/NRIS) Task Force. Comprised of legislators and legislative staff representing twelve states, the Task Force meets twice each year to review new developments in the Landsat program and the applications of natural resource information systems. The NCSL/NRIS Task Force provides state legislators with a voice through which the recommendations of the state's regarding this new technology may be presented to the Congress, the National Aeronautics and Space Administration (NASA), the National Oceanic and Atmospheric Administration (NOAA) and other agencies involved in making policy on Landsat/NRIS programs. Recommendations regarding continuity in the availability of Landsat data and NASA/NOAA technology transfer programs in the face of federal budget cutbacks, data pricing, orbital coverage, and data archiving are currently being considered by the Task Force.

Further information on the Task Force and the NCSL/NRIS Project may be obtained from Mr. Paul A. Tessar, NCSL/NRIS Project, 1125 17th Street, Denver, Colorado 80202 (303/623-6600).

**ORIGINAL PAGE COLOR PHOTOGRAPH**

## WYOMING LEGISLATORS/AGENCIES REVIEW LANDSAT AND KARS PROGRAMS

On February 23 and 24, 1981 Dr. Edward A. Martinko and James W. Merchant made a series of invited presentations to Wyoming legislators and state agency personnel in Cheyenne, Wyoming. The meeting with state legislators was arranged by Senator Earl Christensen, Chairman, Wyoming Senate Agriculture, Public Lands and Water Resources Committee and member of the National Conference of State Legislatures' Natural Resource Information Systems (NCSL/NRIS) Task Force. Martinko and Merchant were joined in the presentation for state legislators, by Mr. Paul A. Tessar, Project Manager, NCSL/NRIS Project, and Loyola M. Caron, Staff Associate, NCSL/NRIS Project. Approximately 25 legislators and guests were briefed on the Landsat Program, Landsat applications in the Western United States, the KARS Program, and applied remote sensing projects which have been carried out by the KARS Program with state agencies in Kansas and Missouri. Particular emphasis was placed on mapping of irrigated lands, noxious weed inventory, crop identification and mapping, rangeland evaluation. wildlife habitat assessment, and strip mined lands evaluation.

The meeting with Wyoming state agencies was organized by Mr. Michael T. O'Grady, Water Resources Engineering Technical Specialist, Wyoming Water Development Commission. Martinko and Merchant reviewed the KARS Program, applied remote sensing projects in Kansas and Missouri, the Landsat Program, and digital processing of Landsat MSS data to meet state data needs. A demonstration of digital image processing was carried out via a remote terminal connected to the University of Kansas Computer Center in Lawrence. Land use/land cover maps were generated for two test sites located in the Big Horn River basin of north central Wyoming. Twenty-nine persons representing eleven Wyoming state agencies and one private firm attended the briefing and demonstration.

## RAPID LANDSAT IMAGE DATE SELECTION FOR CROP IDENTIFICATION

The KARS Program has recently completed a study for NASA's Ames Research Center concerned with the development of a method to rapidly select optimal Landsat dates for crop identification in the High Plains. The study focused on the 1980 growing season. The High Plains region encompasses 232 counties in Colorado, Kansas, Nebraska, New Mexico, Oklahoma, South Dakota, Texas and Wyoming.

Crop development (phenology) models were used to identify potential shifts in spectral reflectance. Landsat dates were chosen on the basis of crop phenology and inferred spectral reflectance characteristics.

(continued on page 4)

## KARS PROGRAM CONDUCTS 1981 SHORT COURSES

On Tuesday, March 31, at the KU Regents Center in Overland Park, the KARS Program held the first of a series of four one day short courses entitled "Remote Sensing: An Overview." The courses were also presented at Topeka, Salina and Pratt, KS. The 82 persons attending the course represented many different disciplines including hydrology, engineering, planning and wildlife conservation. The course attendants included 24 university faculty and students, 29 federal, 20 state and 6 local agency personnel as well as 3 persons from the private sector.

Jim Merchant, KARS Program (right), discusses rangeland evaluation using Landsat digital data with Pratt short course participants Bill Sheppard (left) and Glen Snell, USDA-SCS.

The one day course will be followed up by an intensive five-day course on "Fundamentals of Applied Remote Sensing," to be held at the University of Kansas Space Technology Center in Lawrence. This course will be offered twice, June 1-5 and July 13-17, 1981, and is designed to provide hands-on experience in image interpretation and digital processing of Landsat data.

The course is intended primarily for state, federal and local agency personnel in Kansas as well as college and university faculty and other agency personnel on a space available basis. The extremely low registration fee of only $25 is made possible by a grant from NASA. Further information may be obtained by contacting Anne Kahle, KARS Program, University of Kansas Space Technology Center, Lawrence, Kansas 66045 (Telephone: 913-864-4775, KANS-A-N 564-4775).



...DATE SELECTION (Contd)

Data used in the study were gathered from the weekly Crop-Weather reports published by each state's Crop and Livestock Reporting Service. These reports are designed to provide users with information concerning the developmental progress of major crops throughout the growing season as well as climatic data.

The technique for rapid determination of best Landsat image dates for crop identification should be useful to resource analysts requiring crop inventory information for a large region in a timely and cost-effective manner. Since the Crop and Livestock Reporting Service routinely conducts ground surveys throughout the growing season, the Landsat data user interested in crop inventories can use the methodology developed to reduce the amount of time and money previously invested in survey work done in order to choose imagery required to separate crop types and irrigated and unirrigated cropland.

The methodology, part of a more comprehensive study on the use of crop calendars to be completed in June 1981, was presented by Liz Kipp as a paper at the Kansas Academy of Science's annual meeting in March. Further information concerning this work can be obtained from Liz Kipp or Joe Poracsky.

## LAND USE/LAND COVER INVENTORY OF THE MISSOURI RIVER FLOOD PLAIN

The KARS Program has been awarded a contract by the Missouri River Basin Commission (MRBC) to map land use and land cover in the Missouri River flood plain from Ponca, Nebraska to the river's mouth near St. Louis, Missouri. The maps (and associated acreage statistics) will be an integral part of a comprehensive Missouri River Flood Plain Study being carried out by MRBC. Land use/land cover data developed by the KARS Program will be used by MRBC staff to assist in defining (1) the location of land uses or encroachments that may be potentially hazardous during flooding episodes, (2) the location of sensitive environmental areas, (3) the spatial interrelationships and possible conflicts among different land use and land cover classes, and (4) possible conflicts of existing and proposed land uses with current flood plain management programs. Local, state, and federal agencies will employ the products to address a variety of environmental, developmental, legal and institutional, and flood hazard problems.

KARS Program staff will use medium and large scale (1:63,360 - 1:12,000) color aerial photography as the primary data source for the inventory. The aerial photography will be augmented with data acquired in the field and information supplied by cooperating state agencies. Final products will consist of (1) a set of mylar overlays to the existing 1:24,000 USGS topographic maps covering the study area, (2) acreage statistics for each polygon of land use/land cover and (3) a technical report summarizing project methodology and results. All products will be delivered to MRBC by August 31, 1981. Further details on the Missouri River project may be acquired from either Jim Merchant or Emily Roth.

## KARS STAFF CHANGES

Dr. T. H. Lee Williams, a KARS Research Investigator for four years, has recently been granted tenure and promoted to the rank of Assistant Professor in the Department of Geography-Meteorology at the University of Kansas. Dr. Williams is a remote sensing specialist holding a Ph.D. in Geography from the University of Bristol (England).

Hank Krieger, a KARS staff member for one year, completed a bachelor's degree in environmental studies at KU and has assumed a position with the Defense Mapping Agency in St. Louis, MO. He will initially be involved in a two-year training program in remote sensing.

Linda Terflinger, a KARS staff member for one year, has finished a bachelor's degree in environmental studies at KU and has accepted a position with the Kansas Crop and Livestock Reporting Service in Topeka, KS. She will be working in agricultural remote sensing.

Jim Rosacker has been with the KARS staff for one year and has completed a bachelor's degree in environmental studies at KU. He will be involved in agricultural field work in Ames, IA.

Bob Yoos completed a bachelor's degree in social science at Emporia State University, Emporia, KS. Now a graduate student in the geography department at KU, Bob has joined the KARS staff. He will pursue interests in remote sensing applications in agriculture.

Becky Domermuth holds a bachelor's degree in geography from KU. Now a graduate student in the geography department, Becky has joined the KARS staff with special interests in computer programming and cartography.

Phil Orlowski holds a bachelor's degree in environmental studies from KU. He has joined the KARS staff as a research assistant and will begin a graduate program in environmental studies in the fall pursuing remote sensing applications to natural resource problems.

Debora Sidor has joined the KARS staff as an undergraduate assistant. A senior in the Environmental Studies Program at KU, Debora has an interest in remote sensing applications to natural resources.

**Contributors to this issue of the KARS Newsletter include Jim Merchant and Liz Kipp. Liz Kipp served as editor for this issue.**



## KARS PROGRAM 1981

*The University of Kansas Applied Remote Sensing (KARS) Program, an applied research program of the KU Space Technology Center, receives base funding from the National Aeronautics and Space Administration (NASA) Office of Space and Terrestrial Applications to assist local, regional, state and federal agencies in utilizing satellite and airborne remote sensing techniques in natural resources management, agriculture, planning and other areas. Persons wishing to discuss possible projects or having questions regarding remote sensing applications are invited to contact Dr. Edward A. Martinko, Associate Director, KARS Program (913/864-4775 or KANS-A-N 564-4775).*

## CONFERENCE ON URBAN EROSION AND SEDIMENTATION SET FOR SEPTEMBER

Rain and melting snow each year carry thousands of tons of soil, debris, toxic chemicals, salts, and other pollutants into the sewers of the cities and towns of Mid America. The effects of uncontrolled urban runoff include impaired water quality, clogged storm sewers, and stressed wastewater treatment facilities.

In order to assist decision-makers, planners, technical specialists, and the public in more effectively dealing with such problems, the Mid America Association of Conservation Districts will sponsor, on Thursday, September 24, 1981, a "Mid American Conference on Urban Erosion and Sedimentation." The Symposium will be held at The Inn at Executive Park, I-435 at the Front Street exit, Kansas City, Missouri, from 8:30 A.M. to 3:30 P.M. The conference will be cosponsored by the National Association of Conservation Districts and more than fifteen federal agencies, Kansas and Missouri state, local and regional agencies, and citizens' groups including the KARS Program.

Among the issues to be addressed at the symposium will be (1) the nature and severity of the problem in Kansas and Missouri, (2) the available technology for handling the problem, (3) roles of various agencies and organizations in program administration, (4) existing and needed ordinances and legislation, (5) plans for program development or improvement, and (6) costs of program implementation. Examples of successful state and local programs will also be presented.

Further information and a brochure describing the conference may be obtained from the Mid America Association of Conservation Districts, P.O. Building, Room 225, 301 West Lexington, Independence, MO 64050 (phone 816-461-0880 or 816-254-2040).

# UPCOMING EVENTS

1-5 June and 13-17 July 1981 SHORT COURSES: FUNDAMENTALS OF APPLIED REMOTE SENSING, Lawrence, Kansas. Contact: Anne Kahle, KARS Program, KU Space Technology Center, 2291 Irving Hill Drive, Lawrence, Kansas 66045. 913-864-4775, KANS-A-N 564-4775.

23-26 June 1981 SYMPOSIUM ON MACHINE PROCESSING OF REMOTELY SENSED DATA, West Lafayette, Indiana. Contact: Douglas B. Morrison, Purdue University/ LARS, 1220 Potter Drive, West Lafayette, Indiana 49096. 317-749-2052.

29 June - 1 July 1981 LANDSAT/GEO-BASED INFORMATION SYSTEMS SYMPOSIUM, Biloxi, Mississippi. Contact: Pat Conner, NASA/Earth Resources Laboratory, National Space Technology Laboratories, NSTL Station, MS 39529. 601-688-2042.

9-14 August 1981 INPLACE RESOURCE INVENTORIES: PRINCIPLES AND PRACTICES, Orono, Maine. Contact: L. O. House, Great Northern Paper Company, Millinocket, Maine 04462. 207-723-5131.

18-21 October 1981 SEVENTH WILLIAM T. PECORA SYMPOSIUM, Sioux Falls, South Dakota. Contact: Dr. Benjamin F. Richason, Jr., Department of Geography, Carroll College, Waukesha, Wisconsin 53186. 414-547-1211 ext. 144.

*The Kansas Applied Remote Sensing Newsletter is published in January, April, July and October by the University of Kansas Applied Remote Sensing (KARS) Program having facilities located in the Space Technology Center, Nichols Hall, The University of Kansas. Publication of the KARS Newsletter is supported by NASA Office of University Affairs 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

Kansas Applied Remote Sensing

KARS Newsletter

The University of Kansas | July 1981 | Volume 10, Number 3

## STUDY ON CROP PHENOLOGY AND IRRIGATED LANDS INVENTORY CONCLUDED

The KARS Program has completed an analysis of methodologies for selecting optimal dates of Landsat imagery for irrigated lands identification in the Great Plains. The study, conducted for NASA's Ames Research Center, was specifically focused on the High Plains Regional Aquifer (HPRA), an area encompassing 232 counties in the eight states of Colorado, Kansas, Nebraska, New Mexico, Oklahoma, South Dakota, Texas and Wyoming.

Diminishing groundwater supplies represent a serious threat to the High Plains economy as well as to U.S. crop production. The U.S. Geological Survey responded to this situation by initiating a comprehensive study of the HPRA in 1978. One of the major goals of the HPRA study is to develop computer models for predicting aquifer response to changes in groundwater models.

An inventory of irrigated crop acreage is a crucial input for estimating the volume of groundwater pumpage because the principal use of groundwater in the High Plains is for crop irrigation. The use of Landsat imagery is particularly suitable for such an inventory because it provides information in a timely and cost-effective manner for a large geographical region.

In order to select the best dates of Landsat imagery for identifying irrigated lands, information regarding crop calendars, phenologies and irrigation management practices for the 13 principal crops grown in the HPRA area were compiled by the KARS Program staff. Detailed keys were prepared which listed the phenological data for each of the major crops, as well as irrigation sc[illegible]es and other important crop variables that [illegible]uld affect the level of accuracy in the inter[illegible]tation procedure. These data were used

(Continued on page 3)

## KARS TO AID KANSAS DEPARTMENT OF REVENUE IN IDENTIFYING TAX ASSESSMENT REGIONS

The Division of Property Valuation (DPV) within the Kansas Department of Revenue recently contacted the KARS Program to request assistance in determining regions of homogeneous land characteristics within the state. The Division of Property Valuation is charged with the responsibility of providing for uniform and equal taxation of all property throughout the state. At present, there is concern that unequal tax burdens may exist.

Anticipating certain mandated changes in the state's property taxation structure, the Division of Property Valuation is exploring techniques of dividing the land area of Kansas into homogeneous regions, taking into consideration such factors as rainfall, length of growing season, land use patterns, cropping practices, soil types and topography. The homogeneous land regions will be used along with other data to aid in determining property tax rates across the state.

As a first-look demonstration of a technique for determining homogeneous regions, KARS staff prepared a regionalization of the state based on average annual precipitation, average annual growing season and the USDA Soil Conservation Service's distribution of major soil groups. Once details of the informational requirements for each of the land evaluation criteria have been fully defined by DPV, the KARS Program will institute a pilot study for a selected area within the state. The pilot study will demonstrate the utility of geographic information system/remote sensing technology for identifying homogeneous regions and will document the time and cost effectiveness of such an approach. For further information regarding this project, contact Ed Martinko, KARS Program.

# KANSAS INTERAGENCY TASK FORCE ON APPLIED REMOTE SENSING

The Kansas Applied Remote Sensing (KARS) Program, on Thursday, July 9, 1981, convened the second meeting of the Kansas Interagency Task Force on Applied Remote Sensing at the University of Kansas Space Technology Center in Lawrence. The Task Force has been established to (1) provide policy direction for the KARS Program, (2) define Program goals and priorities, (3) enhance interagency communication, coordination and cooperation on remote sensing and utilization of geographic information systems (GIS), (4) provide feedback to the KARS Program regarding agency needs and concerns, (5) evaluate the Program's performance and requirements, and (6) assess alternatives for greater and more operational utilization of remote sensing/GIS technology on a state-wide basis.

Attending the second Task Force meeting were:

Fred Allen
Kansas Association of Counties

Freeman E. Biery, Director
Division of Weeds and Pesticides
Kansas State Board of Agriculture

Kevin Carr
Kansas Department of Economic Development

Clark Duffy
Kansas Department of Administration
Division of Budget

Verlyn Ebert
Kansas Fish and Game Commission

H. Dean Garwood, Director
Division of Entomology
Kansas State Board of Agriculture

William W. Hambleton, Director
Kansas Geological Survey

Bill Hanzlick, Director
Kansas Fish and Game Commission

Wayne Herndon
Kansas Park and Resources Authority

Rick Illgner, President
Kansas Groundwater Management District
Managers Association
Manager, Southwest Kansas Groundwater
Management District #3

Fred Kerr
Kansas State Senate

Donald F. Kostecki
Kansas Water Office



Ray Menendez
Kansas Department of Revenue

Bob Walters, Kansas Department of Revenue, reported to the Task Force members on the NASA Landsat/Geo-based Information System Symposium which he attended in June. The meeting was held in Biloxi, Mississippi.

Tom Patton
University of Kansas
Research and Graduate Studies

Donald Snethen
Kansas Department of Health and Environment

Edward Unrein
Kansas Park and Resources Authority

Robert L. Walters
Kansas Department of Revenue

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

Edward A. Martinko, Associate Director
KARS Program

James W. Merchant
Senior Remote Sensing Applications
Specialist
KARS Program

Joseph Poracsky
Elizabeth R. Kipp
Anne Kahle
KARS Program

The Task Force considered a number of issues including (1) a User Needs Survey which had been conducted by the KARS Program in conjunction with Kansas state agency personnel, and (2) documentation of the cost effectiveness of remote sensing/GIS technology compared to conventional data gathering techniques.

(Continued on page 4)

...CROP PHENOLOGY (Contd.)

to determine the approximate dates when each crop canopy was fully developed and under irrigation. On this date the soil background would be a minimal component of reflectance, and the irrigated crop would have a higher reflectance alue in Band 7 than nonirrigated crops.

Two methodologies were developed for selecting optimal dates of coverage. Each method used the same kind of crop phenological data, but varied in the agricultural data source.

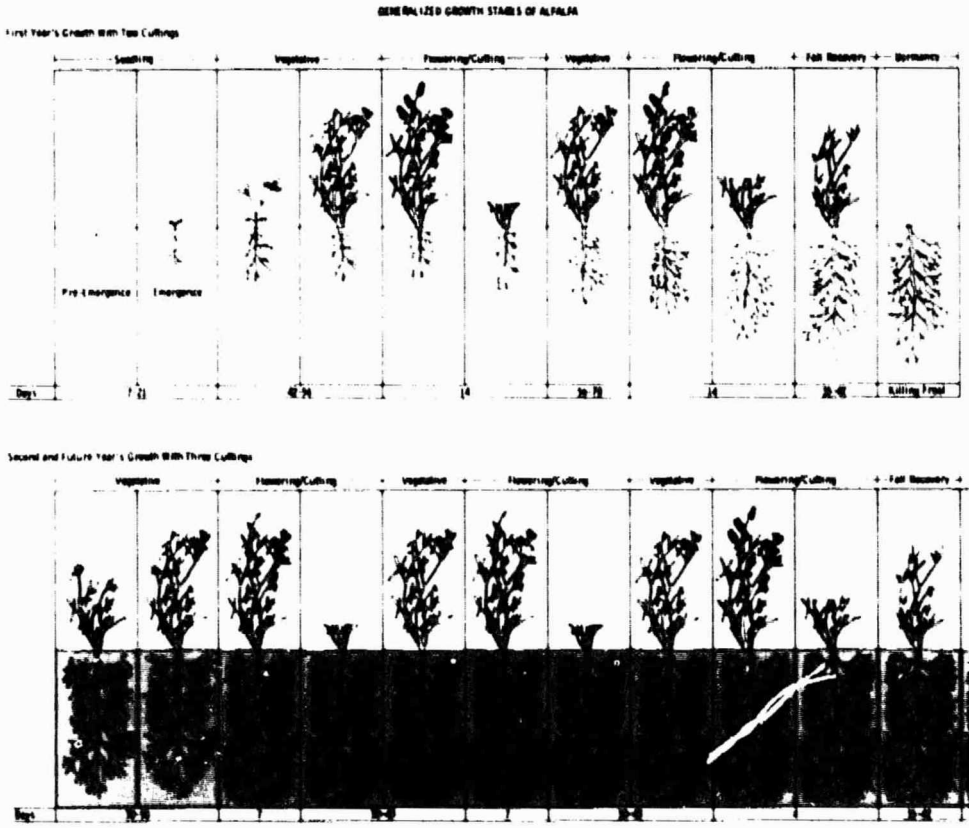
First, a method for rapidly selecting Landsat dates was developed using weekly Crop-Weather Reports published by each state's Crop and Livestock Reporting Service. These reports are designed to provide users with chronological information regarding the developmental progress of major crops throughout the growing season on a regional (8-14 county) and state level. Because only phenological data are reported, the optimal Landsat dates were derived by combining these data with inferred irrigation schedules. This method allowed a quick approximation of the best dates of coverage.

The second method employed the compilation of county level data on crop phenology, irrigation schedules, cropped acreage and other crop parameters. These data were acquired through both a survey questionnaire sent to the USDA's Agricultural Stabilization and Conservation Service (ASCS) and the Cooperative Extension Service, and through published statistics available from the USDA's Economics and Statistics Service (ESS).

The crop data were compiled into crop calendars in a map format. The HPRA area was divided into subunits, termed Irrigated Crop Districts (ICD). Each subunit exhibits similar crop calendar and irrigation characteristics throughout, so that it is homogeneous with regard to its interpretation parameters. Computer-generated maps were produced delineating the distribution of both irrigated and cropped land using a multivariate clustering routine developed by the KARS Program staff. The resulting ICD map contained 31 districts ranging in size from 1-18 counties. The optimal Landsat dates were chosen for each ICD based on crop phenology, irrigation schedules and other parameters derived from the survey questionnaire data and the ESS statistics. This method provided a more precise determination of optimal dates than the first method.

These methodologies for optimal Landsat date determination can be useful tools for both irrigated lands identification as well as for crop identification. The methods were designed to be used for any growing season. The approaches taken in this study can aid in reducing timely and costly ground truth previously needed in order to select Landsat image dates for crop inventory purposes.

(Continued on page 4)

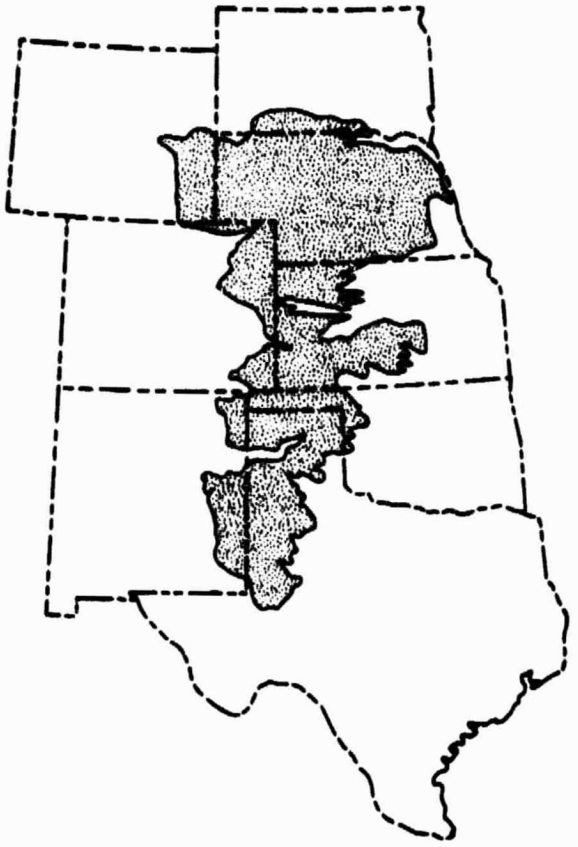



ORIGINAL PAGE
COLOR PHOTOGRAPH

An understanding of the phenology of major crops is an important consideration when selecting imagery dates for analysis. The generalized growth stages of alfalfa are shown here. During the first year, two cuttings are normal. Once established, alfalfa can be cut three times in areas that have relatively long growing seasons.

...CROP PHENOLOGY (Contd.)

ORIGINAL PAGE
COLOR PHOTOGRAPH



High Plains Regional Aquifer study area (Source: U.S. Geological Survey, Lakewood, CO)

A summary report of the study will soon be available. The full technical report is available for the cost of reproduction. Further information regarding this work can be obtained from Joe Poracsky, KARS Program.

## KARS PROGRAM STAFF CHANGES

Loyola M. Caron has recently joined the KARS Program staff. Loyola is a remote sensing specialist with a background in natural resource information systems (NRIS) technology, 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 coming to Lawrence, Loyola was Staff Associate with the National Conference of State Legislatures' Natural Resource Information Systems Project, a program which provides technical assistance to state legislators on Landsat and NRIS technology. She has also worked for North Dakota's Regional Environmental Assessment Program as the earth sciences research coordinator responsible for collecting natural science data for a statewide automated data base. In addition to her work in the KARS Program, Loyola will pursue a degree in Geology at KU.

(Continued on page 6)

...TASK FORCE (Contd.)

The Task Force had requested during its May 1981 meeting, that the KARS Program document, in a systematic fashion, the specific manner in which state agencies could use remote sensing/GIS technology to better accomplish their assigned missions and legally mandated obligations. During June 1981 a User Needs Survey was conducted. Information was gathered regarding (1) agency missions, (2) agency legislative mandates, (3) current and future projects and the necessary data required to conduct those projects, and (4) the frequency of data needs.

Bill Hanzlick, Director of the Kansas Fish and Game Commission, described his tour of NASA's Earth Resources Laboratory at NSTL Station, Mississippi. He and Bob Walters both visited the facilities following NASA's three day meeting in Biloxi.

At least 38 statutes or specific projects in the State of Kansas were identified that could advantageously apply data acquired by remote sensing/GIS technology. These statutes and projects were found in 13 Kansas departments, agencies and commissions. The data needs of federal, regional and local agencies within Kansas have not yet been studied.

Regarding the common data needs of Kansas state agencies, the most recurrent interagency data requirements include a general land use/land cover inventory, irrigated lands identification and classification, and crop identification. Of the 38 different applications of remote sensing/GIS technology identified, 11 are of common interest to at least 2 agencies, and 4 are of interest to at least 6 agencies.

The Task Force recommended that the KARS Program, in conjunction with Kansas state agencies, document the cost-benefits that could be derived by integrating remote sensing data gathering techniques into agency programs. The results of the cost-benefit study will be presented at the next meeting of the Task Force, Monday, September 21, 1981, 9:00 A.M. For more information, contact Ed Martinko or Jim Merchant, KARS Program.

## MEXICAN OFFICIALS REVIEW LANDSAT/KARS PROGRAMS

Dr. Edward Martinko and James Merchant were invited to Chihuahua, Mexico in July to discuss applications of remote sensing/geographic information systems (GIS) technology with officials of Chihuahua state agencies. Approximately 20 agency representatives were briefed on the Landsat program, specific instances where remote sensing/GIS technology has been instrumental in enhancing resource management, and the role of the KARS Program in facilitating the application of this technology. Particular emphasis was placed on a review of alternatives which would enable Chihuahua agency personnel to evaluate the utility of remote sensing/GIS technology for dealing with issues such as development of agriculture, water and forest resources.

## AERIAL PHOTOGRAPHY OF THE UPPER WAKARUSA RIVER WATERSHED

The KARS Program has recently received color infrared aerial photography acquired over the Wakarusa River Watershed upstream from Clinton Reservoir. Photography of the watershed was acquired twice, in February and July 1981, by NASA's Earth Resources Laboratory (ERL) in support of research being conducted at ERL. The imagery was acquired at 1:80,000 and 1:20,000 on both dates. Field data were collected in conjunction with each mission by KARS Program staff. Mr. Stuart Simpson, U.S. Soil Conservation Service District Conservationist, Shawnee County, provided assistance to KARS staff during the initial field work. Further information on this photography can be obtained by contacting Jim Merchant, KARS Program.

## APPLIED REMOTE SENSING SHORT COURSES COMPLETED

During the weeks of June 1-5 and July 13-17 the KARS Program offered two short courses on "Fundamentals of Applied Remote Sensing." Held in the KARS Program facilities at the University of Kansas Space Technology Center in Lawrence, the courses were attended by a total of 28 people.

Course participants included faculty and staff from the University of Kansas, Kansas State University, St. Mary of the Plains College, Fort Hays State University, Pittsburg State University, University of Missouri and the University of Montana; and representatives of several agencies including the Kansas Department of Health and Environment, Kansas Fish and Game Commission, U.S. Geological Survey, Environmental Protection Agency, USDA Soil Conservation Service, National Park Service, Federal Crop Insurance Corporation, Missouri Department of Natural Resources, and several city and regional planning commissions. The courses were offered under a grant to the KARS Program from NASA's Earth Resources Laboratory, NSTL Station, MS.

The courses, accredited by the KU Continuing Education Program, covered the applications of remote sensing to real-world problems. Hands-on training was provided in several areas including air-photo interpretation, visual interpretation of Landsat images and computer-assisted interpretation of Landsat multispectral scanner (MSS) data.

An area of approximately 12 square miles was used throughout the course as an intensive study site. Located just west of Lawrence, the area was chosen because it contained a wide variety of different features and cover types including cropland with various crop types, pasture and rangeland, water bodies, woodland and urbanized areas. Early in the week a short field trip was conducted to familiarize the course attendees with the area.

Initial analysis of the study area was accomplished with black and white panchromatic and color infrared aerial photography. Emphasis was placed on identifying specific features such as terraced fields, schools, power lines, golf courses and residential areas. Later land cover analyses were performed visually on Landsat MSS imagery.

Nearly three days of the course were devoted to computer analysis of Landsat MSS digital data. All computer processing was performed in the KARS Digital Image Processing Laboratory using the University's Honeywell computer and employing a software package developed by the KARS Program. Each student prepared a computer map of the raw MSS data, classified the data and finally identified, named, and mapped the categories of land use and land cover.

Other topics introduced during the week included thermal and radar remote sensing, geographic information systems and the acquisition of remote sensing data. Equipment and interpretation aids available in the KARS Image Interpretation Laboratory were also demonstrated for course participants.

Additional details regarding training in remote sensing available through the KARS Program and the University of Kansas may be obtained from either Dr. Ed Martinko or Dr. Lee Williams, KARS Program.

## WORKSHOP ON MICROPROCESSOR-BASED IMAGE PROCESSING

EROS Data Center, Sioux Falls, SD, has announced a two-day workshop on microprocessor-based image processing systems to be held October 22-23, 1981. The workshop will follow the PECORA VII Symposium on "Remote Sensing: An Input to Geographic Information Systems in the 1980's" which will be October 18-21, 1981.

The objective of the workshop is to allow for an exchange of information on the state-of-the-art in microprocessor image processing, and to provide a forum for public review and discussion of the future direction of this technology. For further information contact the EROS Information Specialist, U.S. Geological Survey, EROS Data Center, Sioux Falls, SD 57198.

---

Contributors to this issue of the KARS Newsletter include Jim Merchant, Liz Kipp and Becky Domermuth. Liz Kipp and Loyola Caron served as co-editors for this issue.

...STAFF CHANGES (Contd.)

Christoph Andres, a West German graduate student from the Technical University of Berlin has been working with the KARS Program for the past two months. His visit to the University of Kansas is part of an exchange program between KU and the German Academic Exchange Service. As a student of urban and regional planning, his interests have focused on the applications of remote sensing in that field. In October, Christoph will return to Germany to pursue an advanced degree in land use planning.

Elizabeth Kipp, a KARS Program staff member for two years, will resign in August, 1981 in order to accelerate the completion of a Masters of Science in Environmental Studies at the University of Kansas. Primarily interested in remote sensing applications in agriculture and vegetation mapping, Liz worked on projects involving land use inventory, wildlife habitat assessment, irrigated lands identification and crop phenology.

Becky Domermuth, a research assistant with the KARS Program since last May, has recently resigned in order to pursue, full time, a Master's degree in Computer Science at KU.

*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

ORIGINAL PAGE
COLOR PHOTOGRAPH

# Kansas Applied Remote Sensing Newsletter

KARS

The University of Kansas | October 1981 | Volume 10, Number 4

## REMOTE SENSING TASK FORCE DELEGATION MEETS WITH GOVERNOR CARLIN

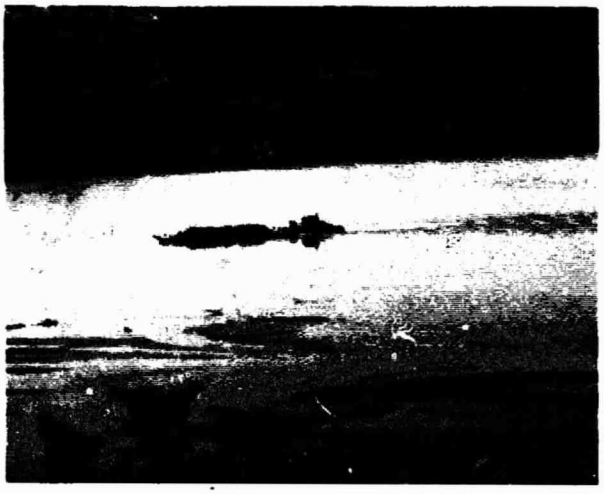
by
Ray Menendez
Kansas Department of Revenue

A delegation of three members of the Kansas Interagency Task Force on Applied Remote Sensing visited Kansas Governor John Carlin on September 10, 1981. Their purpose was to discuss with him the nature and accomplishments of the Task Force, to present him with a copy of the interim user needs report of the Task Force, and to request his advice in regard to alternatives for institutionalizing an operational remote sensing/GIS capability in Kansas. The delegation was composed of Freeman Biery, Director of the Weed and Pesticide Division of the Kansas State Board of Agriculture, Ray Menendez, from the Division of Property Valuation of the Department of Revenue, and Dr. Edward Martinko, Associate Director of the Kansas Applied Remote Sensing (KARS) Program. Bob Wootton, Legislative Liaison in the Governor's Office, was also present at the meeting.

Remote Sensing activities of the KARS Program were outlined to the Governor, the role of the Task Force was explained, and the future of remote sensing in Kansas was discussed. Dr. Martinko presented a summary of the capabilities of Landsat and other remote sensing systems, and displayed examples of maps and other products produced for Kansas agencies by the KARS Program since the Program was initiated in 1972. Ray Menendez briefly discussed the composition of the Task Force and outlined the way in which it is functioning. He also pointed out that, in speaking as a representative of the Task Force, he was part of an unprecedented event in that never before had a Kansas interagency task force such as this urged the funding of a facility over which no single agency would have operational control.

(Continued on page 3)

## MISSOURI RIVER FLOODPLAIN MAPPING COMPLETED



Barge traffic on the Missouri River near Ponca, NE.

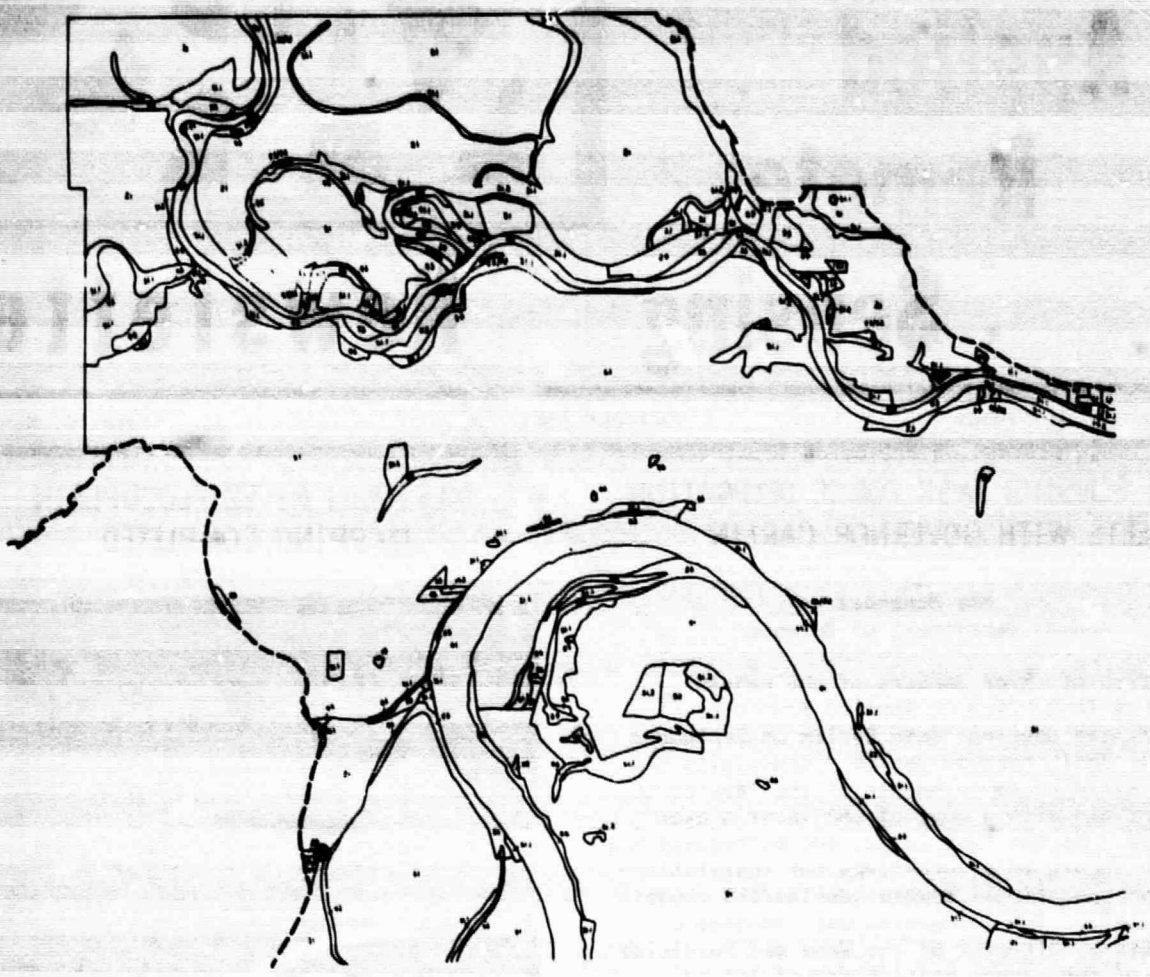
The KARS Program has completed mapping land use and land cover in the Missouri River flood plain from Ponca, Nebraska to the mouth of the river near St. Louis, Missouri. This project was undertaken for the Missouri River Basin Commission (MRBC). The maps are an integral part of the comprehensive Missouri River Flood Plain Study being carried out by the MRBC. The intent of that study is to develop a regional flood plain management program for the Missouri River below Ponca, Nebraska.

Land use/land cover data developed by the KARS Program will be used by MRBC staff to assist in defining (1) the location of land uses or encroachments that may be potentially hazardous during flooding episodes, (2) the location of sensitive environmental areas, (3) the spatial interrelationships and possible conflicts

(Continued on page 3)

ORIGINAL PAGE
COLOR PHOTOGRAPH

Portion of land use/land cover map for the Brunswick West, MO quadrangle.



Land Use and Land Cover Classification System

1. URBAN OR BUILT-UP
   - 11 Residential
     - 11.1 Single
     - 11.2 Mobile Home
     - 11.3 Multi-family
   - 12 Commercial
   - 13 Industrial
     - 13.1 Agricultural Storage
   - 14 Transportation
     - 14.1 Airports
     - 14.2 River Terminals[1]
     - 14.3 Land-based Terminal
     - 14.4 Interstate Highways
     - 14.5 Railyards
   - 15 Utilities
     - 15.1 Power Plants
     - 15.2 Water Supply[1]
   - 16 Waste Water Treatment
   - 17 Solid Waste Disposal Facilities (landfills)
   - 18 Institutional
   - 19 Park and Recreation Facilities (boundaries by MRDC)

2. AGRICULTURAL
   - 21 Cropland
     - 21.1 Center-pivot irrigation
   - 22 Specialty Crops (Orchards)
   - 23 Confined Feeding Operations
   - 24 Grassland/Pasture/Hayland

3. FOREST
   - 31 Flood Plain Woodland
     - 31.1 Over 75 percent cover
     - 31.2 25-74 percent cover
     - 31.3 Recently cleared
   - 32 Shrubland

4. OPEN WATER WETLANDS
   - 41 Missouri River Main Channel
   - 42 Missouri River Side Channels and Backwaters
     - 42.1 Mudflats associated with side channels
   - 43 Tributary Rivers (miles or acres) and Streams
     - 43.1 Mudflats associated with tributary rivers and streams
   - 44 Intermittent Streams and Water Courses
   - 45 Lakes (greater than 20 acres)
     - 45.1 Mudflats associated with lakes
   - 46 Ponds (open water)
     - 46.1 Mudflats associated with ponds

5. SANDBARS AND VEGETATED WETLANDS
   - 51 Sandbars (unconsolidated shores)
   - 52 Emergent (perennial)
   - 53 Shrub/Forest

6. BARREN
   - 61 Mines, Quarries, Gravel Pits, etc.
   - 62 Sand Dunes
   - 63 Other

[1] Obtained by MRDC using corollary data sources.

...MISSOURI RIVER (Continued from page 1)

among different land use and land cover classes, and (4) possible conflicts of existing and proposed land uses with current flood plain management programs.

The area that was mapped covers a distance of 752 river miles, and an area of approximately 1.5 million acres. Metropolitan areas partially or entirely within the flood plain include Sioux City and Council Bluffs, Iowa; Omaha, Nebraska City and Rulo, Nebraska; St. Joseph, Kansas City, Jefferson City and St. Charles, Missouri. The land use/land cover information is in the form of 130 mylar overlays to 1:24,000-scale USGS topographic quadrangles.

KARS Program staff interpreted land use/land cover information for the floodplain, using as primary data sources 1:12,000 Corps of Engineers aerial photography and ASCS county aerial 35mm color slides. The final products consist of (1) 130 mylar overlays to 1:24,000-scale USGS topographic maps covering the study area, (2) acreage statistics summarizing land use and cover by type, and (3) acreage statistics for floodway and flood hazard areas, by county

Missouri River near Omaha, NE.

Ground truth data were collected throughout the study to aid in photo interpretation. Here, Donald Becker (far right), Senior Environmental Specialist for the MRBC, accompanies KARS staff Emily Roth and Phil Orlowski in the field.

In addition to land use/land cover information, collateral data provided by other agencies participating in the study is also contained on the map overlays. These data include the location of water treatment facilities, waste water treatment facilities, landfill facilities, historic sites, boat ramps, and levees.

The overlays and USGS topographic maps are contained in an atlas which is a product of the Missouri River Flood Plain Study. Copies of the atlas will be provided to at least one state agency in each of the five states involved -- South Dakota, Nebraska, Iowa, Kansas and Missouri--and to the agencies which participated in the study--the Environmental Protection Agency (EPA), the Army Corps of Engineers, USDI Fish and Wildlife Service, the Department of Transportation, USDA Soil Conservation Service and the Federal Emergency Management Agency.

For additional information about this project, contact Emily Roth or Jim Merchant, KARS Program.

---

...TASK FORCE DELEGATION (Continued from page 1)

Freeman Biery then reported on the ways in which his agency has utilized remotely-sensed data in the past and the manner in which he hoped to be able to work with the KARS Program in the future. Mr. Biery discussed the benefits of using remote sensing to deal with problems related to musk thistle control, and pesticide and herbicide effectiveness. The KARS Interagency Task Force interim report, entitled "A Survey of Agency Data Needs in Kansas," had been provided to Bob Wootton prior to the meeting, and a copy was presented to Governor Carlin at the conclusion of the presentation.

The Governor's Office will review the progress of the Task Force and the requirements of Kansas agencies for remote sensing services. Results of this review will be presented to the Task Force during its next meeting on December 14, 1981 at the State Capitol in Topeka.

# GEOGRAPHIC INFORMATION SYSTEM USED TO ESTIMATE EROSION HAZARD IN SOLDIER CREEK WATERSHED

NASA's Earth Resources Laboratory (ERL) has delivered to the KARS Program a color map portraying potential soil loss in the Soldier Creek watershed of Jackson County, Kansas. The map was prepared as part of a cooperative KARS/NASA project designed to demonstrate the manner in which Landsat multispectral scanner (MSS) data can be integrated with conventionally acquired data (e.g., soils surveys, hydrologic records) to meet the information needs of Kansas agencies. A geographic information system (GIS) was developed and used to integrate and analyze data from several sources.

## GIS Development for Soldier Creek

Usually computer-based, a GIS is constructed by coding and referencing all data needed to analyze a particular set of problems to a location on the earth's surface. For example, in the Soldier Creek project, data on land use/land cover were obtained by computer classifying Landsat MSS digital data. Data regarding soils and relief were obtained from soils surveys.

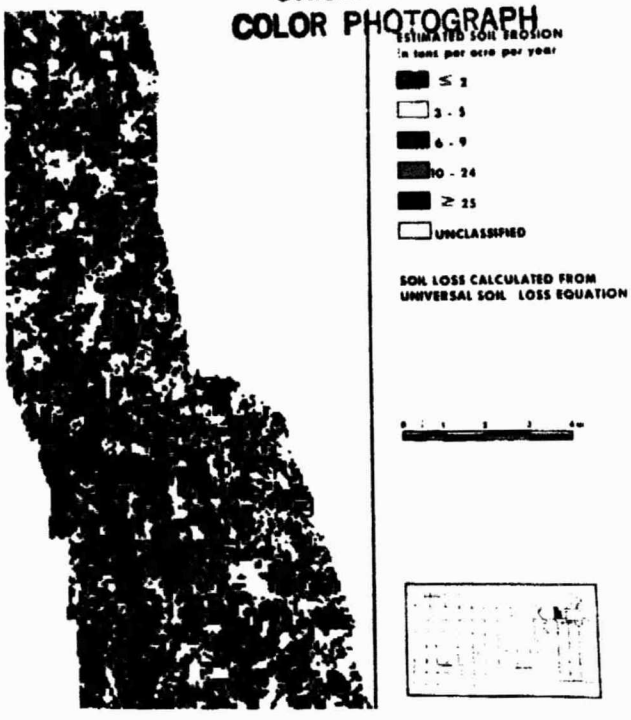
A digitizer was used to enter data into the GIS computer file. A digitizer converts data from its original format (e.g., map) to a numerical ("digital") format which can be used in computer processing. Digitizing may include procedures such as tracing soils boundaries from an existing map with the instrument's cursor. As the tracing is accomplished, the location and other attributes of the area are coded into the computer file.

Geographic information systems provide planners, resource managers and others with an ability to analyze complex spatial interrelationships in a cost effective manner. Once a GIS has been constructed, the data base can be utilized in many ways.

In the Soldier Creek project, for example, one application was to determine the potential for soil erosion. The data evaluated for this application included factors such as land cover, slopes, rainfall, and soils characteristics (e.g., erodability). A modified version of the Universal Soil Loss Equation was employed to evaluate these factors for every 2.5-acre areal unit within the watershed. This resulted in a map and statistical report in which each 2.5-acre cell was classified according to its soil erosion potential. The GIS was also used to prepare a map portraying the prime agricultural land in the watershed. The project results are being used to brief Kansas agencies on the nature, value and uses of GIS's.

On August 20 and 21st, Susan Howard (NASA/ERL) met with KARS staff and representatives of the USDA Soil Conservation Service to present project results and discuss potential GIS applications. A presentation on the Soldier Creek project was also made by Jim Merchant (KARS Program) at the Kansas Soil Survey Work/Planning Conference on August 25, 1981.

ORIGINAL PAGE
COLOR PHOTOGRAPH




This map shows a portion of the Soldier Creek watershed study area. Data from several sources were compiled to produce a color map showing estimated soil erosion in tons per acre per year.

## Other GIS Applications of the KARS Program

The KARS Program is currently engaged in several other projects in which GIS technology is being employed. These include:

(1) preparing a computer-based GIS for the Walnut Creek watershed in west-central Kansas for use by the Kansas Geological Survey in modeling water demand and groundwater hydrology;

(2) constructing, for the U.S. Bureau of Indian Affairs (BIA), a woodland management information system for Indian reservation lands in Kansas;

(3) evaluating, for the Kansas Department of Revenue's Division of Property Valuation, the application of GIS technology for aiding in state-wide equalization of property taxation; and

(4) assessing computer classification of Landsat MSS data and GIS applications in range management for the U.S. Forest Service on the Cimarron National Grassland.

Further information on these projects is available from Jim Merchant, KARS Program.

# RECENT KARS PRESENTATIONS AND PUBLICATIONS

KARS Program staff have participated in a number of meetings and symposia in recent months. Dr. Edward Martinko was a member of the planning committee for the May 1981 Conference on Remote Sensing Education (CORSE-81) held at Purdue University. In addition, he organized and chaired a session on Low-Cost Digital Image Processing. Dr. T. H. Lee Williams organized and led a CORSE discussion session focusing on Experiences in the Implementation of Image Processing for Instruction on a University Main Frame. Martinko and Williams presented the following papers:

Martinko, E. A. *A Perspective on Low-Cost Digital Processing*, Proceedings of CORSE-81, NASA Conference Publication 2197, pp. 229-230. Opportunities for hands-on experience with digital image processing are being integrated into remote sensing education. This paper introduces three categories of computer systems that are available to meet instructional, research and user objectives.

Williams, T. H. Lee. *Low-Cost Digital Image Processing on a University Main-Frame Computer*, Proceedings of CORSE-81, NASA Conference Publication 2197, pp. 231-236. The factors to be considered in developing an instructional digital image processing system are discussed. The advantages and limitations of university mainframe computers for instruction are presented.

Williams, T. H. L., J. Siebert and C. Gunn. *Instructional Image Processing on a University Main Frame - The Kansas System*, Proceedings of CORSE-81, NASA Conference Publication 2197, pp. 249-253. The KARS Program and Department of Geography have developed an interactive instructional digital image processing program package that runs on the University Honeywell computer. This paper discusses the characteristics of the package and experiences of using it in both short courses and regular semester-long courses.

Martinko, E. A. *The University of Kansas Applied Remote Sensing Program: An Operational Perspective*, Proceedings of CORSE-81, NASA Conference Publication 2197, pp. 325-327. This paper defines the structure and orientation of the KARS Program, and summarizes short courses conducted by KARS to provide training in remote sensing technology and applications.

Other recent papers and presentations by KARS staff include:

Williams, T. H. Lee, J. Siebert and C. Gunn. *The KARS Low-Cost Interactive System for Instruction and Research*, Proceedings of the Seventh International Symposium on Machine Processing of Remotely Sensed Data (June 1981), West Lafayette, Indiana: LARS/Purdue University, pp. 178-180. An instructional image processing program package is described.

Merchant, James W. *Inventory and Monitoring of Irrigated Lands*, presented at NASA Landsat/Geobased Information System Symposium, Biloxi, MS, June 1981. Applications of remote sensing/GIS techniques in inventory, monitoring and analysis of irrigation in the U.S. are reviewed. (Abstract only)

Poracsky, Joseph. *Media and Production Techniques for Color Maps from Remote Sensing Data*, presented at In-Place Resource Inventories National Workshop, Orono, Maine, August 1981. Options generally available for producing color maps are reviewed, including a discussion of the advantages and disadvantages of each technique.

Merchant, James W. *Systematic Analysis of Landsat Multispectral Scanner Data for Resource Inventories*, presented at In-Place Resource Inventories National Workshop, Orono, Maine, August 1981. The special characteristics of Landsat MSS data are reviewed and a strategy for systematic selection and application of MSS data analysis techniques is set forth.

Williams, T. H. Lee, C. Gunn and J. Siebert. *Instructional Image Processing in Fortran on a University Mainframe Computer: The Kansas Example*, Proceedings of the American Society of Photogrammetry 1981 Fall Technical Meeting, Falls Church, VA: ASP, pp. 156-168. The considerations involved in using a university mainframe computer in instruction for digital image processing are discussed and illustrated by reference to the Kansas system.

Gunn, Christopher W. *A Strategy for a Low Cost, Full-Featured Microprocessor-Based Image Processing and Geographic Information System*, presented at the Remote Image Processing Station (RIPS) Workshop, EROS Data Center, Sioux Falls, SD, October 1981. Outlines an LSI 11/23-based computer in the $50,000 price range capable of running NASA's ELAS software.

KARS Staff made four presentations at the Pecora VII Symposium on Remote Sensing: An Input to Geographic Information Systems in the 1980's held October 18-21, 1981 in Sioux Falls, SD:

Merchant, James W. *Employing Landsat MSS Data in Land Use Mapping: Observations and Considerations*, Proceedings of the Pecora VII Symposium, in print. The unique qualities of Landsat MSS data are examined and considerations for employing such data in land use inventory, monitoring and modeling are presented.

(Continued on page 6)

....PRESENTATIONS AND PUBLICATIONS (Continued from page 5)

Merchant, James W. and Emily A. Roth. *Inventory and Evaluation of Rangeland in the Cimarron National Grassland, Kansas,* Proceedings of the Pecora VII Symposium, in print. Landsat MSS data are computer classified to inventory range cover types and condition; the structure and applications of a proposed range resources information system founded on Landsat data, and designed to aid in local level range management, are summarized.

Martinko, Edward A. *Monitoring Agricultural Growth in Pronghorn Antelope Habitat,* Proceedings of the Pecora VII Symposium, in print. Landsat MSS imagery was used to evaluate potential pronghorn antelope release sites in Kansas; sites undergoing rapid conversion of rangeland to cropland were judged to be least suitable for their reestablishment.

Merchant, J. W., J. W. Rosacker, C. Gunn, and G. Tappan. *A Resources Management Information System for Indian Reservation Lands in Kansas,* poster presentation. The structure of a GIS for Kansas Indian lands is described and applications (e.g., woodland management, realty appraisal) are outlined. (Summary only)

---

Contributors to this issue of the KARS Newsletter include Ray Menendez, Kansas Department of Revenue, and KARS staff Emily Roth and Jim Merchant. Loyola Caron served as editor for this issue.

*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

Kansas Applied Remote Sensing

KARS Newsletter

The University of Kansas | January 1982 | Volume 11, Number 1

## RESOLUTION TO PROVIDE TASK FORCE MANDATE

Senators Fred A. Kerr (Pratt, KS) and Jane M. Eldredge (Lawrence, KS) introduced Senate Concurrent Resolution No. 1644 into the Kansas Senate, on January 20, 1982. The resolution charges the Kansas Interagency Task Force on Applied Remote Sensing with evaluating the ways in which the Kansas Applied Remote Sensing (KARS) Program "can be most efficiently and effectively maintained," and directs the Task Force to present an initial report to the Governor and Legislature regarding this matter on or before December 31, 1982.

The resolution was chief among the topics discussed at the December and January meetings of the Task Force held at the State Capitol in Topeka. Other major items on the agendas at these meetings were:

- A discussion of legislative and executive alternatives for providing baseline funding for an operational KARS Program;
- A report by Ray Menendez, Kansas Department of Revenue, on the meeting that a delegation of three members of the Task Force had with Governor John Carlin on September 10, 1981. Their purpose was to discuss with him the nature and accomplishments of the Task Force, to present him with a copy of the interim user needs report of the Task Force, and to request his advice in regard to alternatives for institutionalizing an operational remote sensing/geographic information system capability in Kansas. The delegation was composed of Freeman Biery, Director of the Weed and Pesticide Division of the Kansas State Board of Agriculture, Ray Menendez, from the Division of Property Valuation of

(Continued on page 5)

## LOW-COST GEOGRAPHIC INFORMATION SYSTEM AVAILABLE TO COUNTIES

by
Joseph Poracsky

KARS' low-cost Geographic Information System requires only a printer and microcomputer similar to those shown here.

The convenience of having maps portraying up-to-date information is high on every planner's wish list. Having such information available at a variety of scales and in a form where several maps may be readily overlayed and compared is something that has usually been available only in a planner's dreams--until recently.

That such a system of information is made possible by modern computer technology is probably of no surprise to anyone. What may surprise many is the low cost at which such a system can be set

(Continued on page 6)

# A STRATEGY FOR A LOW-COST, FULL-FEATURED MICROPROCESSOR-BASED IMAGE PROCESSING AND GEOGRAPHIC INFORMATION SYSTEM [a/]



by

Christopher W. Gunn
Kansas Applied Remote Sensing (KARS) Program

*The KARS Program is using low-cost microprocessor technology to assemble an image processing and geographic information system comparable in function--if not in speed--to those found on large minicomputers or conventional mainframes. The system uses a Tarak 8600[illegible] color graphics microcomputer as the host device for NASA's ELAS software package. The result should be a powerful system for Landsat applications at a cost of approximately $100,000.*

Until recently, microprocessor-based image processing systems have tended to fall into one of two types that are divided sharply with respect to price and performance. The more costly and powerful type includes systems that are typically built around Digital Equipment Corporation's (DEC) LSI-11 series of 16-bit microprocessors such as the 11/03, 11/2 and 11/23. This sort of system often involves complex, proprietary software as part of an integrated, turnkey package selling from $60,000 to $300,000 or more. Examples include the LCT-11 series and smaller ARIES-II models from Dipix Systems Limited, and the VIEWS series and EARTHVIEW system from Interpretation Systems, Inc.

The other type of microprocessor system typically is built around one of the common 8-bit CPU chips such as the 8080, Z80, 6502 and the like. Systems of this sort have tended to offer sharply reduced software and hardware capabilities at prices that generally fall in the $10,000 to $30,000 range. Examples include the IMPAC system from Egbert Scientific Software and several Apple II image processing implementations. Some of the new intelligent remote sensing work stations, such as the Remote Image Processing Station under development by the USGS EROS Data Center have speed and raw power comparable to this latter class, but gain capabilities through reliance on a time-sharing mini- or mainframe host computer.

## The KARS Approach to Image Processing

The strategy of the Kansas Applied Remote Sensing (KARS) Program has been to assemble--piece by piece--a system with all the capabilities of the high-end class, at a cost not that much greater than the more expensive representatives of the low-end group. Two factors make this possible:

- -- Increasing availability (within the past year or two) of off-the-shelf microprocessor hardware components and peripheral devices with capabilities approaching traditional mid-range minicomputers. This specifically includes 16-bit microprocessors and relatively inexpensive hard disc drives.

- -- The availability in the public domain of advanced image processing program packages developed as part of the NASA technology transfer program.

A working system could, thus, be comprised of the following:

| | |
|---|---|
| DEC LSI 11/23 or 11/24 microcomputer | $ 6,000-$12,000 |
| 300 megabyte disc drive | $18,000-$21,000 |
| Medium-resolution image display | $14,000-$20,000 |
| 9-track tape drive | $ 7,000-$10,000 |
| DEC RSX-11M operating system and FORTRAN | $ 6,000-$ 9,000 |
| ELAS Landsat processing software | $ 3,834[b/] |

This gives a price range of $55,000 to $76,000 which hardly qualifies as cheap. However, a full-fledged minicomputer or one of the so-called "superminis" capable of running comparable software would cost from $200,000 to $400,000.

---

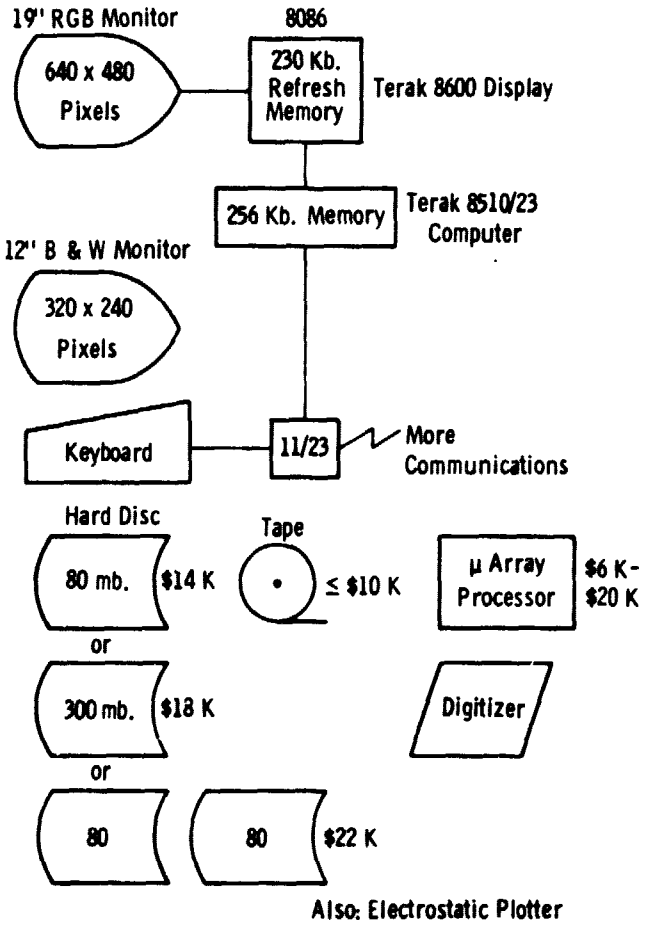
a/ Paper presented at Remote Image Processing Station (RIPS) Workshop, EROS Data Center, Sioux Falls, SD, October 22, 1981.

This work was funded by NASA grant number NGL 17-004-024.

The names of manufacturers and their brand names have been included for completeness. This mention does not constitute an endorsement or recommendation.

b/ This reflects the current price for the software and documentation as quoted by COSMIC.

Several of the above items require further explanation. DEC's LSI 11/23 and 11/24 processors are the most advanced members of the LSI 11 family of 16-bit CPUs. LSI ("large scale integration") 11's are central processing units on a chip or set of chips. The 11/03 and 11/2 were the first to be developed, and they implement only a subset of the capabilities of the DEC PDP 11 series (PDP 11/34, 11/45, 11/55, etc.). They are also limited to addressing 64 kilobytes of memory, the same amount as the 8-bit 8080, Z80, etc. The 11/23 is similar to the 11/2 but is faster and emulates the 11/34 minicomputer. It can address 256 kilobytes of memory, but uses the same microcomputer "Q-Bus" for internal communication as the 11/2. The 11/24 addresses 4 megabytes of memory and uses the same "Unibus" architecture as the larger PDP 11's. Both the 11/23 and the 11/24 can run all of the PDP 11 operating systems: RT-11, RSX-11M, RSTS/E.




The KARS Program's low-cost stand-alone image processing and geographic information system is based on microprocessor technology and off-the-shelf hardware.

ORIGINAL PAGE
COLOR PHOTOGRAPH

## The ELAS Software

It was the compatibility with the standard DEC operating systems that initially attracted the KARS Program to the LSI 11/23. The ELAS package mentioned above (Earth Resources Laboratory (ERL) Applications Software) has been implemented on computers including a PDP 11/34 running RSX-11M and a PDP 11/70 running RSTS/E. Both versions were programmed in DEC's FORTRAN IV-Plus, an extended ANSI 1966 FORTRAN. It should be possible to implement either of these versions of ELAS on an 11/23 or 11/24 with minimal modification. ELAS is available from NASA's COSMIC software distribution center at the University of Georgia.

ELAS was developed by ERL at NASA's National Space Technology Laboratories in Bay St. Louis, MS. It was originally implemented on a Perkin-Elmer Interdata 8/32, a 32-bit "supermini." ELAS was designed as a comprehensive Landsat image processing and geographic information system. It is capable of full- or multi-frame processing of Landsat digital data and has features including radiometric processing, spatial correction and registration of imagery, spectral signature extraction and clustering, maximum likelihood classification and grid-cell-based information extraction. It can merge Landsat data with ancillary information. It supports color video output and hardcopy map output to an electrostatic printer/plotter or a mechanical printer that emulates one.

ELAS is organized as an overlaid program; that is, a program "root" segment resides in the host computer's memory while ELAS is running and the modules that perform the work are loaded from disc as they are needed. This approach reduces the run-time size of the program to a manageable level.

The above off-the-shelf approach, while certainly feasible, is not the actual strategy of the KARS Program. The off-the-shelf system as outlined has two shortcomings:

-- The operating systems RSX-11M and RSTS/E both allow a program to occupy only 56 kilobytes of memory, regardless of how much memory is in the system. As a result, both the RSX-11M and RSTS/E versions of ELAS have undergone a certain amount of pruning. The RSX-11M version, for example, allows analysis of images only about 512 pixels by 512 pixels square. Some features and functions were left out of the RSTS/E implementation.

-- The hardware configuration is slightly more expensive than it need be.

(Continued on page 4)

... MICROPROCESSOR SYSTEM (Continued from page 3)



## Hardware Configuration

KARS has acquired for implementation of ELAS and other software a Terak 8510/23 computer with an 8600HDX integrated color display system. The 8510 has an 11/23 processor, 128K bytes of memory expandable to 256K, a single variable-density 8-inch floppy disc drive and a black-and-white console capable of monochrome graphics at a resolution of 340 by 240. The 8600 display is driven by an Intel 8086 processor. It is capable of displaying 640 by 480 square pixels with 6 bits of color resolution and a 9-bit color lookup table. This allows the display of 64 simultaneous colors from a palette of 512. The 8600 has about 230K bytes of video refresh memory and 34K bytes of control store for the 8086, expandable to 64K. The 8600 has a 19-inch RGB monitor using precision in-line gun technology. Software that runs on the 11/23 supports an extended version of the Association for Computing Machinery's SIGGRAPH core graphics standard, which would allow a display driver to be written in a high-level programming language. Data transfers between the 11/23 and 8086 are accomplished by a fast dual-port memory arrangement. The price of the system with a 13-inch RGB monitor is about $19,000 at educational discount rates. The 19-inch monitor is about $2500 more. This represents a savings of several thousand dollars over an 11/23 and a color display system purchased separately.

The Terak supports both DEC's RT-11 operating system and the UCSD Pascal operating system. RT-11 was chosen because of its similarity with the DEC operating systems for which ELAS has been adapted. RT-11 supports a "virtual array" feature on the 11/23 processor. Essentially, this means that a FORTRAN program can control the 11/23 memory management unit to access the upper 192K of the 11/23 address space. Program code must share the lower 64K with the operating system, but data can be stored in high memory. If this same feature were used on an 11/24, a FORTRAN program could access the upper 4 megabytes of address space--enough for most reasonable applications. Since there are some restrictions on the way "virtual arrays" can be used, an alternative method of memory management using the RT-11 operating system may be necessary.

This approach is not without problems. As an example, ELAS requires FORTRAN integer*4 (32-bit) variables. DEC's FORTRAN IV-Plus has integer*4 variables. However, FORTRAN IV-Plus is not available for RT-11. The "lesser" FORTRAN that runs under RT-11 has integer*4 variables, but does not perform 32-bit arithmetic on them. This would seem to be pure perversity on DEC's part, since there are system subroutines in the MACRO-11 assembly language that support 32-bit integer arithmetic. It may be necessary to use subroutine calls for all 32-bit computations, rather than simple FORTRAN expressions.

Another problem is the speed of the 11/23 CPU. DEC's LSI 11 chips, although appealing to the KARS Program for reasons of software compatibility, are not particularly fast. Other 16-bit CPUs, such as the 8086, Zilog Z8000 or Motorola 68000 are reportedly faster. An appealing solution to this would be the acquisition of an array processor. Until recently, array processors tended to cost in the neighborhood of $30,000 and up. Recently, array processors capable of 1 million floating point operations a second have been marketed in the $5,000 to $8,000 range. Such a device would dramatically increase the throughput of an LSI 11 system.

In fact, such an approach may provide the most cost-effective solution for a variety of computer-bound problems. It may make more sense to use a microprocessor as a "traffic cop" to control data flows to and from high-speed special-purpose processors than to invest in an expensive "super-mini". Throughput should be adequate for single-user installations.

Continued development of microcomputer technology will undoubtedly increase the number of low-cost systems suitable for image processing. The KARS strategy has been based on maintaining --as much as possible--hardware and software compatibility with an in-place ELAS system which has in some ways limited our choices. Ongoing software development for microcomputers will in the near future give potential users a greater selection of off-the-shelf software that will expand their range of hardware options.

---

# REMOTE SENSING COURSE TO BE OFFERED IN KANSAS CITY THIS SUMMER

Remote Sensing 1 (Geography 526), an introductory course covering visual interpretation techniques, is being offered this summer at the University of Kansas Regents Center in Overland Park, Kansas, as part of the Regents Center's Continuing Education program. The class will meet from June 21 to July 26, Monday, Tuesday and Thursday evenings from 7:15 to 9:30 P.M., and Saturdays from 9:15 to 5:00 P.M. The Regents Center is located at 9900 Mission Road.

Remote Sensing I provides a basic working knowledge of applied remote sensing techniques for environmental analysis. Emphasis will be placed on visual interpretation and mensuration of aerial photography, space imagery, and thermal and radar imagery. It is the first of a sequence of undergraduate and graduate courses in remote sensing offered by the Department of Geography-Meteorology at the University of Kansas.

Course enrollment will be limited. Anyone wishing to enroll is encouraged to contact Dr. T. H. Lee Williams, Department of Geography, Lindley Hall, University of Kansas, Lawrence, Kansas 66045; Phone (913) 864-5143.

# LANDSAT PRICE INCREASES EFFECTIVE OCTOBER 1, 1982

The National Oceanic and Atmospheric Administration (NOAA) has announced that prices for Landsat products and services will increase on October 1, 1982, by a factor of about 2½. This increase is called for by the decision that users bear the costs of operating and maintaining the Landsat-D system, by paying fees for products and services provided by the system.

When the Landsat-D system becomes operational in 1983, it will be possible for users to request the special acquisition of Landsat MSS scenes that are not scheduled for collection. The charges for this new service will be $790.00 or greater, depending on the type of data product ordered.

Data prices were increased last yea on October 1, 1981 due to the cost increases associated with reproduction operations. Just prior to this price increase being put in effect, a significant amount of data was purchased by many users. The EROS Data Center anticipates that this same reaction to a price increase will occur prior to October 1 of this year. However, due to the significance of the new October prices, the pre-buys will probably be greater than last year's. *Users planning to buy data before the next increase are strongly urged to place their orders in spring and early summer so that their orders are delivered before the October 1 deadline. Data orders received but not delivered before the October 1 deadline could be subject to the new prices.* The EROS Data Center's production capacity has limited elasticity to respond to large surges in data demand without serious extension of turnaround times.

Prices for some Landsat data and products in the archive are listed in the table below.

More information can be obtained from the EROS Data Center, User Services, Sioux Falls, SD, (605)-594-6151; or the KARS Program.

| LANDSAT DATA AND PRODUCTS | CURRENT PRICE | PRICE AS OF 10/1/82 |
|---|---|---|
| Imagery Products | | |
| 70 mm film positive (B & W) | $ 8 | $ 26 |
| 70 mm film negative (B & W) | 10 | 32 |
| 10 in. film positive (B & W) | 10 | 30 |
| 10 in. film negative (B & W) | 12 | 35 |
| 10 in. paper (B & W) | 10 | 30 |
| 20 in. paper (B & W) | 20 | 58 |
| 40 in. paper (B & W) | 35 | 95 |
| 10 in. film positive (color) | 25 | 74 |
| 10 in. paper (color) | 15 | 45 |
| 20 in. paper (color) | 35 | 90 |
| 40 in. paper (color) | 70 | 175 |
| Generation of Color Composite (false color IR - add to product price) | 75 | 195 |
| Digital Products | | |
| 9-track, 800 or 1600 BPI CCT; MSS Scene - all available bands | 300 | 650 |
| 9-track, 800 or 1600 BPI CCT; RBV (Single-subscene) | 300 | 650 |
| 9-track, 800 or 1600 BPI CCT; RBV (set of 4 subscenes) | 600 | 1300 |

...INTERAGENCY TASK FORCE
(Continued from page 1)

the Department of Revenue, and Dr. Edward Martinko, Associate Director of the Kansas Applied Remote Sensing (KARS) Program.

Bob Wootton, Legislative Liaison in the Governor's Office, was also present at that meeting with the Governor. He reported to the Task Force that Governor Carlin was favorably impressed with and supportive of the work of the Task Force and the requirements of Kansas agencies for operational remote sensing services.

- A report by Dr. Edward Martinko and Raney Gilliland, Kansas Legislative Research, regarding the Governor's recommendation, in his FY1983 Budget, that a fee fund be established to aid agencies in working contractually with the KARS Program. Such a fund should help facilitate transfer of contractual funds from the agencies to the KARS Program.

Additional information regarding the Kansas Interagency Task Force on Applied Remote Sensing (including summaries of all Task Force meetings), Resolution 1644, or related matters can be obtained from either Edward Martinko or James Merchant, KARS Program.

... INFORMATION SYSTEM (Continued from page 1)

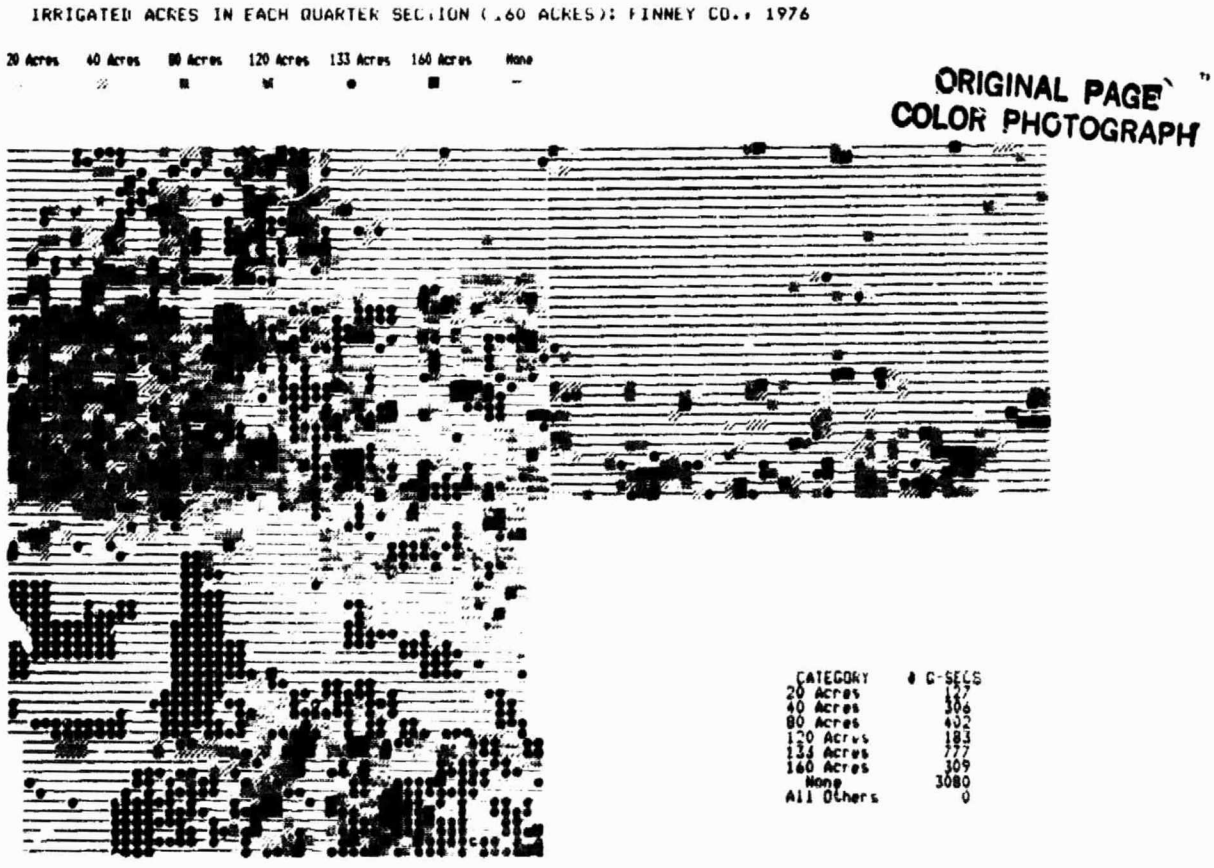
up and operated, even within a small planning group having limited resources and personnel. It is not necessary to have access to a large, multi-user computer. For many of the applications necessary in a planning region of one to several counties in area, a microcomputer, much like those being sold as "home-computers", will suffice. The system is compact; the unit containing the computer, keyboard and screen takes up only slightly more desk space than an electric typewriter, and the printer an equal amount of space.

Such a low-cost system has been assembled by the Kansas Applied Remote Sensing (KARS) Program at the University of Kansas. The total cost of the hardware involved--a microcomputer and a dot matrix printer with graphics capability--was about $3900. Personnel input included about 8 man-weeks of program development and an additional 12 man-weeks of unspecialized labor for tabulating data and entering it into the computer.

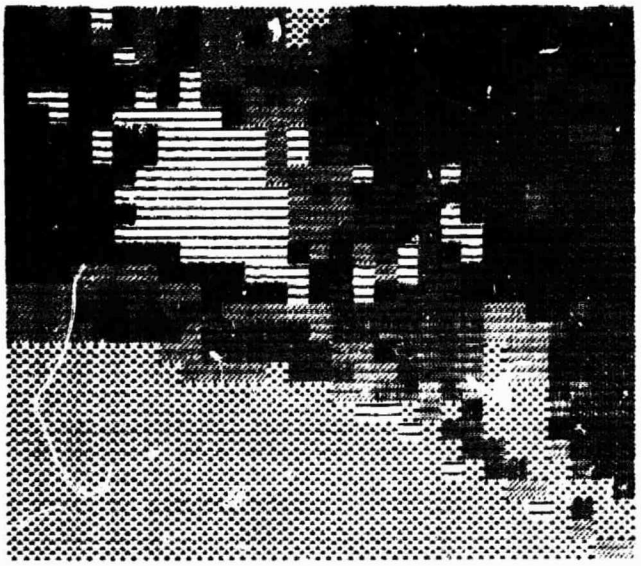
For a recent demonstration of the system's capabilities the KARS Program compiled an information data base for Finney County, Kansas. This effort was conducted for the Division of Property Valuation, Kansas Department of Revenue, and was aimed at exploring techniques that would assist them in the potential reappraisal of all land in Kansas. The data base included information concerning soils, topography, groundwater, land use, and land ownership, all geographically referenced in an easily available and readily manipulable form. Such a data base/manipulation capability is called a Geographic Information System (GIS).

In the creation and application of a GIS a computer is used to store data, to overlay various types of data, and to produce maps and statistics of the overlayed information. In concept a GIS is exceedingly simple. Involved are three basic steps: collecting data and entering it into the computer, using some programs to analyze the data, and employing the computer to prepare maps and statistical summaries.

Data collection begins by dividing the county into equal area cells. A decision must be made about the size of the cell that will represent the basic unit of data measurement. For instance, a 40-acre size tract might be chosen, and for a particular type of information, such as land use, the data relative to each 40-acre tract would be recorded and entered into the computer. The tract boundaries are usually referenced to a standard system such as the Public Land Survey (Township and Range System). When all 40-acre tracts have been entered into the computer, the result is a "file" of data concerning land use. Similarly, a file is




A map of the irrigated land in each quarter section of Finney County. This was prepared from Landsat satellite-derived information using a low-cost microcomputer-based GIS. The prominent circular irrigated areas in the lower third of the map are center pivot irrigation systems in the Sand Hills region south of the Arkansas River.



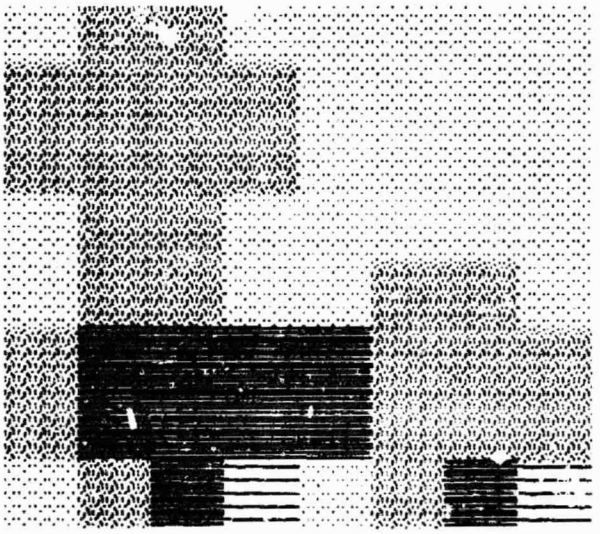
A map portraying the suitability for dryland agriculture of quarter-section parcels near Garden City, Kansas. The grassland pattern indicates land suitable for grazing or rangeland and occurs predominately at the bottom of the map, south of the Arkansas River. Horizontal lines represent unclassified lands. The remaining patterns indicate lands ranging from being well suited for dryland farming (dark tones) to poorly suited for dryland farming (light tones).

created for each other type of information of interest. This may include items such as soils, population, school districts, zoning, water quality, and other data which can be geographically referenced. These information files represent the data base for the county.

The computer may then be instructed, via a set of simple typed commands, to make a comparison between two or more files from the data base. For instance, the computer may be instructed to make a comparison between land use data, population data and soils data. This comparison might be accomplished in such a way as to identify areas where residential or industrial development has occurred (a) on prime agricultural land, or (b) on non-prime agricultural land. Additionally, areas where potential residential development could occur (a) without loss of prime agricultural land, and (b) with loss of prime agricultural land, could be identified. Soils data could be interpreted to indicate those areas suitable for septic development. A map could also be requested that portrays only those areas having suitable soils and that are also zoned for residential development. The possible ways of comparing data to determine and forecast impacts of alternative planning decisions are numerous.

The computer may also be used to prepare graphics for the planner. By means of a few typed instructions, the computer can be directed to prepare a map or maps on the printer. Maps may be prepared portraying specified comparisons or portraying each of the original data sets that went into an analysis. Various scales may be specified for the maps but, most importantly, all of them may be prepared at one uniform scale for ease of visual comparison and presentation. Statistical summaries (e.g. acres) may also be produced.

Assuming that the GIS is created and the basic data files have been prepared, each of the example comparisons just outlined could be completed in about 15-25 minutes. This time includes sitting at the machine typing the instructions, waiting for the computer to perform the analysis, obtaining the areal statistics and having the computer prepare the map.



A map showing the comparison of the type of cropland (irrigated vs dryland) with soil type (sandy vs. not sandy). The area shown is only one section (640 acres), but the cell size is 10 acres. The larger scale of the map is one of the options available with a GIS.

The advantages of a GIS, particularly for a planning office having only minimal staff, are numerous. Some of the more obvious advantages include:

- Reduced time and, therefore, cost for performing most types of map analysis and comparison tasks.
- Flexibility in approaches to a problem; no longer are you forced to use just one set of analyses based on one or two data sets, but can try several options in the same or less time as was formerly required for just one option.
- Quicker response to "urgent" and "immediate" requests for information or data analysis.
- Decreased drafting time for maps and freeing of valuable planning personnel time to do planning; this can be especially important

(Continued on page 8)

... INFORMATION SYSTEM (Continued from page 7)

in smaller offices where planning staff often double as draftspeople.

- Standardized scale and format of maps, thus avoiding the common problem of meshing data from maps of different scales.
- Ability to update data files easily as changes occur, thus keeping the working data current.
- Maintenance of historical data at selected benchmark dates in a consistent format, thus allowing for analysis of temporal changes.
- Ability to expand the data base by preparing additional data files.
- Availability of a microcomputer for other uses in the planning office such as administrative and text processing functions.

Virtually any type of data may be entered into a GIS, as long as it contains readily identifiable locational information. For example, in the KARS demonstration there were three different types of data utilized from five different sources. Land use was derived from Landsat satellite data. Land ownership and groundwater availability were derived from two different tabular listings and referenced by means of legal descriptions.

The KARS demonstration was conducted for Finney County, Kansas, a 1700+ square mile county in southwestern Kansas that is heavily and diversely developed agriculturally. For the demonstration, the basic measurement unit chosen was the quarter section (160 acres). The time required to tabulate each type of data and to enter it into the computer varied with the type of data source and the level of data extraction. The soils data, for instance, required about one man-week, while the topographic data (elevation), due to the detailed nature of the topographic maps used, required about three man-weeks.

The programs developed by the KARS Program are not specific to Finney County, but can be easily adapted to other counties. The KARS Program is an applied research program of the University of Kansas Space Technology Center and has 10 years experience in dealing with federal, state and local agencies on data acquisition and data analysis problems. Program personnel would welcome inquiries from county and regional planners and other interested parties about establishing similar systems for other areas. Additional information concerning geographic information systems and any aspect of remote sensing applications and/or training may be obtained from Dr. Edward Martinko or James Merchant, Kansas Applied Remote Sensing (KARS) Program, University of Kansas Space Technology Center, Lawrence, KS 66045; (913) 864-4775.

*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. 17-004-084. 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

Remote Sensing Short Courses (Continued)

Garden City, Kansas, April 28, 1980
Manhattan, Kansas, April 28, 1980
Pittsburg, 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.

# APPENDIX IV
# REPRESENTATIVE KARS ACTIVITIES

1980 - 1982

## REPRESENTATIVE KARS ACTIVITIES
## 1980 - 1982

- 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

August 11-15, 1980

A five-day Landsat oriented training course entitled "Fundamentals of Remote Sensing" was held for 18 participants. Funding for the course was provided by NASA. Personnel from the following agencies and firms participated:

University of Kansas
Kansas State University
University of Missouri
Ottawa University
Baker University
Kansas Department of Health and Environment
Riley County Planning Commission
U.S. Geological Survey (Lawrence, Kansas)
National Oceanic and Atmospheric Administration
U.S. Department of Interior
U.S. Army Corps of Engineers
Defense Mapping Agency (Kansas City)
Farmland Industries
Midwest Research Institute

August 20, 1980

Jim Merchant gave a presentation entitled "Remote Sensing Applications in Natural Resource Management and Geographic Information Systems" in Manhattan, Kansas at the Kansas Soil Survey Planning Workshop.

August 21, 1980

KARS Program presentation at quarterly meeting of Kansas Groundwater Managers Association.

September 8-12, 1980

A five-day Landsat oriented training course entitled "Fundamentals of Remote Sensing" was held. Funding for the course was provided by NASA. Registrants represented:

Environmental Protection Agency (Kansas City)
U.S. Geological Survey (Lawrence)
Bureau of Indian Affairs
Federal Highway Administration (Kansas City)
U.S. Department of Agriculture
National Oceanic and Atmospheric Administration
Water and Power Resources Service
Kansas Department of Health and Environment
Missouri Department of Economic Development
Lawrence, Kansas Planning Office
City of Shawnee

October 8, 1980

KARS personnel met with two staff members of the Kansas Water Resources Board to discuss new projects and the possibility of a presentation to the Kansas Water Council, composed of the heads of all of the water agencies in Kansas.

| | |
|---|---|
| October 14, 1980 | KARS personnel met with a technical staff member of DOW Chemical Company, who was referred to the KARS Program by agencies in southwest Kansas who have worked with the KARS Program. Discussions centered on the possibility of providing contractual services for delineating crop types and irrigated land in two test counties in Kansas. |
| October 17, 1980 | KARS personnel met with officials of Farmland Industries, Inc. to discuss the details of their long-term needs for remote sensing applications and the initiation of contractual work. Agreement was reached on preliminary work and a proposal has been submitted. Farmland Industries is a regional agricultural cooperative with some 2,200 local cooperatives and 500,000 farmers as member-owners. Farmland Industry officials have also invited KARS staff to the first meeting of the group forming "Agrisat Committee Inc." to be patterned after the Geosat Committee Inc. |
| October 17, 1980 | The KARS Program presented a display of remote sensing applications at the "Prime Agricultural Lands Symposium" in Salina, Kansas. Cooperating groups included:<br><br>Kansas Association of County Planners<br>National Association of Counties<br>Kansas Council of Chapters, Soil Conservation Society of America<br>Kansas Farm Bureau<br>Kansas State Grange<br>Evans Grain Company, Salina<br>Planters State Bank & Trust Co., Salina |
| October 29, 1980 | Approximately 90 persons participating in the Soil Conservation Society of America (SCSA) Symposium toured the KU Space Technology Center and heard presentations about the KARS Program. The presentations were well received and have resulted in many complimentary letters and phone calls, as well as new project leads. |
| November 6, 1980 | KARS staff members James Merchant and Emily Roth attended the quarterly meeting of the State Water Council. The Water Council is comprised of the heads of all state agencies involved in water resources management in Kansas. KARS staff have discussed coordination of remote sensing with Council staff. The KARS Program may be invited to make a presentation on this issue at the Council's February 1981 meeting. |

| | |
|---|---|
| November 6, 1980 | Professor Duane Nellis of the Kansas State University Department of Geography brought his Introductory Remote Sensing class of about 16 undergraduate and graduate students to KARS for a tour. Included in the visit was a demonstration of the several pieces of remote sensing equipment in the Program, including KARS emerging digital processing capability, and an explanation of some of the KARS Program's recent applications projects. |
| November 14, 1980 | A group of 18 Human Ecology students from Bethany College in Lindsborg, Kansas, led by Professor Victor Streufert, visited the KARS facility. They were especially interested in the irrigation and groundwater-related work and its implications for the future economy of western Kansas. |
| November 18, 1980 | KARS staff members James Merchant and Joe Poracsky met with John Gottschamer of the Kansas Water Resources Board to discuss the establishment of a state inter-agency remote sensing coordination committee. |
| January 14, 1981 | KARS staff member Joe Poracsky attended the meeting of the Kansas Groundwater Management Districts Association in Salina. In addition to the five groundwater manager's representatives who were in attendance from the Kansas Water Resources Board, the Division of Water Resources of the State Board of Agriculture, Kansas Department of Health and Environment, Kansas Geological Survey, Cooperative Extension Service and the U.S. Geological Survey were also represented. Reports on KARS's work on the High Plains Crop Calendar Study and the Mapping of Irrigated Lands in the Walnut Creek Valley were both received with a great deal of interest. |
| January 15, 1981 | KARS staff member Joe Poracsky made a full day presentation at Bethany College in Lindsborg, Kansas, to two combined inter-term classes, "Technology and the Quality of Life" and "A Century of Technology: 1881 - 1981." The talk dealt with remote sensing technology and its application to measuring and evaluating environmental quality. The audience consisted of about 70 students and 8 faculty members from various departments. A scaled-down version of the same talk was presented to a select group of about 35 students and 5 instructors from Lindsborg area high schools. |
| January 15, 1981 | Dr. G. Morgan Powell, Kansas State Extension Service, visited with KARS staff member James Merchant to discuss possible cooperative research and demonstration projects dealing with water management in northwest Kansas. Dr. Powell will submit a letter outlining Extension Service data needs and requesting KARS assistance. |

| | |
|---|---|
| January 22, 1981 | Dr. Edward A. Martinko presented an invited paper entitled "Remote Sensing for Watershed Management in Kansas" at the annual meeting of the State Association of Kansas Watersheds. The meeting was attended by approximately 200 representatives of state and local agencies and Kansas state legislators. |
| January 27-28, 1981 | Dr. Edward A. Martinko and Mr. James Merchant met with Senator Fred Kerr, the Chairman of the Senate Committee on Agriculture and Small Business, Vice-Chairman of the Committee on Energy and Natural Resources and a member of the Committee on Assessment and Taxation, to brief him on the National Conference of State Legislatures (NCSL) Natural Resources Information Systems Task Force and the Kansas Applied Remote Sensing Program activities in Kansas. |
| February 5, 1981 | KARS staff member James Merchant represented the KARS Program at a meeting of the planning committee for a bi-state (Kansas and Missouri) conference on urban erosion which will be held in Kansas City in September 1981. The KARS Program has been invited to co-sponsor the meeting along with more than 10 other state, regional and federal agencies and to participate in the conference. |
| February 6, 1981 | Mr. Joe Poracsky and Dr. Edward Martinko were interviewed by NBC Channel 4 (Kansas City, MO) about KARS work in southwest Kansas. Channel 4 is preparing a special on drought and water problems in the High Plains region to be released in March, 1981. |
| February 13, 1981 | Dr. Edward Martinko attended the February meeting of the Kansas Water Council in Topeka, Kansas, at the invitation of the Water Resources Board. The Water Council consists of the Directors of the agencies in Kansas which deal with water problems. He also met with Department of Revenue personnel about the joint KARS-Revenue demonstration project. |
| February 28, 1981 | Kansas Senators Fred Kerr and Jane Eldredge visited the KU Space Technology Center for a presentation on current and past KARS activities in Kansas. KARS staff members Ed Martinko, James Merchant and Chris Gunn discussed KARS capabilities, relationships with agencies and needs for more firm state commitment to remote sensing. KARS staff were invited to speak with three committees of the state legislature on March 18, 1981 (see below). |

| | |
|---|---|
| March 1, 1981 | James Merchant made three 30 minute presentations about the KARS Program to high school seniors being considered for scholarships at the University of Kansas. |
| March 3, 1981 | James Merchant met with Mr. Fred Bryan, Kansas Power and Light Company (KP&L), to discuss a possible funded project to map irrigated lands in western Kansas. KP&L will review their needs and meet with KARS representatives to discuss the matter further. |
| March 3, 1981 | KARS staff member James Merchant was the invited speaker at the annual meeting of the Shawnee County Soil Conservation District. Shawnee County includes the capitol city of Topeka. The meeting was attended by over 200 representatives of state and local governments including participants in the Upper Wakarusa Watershed Rural Clean Water Program (RCWP) in which the KARS Program is involved. Merchant reviewed the KARS Program history of involvement in applied remote sensing projects in Kansas and discussed prospects for the future. |
| March 6, 1981 | James Merchant was the invited speaker for the annual meeting of the Northeast Kansas regional chapter of the Soil Conservation Society of America (SCSA) held in Lawrence. Merchant provided a tour of KARS facilities and discussed KARS work with Kansas agencies. The meeting was attended by approximately 20 persons including representatives of the U.S. Soil Conservation Service, the Leavenworth County Commission and the Shawnee County Soil Conservation District. |
| March 10, 1981 | Prof. B. G. Barr, Ed Martinko and James Merchant met with Bill Hanzlick, Director, Kansas Fish and Game Commission, to discuss prospects for state funding of the KARS Program and legislative presentations to be made by KARS staff on March 18, 1981. Hanzlick gave his agency's full support to the KARS Program, provided suggestions on procedural matters, and indicated that he would attend the presentations on March 18. |
| March 12, 1981 | Prof. B. G. Barr, Ed Martinko and James Merchant met with Senator Fred Kerr to discuss objectives, logistics and procedural matters regarding the legislative presentation to be made on March 18, 1981. Senator Kerr seems very supportive of the KARS Program. |

| | |
|---|---|
| March 18, 1981 | Prof. B. G. Barr and Dr. Ed Martinko made three one hour presentations to, respectively, the Kansas Senate Committee on Energy and Natural Resources, the Kansas House Committee on Agriculture and Livestock, and the Kansas Senate Committee on Agriculture and Small Business. The National Conference of State Legislatures participated in the presentations. Among the issues discussed were KARS history, funding, applied remote sensing work in Kansas, involvement of other states in remote sensing and a proposal for a state funding program in Kansas. Some 45 legislators, as well as some 30 spectators, mostly from various Kansas agencies, were addressed. |
| March 20, 1981 | KARS staff member Elizabeth Kipp presented a paper at the Annual Meeting of the Kansas Academy of Science held at Winfield, Kansas. The paper reported a technique developed for selecting optimal Landsat dates for crop identification in the Great Plains. This work was accomplished as part of a research project being carried out by the KARS Program for NASA/Ames Research Center. |
| March 20, 1981 | Joseph Poracsky and Elizabeth Kipp met with Sumner County, Kansas planning personnel in Wellington to discuss a possible demonstration project. As presently being considered, the project would utilize digital Landsat data to prepare land use change information over an eight year period and identify residential development resulting from the sprawl of the Wichita urbanized area. |
| March 26, 1981 | Joseph Poracsky attended a meeting of the Kansas Groundwater Management Districts Association in Topeka and reported on the status of KARS Program studies with the Kansas Geological Survey in the Walnut Creek Valley and the NASA/Ames Research Center. Also attending the meeting were members of all the major water-related agencies in the state, including the Water Resources Board, Division of Health and Environment and both the Kansas and U.S. Geological Surveys. |
| March 27, 1981 | Joseph Poracsky, Hank Krieger and Kit Gunn made presentations on remote sensing, mapping and digital processing to a group of eighteen students and one faculty member from Haskell Indian Junior College class on Technical Mapping and Drafting. |

| | |
|---|---|
| March 27-28, 1981 | Elizabeth Kipp and James Rosacker conducted field work in the Upper Wakarusa River Watershed. They were assisted by Stewart Simpson, U.S. Soil Conservation Service District Conservationist for Shawnee County. The field work will support KARS work with Kansas public agencies and NASA's Earth Resources Laboratory on the Rural Clean Water Program (RCWP). The RCWP is one of thirteen designed to assess integrated techniques for controlling erosion and non-point pollution. |
| March 31, 1981 | James Merchant and Joseph Poracsky presented a one day short course on remote sensing at the University of Kansas Regents Center in Kansas City. The short course was funded by NASA/Earth Resources Laboratory. There were twenty registrants from eleven agencies, universities and private firms. |
| April 2, 1981 | James Merchant and Joe Poracsky presented a one day short course on remote sensing at Washburn University in Topeka. There were twenty-four registrants from eleven agencies, universities, and private firms including USDA/ESS, USGS, University of Kansas, Kansas State University, Kansas State and Extension Forestry, Kansas State Board of Agriculture and the University of Nebraska. |
| April 7, 1981 | James Merchant and Joe Poracsky presented a one day short course on remote sensing at the Kansas Technical Institute in Salina. There were twenty-one registrants from eight agencies, universities and private firms such as City of Salina Planning and Community Development and Marion County Extension Service. |
| April 8, 1981 | Lee Williams and Elizabeth Kipp met with Don Kurz, Natural History Land Specialist with the Missouri Department of Conservation (MDC), to discuss the use of remote sensing in locating prairie in southwest Missouri. MDC has funding from the Region IV Office of Surface Mining (OSM) in Kansas City to inventory the native prairie in Missouri to assist OSM in evaluating the environmental impact component of permit applications for new mining operations. A five month test and demonstration project for $12,000 to be funded by MDC, for two sites totalling about 150 square miles, in St. Clair and Vernon counties, was proposed. A decision on funding will be made by MDC shortly. |
| April 9, 1981 | James Merchant and Joseph Poracsky met with Don Mecklenburg, U.S. Forest Service, in Elkhart, Kansas to present results of KARS digital processing of Landsat data for the Cimarron National Grassland. Field checking showed the analysis to be highly accurate. |

| | |
|---|---|
| April 26, 1981 | James Merchant presented an invited talk "Satellite Images of Earth" at the University of Kansas' Spencer Museum of Art. The presentation is in connection with a special exhibit of art inspired by remote sensing of the earth and other planets. |
| April 27-28, 1981 | Ed Martinko and James Merchant accompanied Kansas Senator Fred A. Kerr to the Regional Conference on the Operational Land Remote Sensing Program in Austin, Texas. Merchant also attended the joint meeting of the National Conference of State Legislature's Natural Resources Information Systems Task Force and the National Governor's Association's Earth Resources Data Council held April 30-May 1. |
| May 5, 1981 | The KARS Program initiated work on a $50,000 contract to map land use and land cover in the Missouri River Floodplain for the Missouri River Basin Commission. |
| May 7, 1981 | The KARS Program convened the first meeting of the Interagency Task Force on Applied Remote Sensing for Kansas agencies at the Space Technology Center. The Directors of fourteen Kansas agencies met to discuss cooperative projects and common data needs that could be provided through remote sensing technology. Senator Fred Kerr made a presentation to the agency representatives. |
| May 8, 1981 | Dr. E. A. Martinko attended the quarterly meeting of the Kansas Water Council, an interagency coordinating committee charged with management of water resources in Kansas. Most agencies on the Council are also represented on the Interagency Task Force on Applied Remote Sensing. |
| May 11-15, 1981 | James Merchant and Ed Martinko attended the Fifteenth International Symposium of Remote Sensing of Environment at Ann Arbor, Michigan. Merchant presented a paper entitled "Utilization of Spatial Complexity in Computer Classified Landsat MSS Data for Multi-factoral Thematic Mapping." Martinko and Merchant presented a display on the KARS Program and met with a number of persons who had expressed an interest in KARS projects. |
| May 18-21, 1981 | Dr. Ed Martinko and Dr. Lee Williams attended the 19o81 Conference on Remote Sensing Education at Purdue University. Dr. Martinko chaired the session entitled "Low-cost Digital Image Processing on a University Main Frame Computer" and chaired a discussion session on the same topic. Dr. Martinko also made a presentation bout the relationship of the KARS Program to NASA's Regional Applications Program. |

| | |
|---|---|
| May 20-22, 1981 | James Merchant traveled to Denver, Colorado and Cheyenne, Wyoming to discuss funded applied research projects with agencies that have expressed interest in working with the KARS Program. Meetings were held with the U.S. Forest Service, U.S. Bureau of Land Management, U.S. Fish and Wildlife Service, Rocky Mountain Forest and Range Experiment Station and Wyoming Water Development Commission. The KARS Program was invited by the Wyoming Water Development Commission to submit a proposal to aid the State of Wyoming in utilizing Landsat data. |
| May 27, 1981 | Prof. B. G. Barr and Dr. E. A. Martinko met with representatives of Farmland Industries to discuss long-term consulting and applied research. The meeting focussed on continuation and enhancement of the present contractual agreement between Farmland Industries and the KARS Program. |
| June 1-5, 1981 | The KARS Program offered a five day short course on applied remote sensing at the University of Kansas Space Technology Center. The course, funded by the NASA Earth Resources Laboratory, focussed on digital analysis of Landsat MSS data. |
| June 11, 1981 | Dr. Edward A. Martinko made an invited presentation at a meeting of the Kansas Chapter of the American Institute of Real Estate Appraisers on the Kansas Applied Remote Sensing Program. |
| June 12, 1981 | James Merchant met with representatives of the U.S. Forest Service in Elkhart, Kansas to discuss funding for the Cimarron National Grassland range mapping and evaluation project initiated in 1980 as a demonstration project. Eight district rangers and two area directors reviewed the digital analysis of Landsat MSS data. Merchant was invited to present project results and pursue funding with area office personnel in Pueblo, Colorado during July. |
| June 18, 1981 | Edward Martinko and James Merchant met, at the University of Kansas Space Technology Center, with Elizabeth Cook, Missouri Department of Conservation, to discuss potential contractual work by the KARS Program for Missouri state agencies. |
| June 23-26, 1981 | Dr. T. H. Lee Williams and Christopher Gunn participated in the Symposium on Machine Processing of Remote Sensing Data held at Purdue University. They presented a paper on KARS Program capabilities in the area of digital image processing. |

June 29-July 1, 1981 Dr. Edward A. Martinko and James Merchant attended the Second Landsat/Geobased Information System Symposium held in Biloxi, Mississippi. The Symposium, sponsored by NASA's Earth Resources Laboratory, was also attended by Mr. Bill Hanzlick, Director, Kansas Fish and Game Commission and Mr. Robert Walters, Director of Property Valuation, Kansas Department of Revenue. Merchant presented an invited paper on "Irrigated Lands Identification and Monitoring."

July 9, 1981 The second meeting of the Kansas Interagency Task Force on Applied Remote Sensing was convened at the University of Kansas Space Technology Center. Results of a Kansas Agency User Needs Study conducted by the KARS Program and funding alternatives were discussed. The Task Force appointed a delegation to meet with Governor John Carlin to discuss the establishment of base funding for the KARS Program. An initial meeting was held on the afternoon of July 9 with Bob Wootton, Governor Carlin's Legislative Liaison. Members of the delegation included Senator Fred Kerr, Mr. Bill Hanzlick (Director, Kansas Fish and Game Commission), Mr. Ray Menendez (Division of Property Valuation, Department of Revenue), Freeman Biery (Director, Weed and Pesticide Division, Kansas State Board of Agriculture) and Dr. Edward Martinko. The delegation was accompanied and advised by Mr. Clark Duffy (Division of Budget).

July 13, 1981 Elizabeth Kipp attended a meeting of the Upper Wakarusa River Rural Clean Water Program (RCWP) in Topeka. She spoke to federal, state and local agencies about the February 1981 aerial photography of the watershed acquired by NASA and provided to the KARS Program, and reviewed the KARS Program's interest in working with agencies on the utilization of remote sensing and geo-data bases for dealing with soil erosion and water pollution problems.

July 13-17, 1981 The KARS Program offered a five day short course on applied remote sensing at the University of Kansas Space Technology Center. The course, funded by the NASA Earth Resources Laboratory, focussed on digital analysis of Landsat MSS data.

| | |
|---|---|
| July 19-21, 1981 | Edward Martinko and James Merchant met with officials of the State of Chihuahua, Mexico, to discuss possible contractual work with the KARS Program. The work would involve resource analysis and planning utilizing Landsat data and geographic information system technology. The KARS Program was invited to submit a proposal for an 18 month study to involve user needs assessment, agency training and demonstration projects. |
| August 9-14, 1981 | Joseph Poracsky and James Merchant attended the In-place Inventories Workshop in Orono, Maine. Poracsky presented a paper dealing with the cartographic display of data derived through remote sensing. Merchant spoke on the systematic analysis of Landsat MSS data for resource inventories. |
| August 13, 1981 | Ray Menendez, representing the Kansas Interagency Task Force on Applied Remote Sensing, and Ed Martinko met with Governor John Carlin's legislative liaison Bob Wootton to discuss state funding for the KARS Program and the anticipated meeting with Governor Carlin. They also met with Clark Duffy, Kansas Division of Budget, to discuss funding mechanisms and alternatives for institutionalization of applied remote sensing activities in Kansas. |
| August 20-21, 1981 | Susan Howard, NASA/Earth Resources Laboratory visited the KU Space Technology Center to work on completion of a cooperative demonstration project being undertaken in the Soldier Creek Watershed of northeast Kansas. The project involves the assessment of soil erosion potential utilizing Landsat data in a geo-data base. Howard and James Merchant met on August 21 with representatives of the U.S. Soil Conservation Service to review the project. They expressed a desire to employ this technique more widely in Kansas. |
| August 24, 1981 | Profess - B. G. Barr and Dr. Ed Martinko met with representatives of Farmland Industries, Inc. to discuss continuation of remote sensing applications research on a cooperative basis. Subsequent discussions with Farmland addressed their corporate objectives and possible directions for remote sensing research. |

| | |
|---|---|
| August 25, 1981 | James Merchant spoke at the Kansas Soil Survey Planning Workshop in Manhattan, Kansas, regarding the KARS Program's work on using geographic information systems for resources management. He reviewed the KARS/NASA Soldier Creek project for representatives of ten state and federal agencies. |
| September 8, 1981 | James Merchant met with John W. Campbell, Assistant Attorney General, to discuss the use of remote sensing data in a lawsuit which will determine the state's ownership of the Arkansas River and environs. |
| September 10, 1981 | Dr. Ed Martinko, Ray Menendez, Kansas Department of Revenue, and Freeman Biery, Kansas State Board of Agriculture, met with Governor John Carlin and Bob Wootten, Legislative Liaison to the Governor, to discuss the need for state funding of the KARS Program and the work of the Kansas Interagency Task Force on Applied Remote Sensing. |
| September 11, 1981 | Dr. Lee Williams presented a paper entitled "Instructional Image Processing in Fortran on a University Mainframe Computer: The Kansas Example" at the American Society of Photogrammetry Fall Convention, San Francisco, California. The paper focussed on image processing software developed by the KARS Program. |
| September 24, 1981 | The KARS Program, along with fifteen other state and federal agencies, co-sponsored the Mid-America Urban Erosion/Sedimentation Conference in Kansas City, MO. Approximately 300 persons attended, primarily from Kansas, Missouri, Nebraska and Iowa. Joseph Poracsky attended the meeting and prepared a display on KARS soil-related remote sensing projects. |
| October 19, 1981 | Emily Roth met Mr. Donald Marlow, Area Watershed Specialist for the Upper Wakarusa Rural Clean Water Program to discuss ongoing remote sensing activities in the Upper Wakarusa watershed and study the aerial photographic coverage of the area. |
| October 19-21, 1981 | Edward Martinko and James Merchant made presentations on KARS projects at the Pecora VII Symposium held in Sioux Falls, SD. Martinko spoke on Pronghorn Antelope Habitat Evaluation, Merchant on rangeland resource inventory and on land use mapping with Landsat MSS data. |

| | |
|---|---|
| October 20, 1981 | Loyola Caron spoke to eleven members of the Topeka Chapter of the American Society of Appraisers in Topeka, Kansas. She presented an overview of what remote sensing is, and how several agencies in Kansas are using it to aid in making planning and management decisions. She also discussed the work of the Kansas Interagency Task Force on Applied Remote Sensing. |
| October 22, 1981 | Christopher Gunn presented a paper on KARS digital image processing using microprocessor based hardware at the Remote Image Processing Station (RIPS) Workshop, EROS Data Center, Sioux Falls, SD. |
| October 27, 1981 | The KARS Program hosted graduate students from Kansas State University who are studying remote sensing. Joe Poracsky met with the group to discuss the KARS Program. |
| November 16-17, 1981 | Dr. Edward Martinko made a presentation on satellite remote sensing and geographic information system technology to county commissioners, county engineers and county appraisers representing the 105 counties in Kansas at the annual meeting of the Kansas Official Council in Wichita, Kansas. |
| November 19, 1981 | James Merchant met with 9 visiting graduate students and faculty from the University of Nebraska to discuss remote sensing and KARS remote sensing applications with Kansas natural resources and environmental agencies. |
| November 19, 1981 | Ed Martinko and Loyola Caron met with Terry Funk, Kansas Fish and Game Commission, at the KU Space Technology Center. Their discussions focussed on KARS Landsat-based evaluation of Pronghorn Antelope habitat and potential future projects involving management decisions related to wild turkey and prairie chicken management. |
| December 8-9, 1981 | Ed Martinko and Lee Williams presented papers at the 43rd Midwest Fish and Wildlife Conference held in Wichita, Kansas. Martinko spoke on "A Spatial Analysis of Antelope Habitat Parameters in Kansas" and Williams spoke on "The National AML Inventory in Wildlife and Fisheries Development of Abandoned Coal Mine Areas." |

| | |
|---|---|
| December 8, 1981 | A news/videotape crew from KAKE-TV, Wichita, Kansas visited the Space Technology Center to acquire information on the use of Landsat in Kansas, the KARS Program and the Kansas Interagency Task Force on Applied Remote Sensing. James Merchant participated in a videotaped interview and tour of KARS facilities. |
| December 11, 1981 | KARS staff made a presentation covering KARS activities to the Transportation Advisory Group which visited the KU Space Technology Center. The group acts in an advisory capacity to the University of Kansas Transportation Center and is composed of consultants and professionals in government and industry. |
| December 14, 1981 | The Kansas Interagency Task Force on Applied Remote Sensing met at the State Capitol Building in Topeka. Topics discussed included a recent meeting with Governor John Carlin and members of the Task Force, the forthcoming legislative session and KARS funding alternatives. |
| December 15, 1981 | James Merchant traveled to Nashville, Tennessee as a consultant to the National Conference of State Legislatures. Merchant participated with Mr. Rhett Speer, NCSL National Resources Information System Project Director, in a meeting with state legislative staff, advisors to the Governor of Tennessee and state agency heads and representatives, to discuss the Landsat Program, and advantages and alternatives for establishing a state remote sensing/GIS capability. |
| January 5, 1982 | Robert Walters, Director, Property Valuation, Kansas Department of Revenue visited with Ed Martinko, James Merchant and Joe Poracsky to review preliminary results of a project for Finney County, Kansas. The project is being carried out to demonstrate the potential application of a geographic information system in statewide tax reappraisal in Kansas. |
| January 9, 1982 | James Merchant and Loyola Caron attended the annual meeting of the Kansas Association of Professional Soils Classifiers in Manhattan, Kansas. Merchant made an invited presentation to the group entitled "The Use of Remote Sensing in Soils and Natural Resources Inventories." |

| | |
|---|---|
| January 11, 1982 | Professor Bill Barr, Ed Martinko, Jim Merchant and Loyola Caron met with representatives of DuPont Company to discuss possible remote sensing projects. |
| January 12, 1982 | Ed Martinko, James Merchant and Loyola Caron met at the Space Technology Center with Dave Larson and Doris Nagel, Kansas Corporation Commission, to discuss the Kansas Interagency Task Force on Applied Remote Sensing and possible contractual work related to illegal oil well detection, transmission line corridor analysis, power plant siting and pollution monitoring. |
| January 13, 1982 | Senator Fred Kerr, Chairman, Agriculture and Small Business Committee, Kansas Legislature, and Mr. Ramon Powers, Research Associate, Legislative Research Department, Kansas Legislature, met with Dr. Edward Martinko and Mr. James Merchant to review the resolution and bill being prepared for submission to the 1982 Kansas Legislature. Discussions focussed on the goals of the KARS Program and the formal composition of the Kansas Interagency Task Force on Applied Remote Sensing. |
| January 18, 1982 | The Kansas Interagency Task Force on Applied Remote Sensing met at the State Capitol in Topeka. The Task Force discussed (1) the current legislative session, (2) the Governor's proposal for a fee fund for the KARS Program, and (3) proposed legislation dealing with the KARS Program and the Task Force. Senator Fred Kerr reviewed a resolution to establish the Task Force and mandate consideration of alternatives for institutionalization of the KARS Program as a service agency to State government. |
| January 19, 1982 | James Merchant met with Dr. Wakfield Dort, University of Kansas Department of Geology, to discuss the use of remote sensing data in an impending court case in which Dr. Dort has been called as an expert witness by the Kansas Attorney General's Office. The case involves questions pertaining to the State's ownership of the Arkansas River channel. Remote sensing data would be used to establish the historical dimensions and course of the river and to document changing land use. |
| January 21, 1982 | Dr. Edward Martinko made an invited presentation at the Kansas Association of Watersheds Annual Meeting entitled "The Use of Remote Sensing and Geographic Information System Technology for Watershed Management." |

| | |
|---|---|
| January 26, 1982 | James Merchant met with Martin Stein, Kansas State Historical Society, to discuss contractual work involving applications of geographic information systems (soil erosion models) to archaeological research. |
| February 1, 1982 | Edward Martinko, James Merchant and Loyola Caron met with a representative of Doane Western, Inc., to discuss potential contractual work with agribusiness and alternative mechanisms for establishing contacts with private agricultural firms. |
| February 10, 1982 | B. G. Barr, Edward Martinko and James Merchant met with a representative from Doane Western, Inc. (Kansas City, MO) and a private agribusiness consultant (Chicago, IL) to discuss the potential applications of remote sensing in agribusiness. The meeting focussed on establishing a possible cooperative relationship to develop such applications. |
| February 10, 1982 | Edward Martinko and James Merchant attended a meeting of the Kansas Senate Committee on Energy and Natural Resources in Topeka. Senator Kerr's resolution regarding the Kansas Interagency Task Force on Applied Remote Sensing was introduced to the Committee and was supported unanimously. |
| February 22, 1982 | Edward Martinko, James Merchant and Joe Poracsky met with William Roth and Larry Brown, USDA Soil Conservation Service State Soil Conservationist and Assistant State Soil Conservationist respectively, to discuss techniques and alternatives for initiating a statewide program to digitize soils surveys. |
| February 24, 1982 | James Merchant participated in a seminar for the Douglas County, Kansas, agricultural and agribusiness community. Merchant spoke on the KARS Program's work with the agricultural sector. |
| February 25, 1982 | James Merchant attended the regular meeting of the Kansas Groundwater Management Districts in Topeka. He reported on the status of KARS Projects related to water resources management and the work of the Kansas Interagency Task Force on Applied Remote Sensing. |
| March 1, 1982 | Bill Barr and Edward Martinko met with University of Kansas officials and Senators Ron Hein and Billy McCray of the Kansas Senate Ways and Means Committee to discuss State funding for the KARS Program. |

| | |
|---|---|
| March 3, 1982 | Edward Martinko and James Merchant met with two representatives of agribusiness to discuss a possible joint venture designed to promote the applications of remote sensing/GIS technology in the agricultural sector. |
| March 5, 1982 | Lee Williams presented an invited paper entitled "The Role of Remote Sensing in Mined Land Reclamation" at the Symposium on Rehabilitation of Disturbed Lands held at Kansas State University, Manhattan. |
| March 13-14, 1982 | Lee Williams attended a workshop on Geographic Information Systems at Colorado State University, Fort Collins, Colorado. During this course he arranged for the KARS Program to acquire the MAPS-GIS software. |
| March 14-19, 1982 | Edward Martinko, James Merchant, Joe Poracsky and Lee Williams presented papers on KARS projects at the annual meeting of the American Society of Photogrammetry, Denver, Colorado.<br><br>Lee Williams was Moderator of the session on Remote Sensing Contributions to Hydrologic Studies in the Great Plains and Mountain States. |
| March 31, 1982 | James Merchant and Emily Roth met at the Space Technology Center with officials of the Bureau of Indian Affairs (BIA) to discuss the completion of work on a KARS project to construct a geographic information system (GIS) for BIA managed lands in Kansas. The GIS will be used in woodland management and land appraisal. |

# APPENDIX V

## KARS PROGRAM PRESENTATIONS AND PUBLICATIONS

April 1, 1981 - March 31, 1982

KARS Program Presentations and Publications--April 1, 1982 - March 31, 1982

Martinko, E. A. *A Perspective on Low-Cost Digital Processing,* Proceedings of the 1981 Conference on Remote Sensing Education, Purdue University, May 18-21, 1981, NASA Conference Publication 2197, pp. 229-130. Opportunities for hands-on experience with digital image processing are being integrated into remote sensing education. This paper introduces three categories of computer systems that are available to meet instructional, research and user objectives.

Williams, T. H. Lee. *Low-Cost Digital Image Processing on a University Main-Frame Computer,* Proceedings of the 1981 Conference on Remote Sensing Education, Purdue University, May 18-21, 1981, NASA Conference Publication 2197, pp. 231-236. The factors to be considered in developing an instructional digital image processing system are discussed. The advantages and limitations of university main-frame computers for instruction are presented.

Williams, T. H. L., J. Siebert and C. Gunn. *Instructional Image Processing on a University Main Frame - The Kansas System,* Proceedings of the 1981 Conference on Remote Sensing Education, Purdue University, May 18-21, 1981, NASA Conference Publication 2197, pp. 249-253. The KARS Program and Department of Geography have developed an interactive instructional digital image processing program package that runs on the University Honeywell computer. This paper discusses the characteristics of the package and experiences of using it in both short courses and regular semester-long courses.

Martinko, E. A. *The University of Kansas Applied Remote Sensing Program: An Operational Perspective,* Proceedings of the 1981 Conference on Remote Sensing Education, Purdue University, May 18-21, 1981, NASA Conference Publication 2197, pp. 325-327. This paper defines the structure and orientation of the KARS Program, and summarizes short courses conducted by KARS to provide training in remote sensing technology and applications.

Williams, T. H. Lee, J. Siebert and C. Gunn. *The KARS Low-Cost Interactive System for Instruction and Research,* Proceedings of the Seventh International Symposium on Machine Processing of Remotely Sensed Data (June 1981), West Lafayette, Indiana: LARS/Purdue University, pp. 178-180. An instructional image processing program package is described.

Merchant, James W. *Inventory and Monitoring of Irrigated Lands*, presented at NASA Landsat/Geobased Information System Symposium, Biloxi, MS June 1981. Applications of remote sensing/GIS techniques in inventory, monitoring and analysis of irrigation in the U.S. are reviewed.

Poracsky, Joseph. *Media and Production Techniques for Color Maps from Remote Sensing Data*, presented at In-Place Resource Inventories National Workshop, Orono, Maine, August 1981. Options generally available for producing color maps are reviewed, including a discussion of the advantages and disadvantages of each technique.

Merchant, James W. *Systematic Analysis of Landsat Multispectral Scanner Data for Resource Inventories*, presented at In-Place Resource Inventories National Workshop, Orono, Maine, August 1981. The special characteristics of Landsat MSS data are reviewed and a strategy for systematic selection and application of MSS data analysis techniques is set forth.

Williams, T. H. Lee, C. Gunn and J. Siebert. *Instructional Image Processing in Fortran on a University Mainframe Computer: The Kansas Example*, Proceedings of the American Society of Photogrammetry 1981 Fall Technical Meeting, Falls Church, VA: ASP, pp. 156-168. The considerations involved in using a university mainframe computer in instruction for digital image processing are discussed and illustrated by reference to the Kansas system.

Gunn, Christopher W. *A Strategy for a Low Cost, Full-Featured Microprocessor-Based Image Processing and Geographic Information System*, presented at the Remote Image Processing Station (RIPS) Workshop, EROS Data Center, Sioux Falls, SD, October 1981. Outlines an LSI 11/23-based computer in the $50,000 price range capable of running NASA's ELAS software.

Merchant, James W. *Employing Landsat MSS Data in Land Use Mapping: Observations and Considerations*, Proceedings of the Pecora VII Symposium on Remote Sensing: An Input to Geographic Information Systems in the 1980's, October 18-21, 1981, Sioux Falls, SD, pp. 71-91. The unique qualities of Landsat MSS data are examined and considerations for employing such data in land use inventory, monitoring and modeling are presented.

Merchant, James W. and Emily A. Roth. *Inventory and Evaluation of Rangeland in the Cimarron National Grassland, Kansas,* Proceedings of the Pecora VII Symposium on Remote Sensing: An Input to Geographic Information Systems in the 1980's, October 18-21, 1981, Sioux Falls, SD, pp. 104-113. Landsat MSS data are computer classified to inventory range cover types and condition; the structure and applications of a proposed range resources information system founded on Landsat data, and designed to aid in local level range management, are summarized.

Martinko, Edward A. *Monitoring Agricultural Growth in Pronghorn Antelope Habitat,* Proceedings of the Pecora VII Symposium on Remote Sensing: An Input to Geographic Information Systems in the 1980's, October 18-21, 1981, Sioux Falls, SD, pp. 210-216. Landsat MSS imagery was used to evaluate potential pronghorn antelope release sites in Kansas; sites undergoing rapid conversion of rangeland to cropland were judged to be least suitable for their reestablishment.

Merchant, J. W., J. W. Rosacker, C. Gunn, and G. Tappan. *A Resources Management Information System for Indian Reservation Lands in Kansas,* poster presentation at the Pecora VII Symposium on Remote Sensing: An Input to Geographic Information Systems in the 1980's, October 18-21, 1981, Sioux Falls, SD. The Structure of a GIS for Indian Lands is described and applications (e.g., woodland management, realty appraisal) are outlined.

Martinko, Edward A. and Loyola M. Caron. *A Spatial Analysis of Antelope Habitat Parameters in Kansas,* 43rd Midwest Fish and Wildlife Conference, December 8-9, 1981, Wichita, KS.

Williams, T. H. Lee. *The National AML Inventory in Wildlife and Fisheries Development of Abandoned Coal Mine Areas,* 43rd Midwest Fish and Wildlife Conference, December 8-9, 1981, Wichita, KS.

*McClain, T. J., J. Poracsky, C. Gunn, and R. McDowell. *Groundwater*

---

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

*Withdrawal Estimation Utilizing Landsat Imagery,* 1982 Annual Convention of the American Congress of Surveying and Mapping and the American Society of Photogrammetry, March 15-19, 1982, Denver, CO. 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,* 1982 Annual Convention of the American Congress of Surveying and Mapping and the American Society of Photogrammetry, March 15-19, 1982, Denver, Co. 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,* pp. 516-522, 1982 Annual Convention of the American Congress of Surveying and Mapping and the American Society of Photogrammetry, March 15-19, 1982, Denver, CO. 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.

Williams, T. H. Lee. *An Integrated Inventory of Abandoned Coal Mine Lands in Kansas,* 1982 Annual Convention of the American Congress of Surveying and Mapping and the American Society of Photogrammetry, March 15-19, 1982, Denver, CO. 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.

# APPENDIX VI
# SENATE CONCURRENT RESOLUTION NO. 1644

Session of 1982

# Senate Concurrent Resolution No. 1644

By Senators Kerr and Eldredge

1-20

A CONCURRENT RESOLUTION establishing a task force on the Kansas Applied Remote Sensing Program.

WHEREAS, The Kansas Applied Remote Sensing Program is located in the Space Technology Center at the University of Kansas and utilizes the constant flow of information about the earth's surface acquired by the Landsat satellites and other remote sensors; and

WHEREAS, Through remote sensing, the Kansas Applied Remote Sensing Program has the capability of inventorying, monitoring and evaluating Kansas' natural resources; and

WHEREAS, The Kansas Applied Remote Sensing Program has the capability of providing information that will facilitate the functions of state agencies in a timely manner; and

WHEREAS, The Kansas Applied Remote Sensing Program can, in many instances, assist state agencies with tasks that would be difficult or otherwise impossible to accomplish because of time and manpower limitations; and

WHEREAS, The Kansas Applied Remote Sensing Program is able to perform certain data collection functions for state agencies in a cost-effective manner; and

WHEREAS, The Kansas Applied Remote Sensing Program can provide useful data and services in areas such as reappraisal of land for taxation purposes, water use, pesticide damage, hazardous waste, water quality, wildlife management, noxious weed location and control, surface mining reclamation, soil conservation, rangeland condition evaluation and other critical areas; and

WHEREAS, The National Aeronautics and Space Administration has established the Kansas Applied Remote Sensing Program at the University of Kansas and has offered to the state the opportunity to utilize and evaluate this technology; and

WHEREAS, This opportunity for Kansas will be lost because of the termination of baseline funding by the National Aeronau-

tics and Space Administration; and

WHEREAS, The loss of such a system will result in state agencies having no in-state source of comparable data as that provided by the Kansas Applied Remote Sensing Program: Now, therefore,

*Be it resolved by the Senate of the State of Kansas, the House of Representatives concurring therein:* 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 and to recommend to the legislature and the governor ways to prevent the loss of a valuable data source. The membership of the task force shall be composed 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 chairperson of the task force shall be elected from among the members by the membership of the task force; and

*Be it further resolved:* That the staff of the Kansas Applied Remote Sensing Program shall provide such assistance as may be requested by the task force; and

*Be it further resolved:* 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; and

*Be it further resolved:* That the secretary of state is hereby directed to transmit an enrolled copy of this resolution to the governor, the president of the senate, the speaker of the house of representatives and the chancellor of the University of Kansas.

# APPENDIX VII
# SUMMARY OF THE MEETINGS OF
# THE KANSAS INTERAGENCY TASK FORCE ON APPLIED REMOTE SENSING

THE UNIVERSITY OF KANSAS SPACE TECHNOLOGY CENTER
Raymond Nichols Hall
2291 Irving Hill Drive—Campus West Lawrence, Kansas 66045

Kansas Applied Remote Sensing (KARS) Program
(913) 864-4775
KANS-A-N 564-4775

May 12, 1981

KANSAS INTERAGENCY TASK FORCE ON APPLIED REMOTE SENSING

Summary of Initial Meeting
May 7, 1981

On Thursday, May 6, 1981, the Kansas Applied Remote Sensing (KARS) Program convened the first meeting of the Kansas Interagency Task Force on Applied Remote Sensing at the University of Kansas Space Technology Center in Lawrence. The Task Force has been established to (1) provide policy direction for the KARS Program, (2) define project goals and priorities, (3) enhance interagency communication, coordination and cooperation on remote sensing and utilization of geographic information systems, (4) provide feedback to the KARS Program regarding agency data needs and concerns, (5) evaluate the Program's performance and requirements, and (6) assess alternatives for greater and more operational utilization of remote sensing/geographic information system technology on a state-wide basis.

Attending the initial Task Force meeting were:

Donald D. Kostecki
Kansas Water Resources Board

William Hambleton, Director
Kansas Geological Survey

Ray Menendez
Kansas Department of Revenue

Robert Burcke
Kansas Department of Revenue

Freeman E. Biery, Director
Weed & Pesticide Division
Kansas State Board of Agriculture

Rick Illgner, Manager
Southwest Kansas Groundwater Management District #3
President, Kansas Groundwater Management District
Managers Association

Michael Butler
Kansas Department of Health & Environment

Wayne Herndon
Kansas Park & Resources Authority

Ramon Powers
Kansas Legislative Research Department

Raney Gilliland
Kansas Legislative Research Department

R. C. (Pete) Loux, Chairman
Kansas Corporation Commission

Bill Hanzlick, Director
Kansas Fish and Game Commission

Dean Garwood, Director
Entomology Division
Kansas State Board of Agriculture

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

Edward A. Martinko, Associate Director
KARS Program
University of Kansas Space Technology Center

James W. Merchant
Senior Remote Sensing Applications Specialist
KARS Program
University of Kansas Space Technology Center

Prof. B. G. Barr, Dr. Edward Martinko and James Merchant (KARS Program) began the meeting with

(1) a review of the history, function and operation of the KARS Program (see enclosed brochure),
(2) a summation of remote sensing/geographic information systems (GIS) applications in Kansas,
(3) a report on the KARS Program's March 18, 1981 presentations to, respectively, the Kansas Senate Committee on Energy and Natural Resources, the Kansas House Committee on Agriculture and Livestock, and the Kansas Senate Committee on Agriculture and Small Business,
(4) a synopsis of the Landsat Program and the probable impacts of proposed federal budget cutbacks on Kansas state agency utilization of remote sensing/GIS technology,
(5) a discussion of the need for better coordination among state agencies in order to identify high priority common data needs which can be met through application of remote sensing/GIS technology and to evaluate alternatives for enhancing and ensuring continual access to such technology, and
(6) a summation of the manner in which such issues have been addressed in other states (e.g., Texas, Minnesota, Iowa, Louisiana).

Bill Hanzlick, Director, Kansas Fish and Game Commission, at the request of Senator Fred A. Kerr, reported on Senator Kerr's recent appointment to the National Conference of State Legislature's Natural Resource Information Systems (NCSL/NRIS) Task Force. Comprised of legislators and legislative staff representing twelve states, the Task Force meets twice each year to review new developments in the Landsat program and the applications of natural resource information systems. The NCSL/NRIS Task Force provides state legislators with a voice through which the recommendations of the states regarding this new technology may be presented to the Congress, the National Aeronautics and Space Administration (NASA), the National Oceanic and Atmospheric Administration (NOAA) and other agencies involved in making policy on Landsat/NRIS programs. Recommendations regarding continuity in the availability of Landsat data and NASA/NOAA technology transfer programs in the face of federal budget cutbacks, data pricing, orbital coverage, and data archiving are currently being considered by the NCSL/NRIS Task Force. Mr. Hanzlick also conveyed Senator Kerr's support of the Kansas Interagency Task Force concept.

The Task Force then considered a number of issues including (1) the objectives and composition of the Task Force, (2) the desirability of a systematic evaluation of state agency data needs which might be met through application of remote sensing/geographic information system (GIS) technology, (3) the common requirements of many agencies for similar data (e.g., land use/land cover), the advantages inherent in coordination of data collection efforts, and (4) alternatives for enhancing access and application of remote sensing/GIS technology.

The Task Force formulated a number of recommendations including:

(1) Task Force composition -- An invitation to participate in the Task Force will be extended to state agencies which might potentially be able to use remote sensing/GIS technology. These will include, but not be limited to:

- Kansas Fish and Game Commission
- Kansas Water Resources Board
- Kansas Geological Survey
- Kansas Department of Health and Environment
- Kansas Park and Resources Authority
- Kansas Groundwater Management Districts
- Kansas State Board of Agriculture
  - Division of Water Resources
  - Weed & Pesticide Division
  - Entomology Division
- Kansas Department of Revenue
- Kansas Corporation Commission
- Kansas Department of Administration
  - Division of Budget
- Kansas Department of Economic Development
- Kansas Department of Transportation

The Kansas Applied Remote Sensing (KARS) Program will coordinate Task Force activities and provide liason with NASA, NOAA, NCSL, NGA, the Five Agency Project, and other states. Liason will also be maintained with the Legislative Research Department, the Governor's Office, and private industry.

It was recommended that (1) organizations representing county, municipal and intergovernmental units (e.g., League of Kansas Municipalities) be represented on the Task Force and (2) in the future, an invitation be extended to federal (SCS, ASCS, USGS, WPRS, EPA), local and regional agencies to attend and participate in the Task Force meetings as non-voting guests.

(2) Systematic Evaluation of User Needs -- There was a consensus that state agencies with which the KARS Program has worked have benefited from and need to enhance and ensure continual access to, application of remote sensing/GIS technology. The Task Force noted, however, that there is a need to document, in a systematic fashion, the specific manner in which each agency may use such technology to better carry out its assigned mission and legally mandated obligations.

The KARS Program was requested to conduct an assessment of Kansas state agencies' data needs which might be better met through application of remote sensing/GIS technology. The study will include an assessment of the potential for cost savings and the identification of high priority common data requirements. Task Force representatives will assist KARS staff in carrying out this work. Results of the study will be presented at the next meeting of the Task Force.

(3) July meeting -- The Task Force will meet at the University of Kansas Space Technology Center on July 9, 1981 (9:00 A.M.) to review the results of the User Needs Study and to discuss alternatives which will allow the KARS Program to more effectively meet data requirements identified.

THE UNIVERSITY OF KANSAS SPACE TECHNOLOGY CENTER
Raymond Nichols Hall
2291 Irving Hill Drive—Campus West Lawrence, Kansas 66045

Kansas Applied Remote Sensing Program
(913) 864-4775
KANS-A-N 564-4775

August 11, 1981

KANSAS INTERAGENCY TASK FORCE ON APPLIED REMOTE SENSING

Summary of Second Meeting
July 9, 1981

On Thursday, July 9, 1981, the Kansas Applied Remote Sensing (KARS) Program convened the second meeting of the Kansas Interagency Task Force on Applied Remote Sensing at the University of Kansas Space Technology Center in Lawrence. The Task Force has been established to (1) provide policy direction for the KARS Program, (2) define project goals and priorities, (3) enhance interagency communication, coordination and cooperation on remote sensing and the utilization of geographic information systems (GIS), (4) provide feedback to the KARS Program regarding agency data needs and concerns, and (5) evaluate greater and more operational utilization of remote sensing/GIS techn .ogy on a state-wide basis.

Attending the second Task Force meeting were:

Donald F. Kostecki
Kansas Water Office

William W. Hambleton, Director
Kansas Geological Survey

Ray Menendez
Kansas Department of Revenue

Robert L. Walters
Kansas Department of Revenue

Freeman E. Biery, Director
Division of Weeds and Pesticides
Kansas State Board of Agriculture

Rick Illgner, President
Kansas Groundwater Management District
Managers Association
Manager, Southwest Kansas Groundwater
Management District #3

Don Snethen
Kansas Department of Health and Environment

Wayne Herndon
Kansas Park and Resources Authority

Edward Unrein
Kansas Park and Resources Authority

Bill Hanzlick, Director
Kansas Fish and Game Commission

Verlyn Ebert, Planner
Kansas Fish and Game Commission

H. Dean Garwood, Director
Kansas State Board of Agriculture
Division of Entomology

Fred Kerr
Kansas State Senate

Tom Patton
University of Kansas
Research and Graduate Studies

Fred Allen
Kansas Association of Counties

Kevin Carr
Kansas Department of Economic Development

Clark Duffy
Kansas Department of Administration
Division of Budget

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

Edward A. Martinko, Associate Director
KARS Program
University of Kansas Space Technology Center

James W. Merchant
Senior Remote Sensing Applications Specialist
KARS Program
University of Kansas Space Technology Center

Joseph Poracsky
Graduate Research Assistant
KARS Program
University of Kansas Space Technology Center

Elizabeth R. Kipp
Graduate Research Assistant
KARS Program
University of Kansas Space Technology Center

Anne Kahle
Secretary
KARS Program
University of Kansas Space Technology Center

The meeting began with introductions by Professor Bill Barr and Dr. Ed Martinko. Jim Merchant summarized a number of developments which had occurred since the initial Task Force meeting on May 7, 1981:

(1) The National Aeronautics and Space Administration (NASA) budget for remote sensing technology transfer and regional applications programs remains unresolved. While it appears likely that NASA will continue to support some activities of this nature in the future, it seems clear that the States will be required to bear the major costs of implementing and maintaining operational remote sensing programs.

(2) The KARS Program has purchased a Terak 8600 HD23X image display and processing system supported by two microcomputers. The new equipment will significantly enhance the KARS Program's capabilities for processing Landsat MSS digital data and for utilizing geographic information systems. The new equipment is expected to be delivered by October 1981 and to be operational soon after.

(3) In response to a recommendation made at the initial Task Force meeting, seven Kansas agencies have provided the KARS Program with letters indicating their support for an operational Kansas Applied Remote Sensing Program and outlined their needs for data acquired through such a program. The KARS Program would find it valuable to have similar letters from other agencies.

(4) The KARS Program has been in contact with persons in the State of Tennessee regarding their efforts to establish a state-funded remote sensing/GIS program and have obtained information and a copy of legislation enacted for providing such a program. This information is available from the KARS Program upon request.

(5) A copy of the National Conference of State Legislators' Newsletter was handed out. Included in the newsletter was an article on the first meeting of the Kansas Interagency Task Force on Applied Remote Sensing as well as information regarding six or seven other state operational remote sensing/GIS programs.

(6) The Second NASA Landsat/Geo-Based Information System Symposium was held in Biloxi, Mississippi on June 29-July 1 and was attended by Bill Hanzlick, Kansas Fish and Game Commission, Bob Walters, Kansas Department of Revenue, Ed Martinko and Jim Merchant. The meeting was designed to present an update on the status of remote sensing in other states. Papers were presented on the activities and the performance of operational programs in other states. Jim Merchant presented a paper entitled "Irrigated Lands Inventories in Kansas." Hardware presentations and demonstrations were also given at NASA's Earth Resources Laboratory facility in Bay St. Louis, Mississippi.

Ed Martinko reported on the User Needs Survey which had been conducted by the KARS Program upon the request of the Task Force at the initial meeting in May. It was indicated that the document would be updated in the future on an ongoing basis.

The Task Force then considered a number of issues including (1) the revision of the User Needs Study, (2) documentation of the cost-effectiveness of remote sensing/GIS technology over conventional data gathering techniques, and (3) the formation of a delegation made up of several Task Force members who would discuss funding possibilities with the Governor's Office.

The Task Force formulated a number of recommendations including:

(1) Revision of the User Needs Study -- There was a consensus that the Task Force members would once more fill out Table 2 of the User Needs Study, but this time prioritize their need for each type of data by indicating:

#1: This data requirement is a necessity for this agency;
#2: This agency could probably use this type of data; or
#3: This agency could possibly use this type of data.

As an aid in completing the Table, the KARS Program would provide a detailed description of each data requirement category. Finally, it was suggested that any additional data needs that agencies may have considered since the survey had been conducted be included in the revision.

(2) Systematic Evaluation of Cost Benefits -- There was concurrence among the Task Force members that remote sensing technology could be utilized by state agencies to better carry out assigned missions and legally mandated obligations. It was noted, however, that an assessment of the potential cost savings of remote sensing/GIS technology over conventional data gathering techniques was needed. The KARS Program was requested to conduct such an assessment with Task Force representatives assisting the KARS staff in carrying out this work.

(3) Task Force Delegation -- It was determined that a group of Task Force members, made up of Ray Menendez, chairman, Bill Hanzlick, Clark Duffy, Senator Kerr and Ed Martinko, present the question of institutionalizing the KARS Program and an update on the Task Force meeting to the Governor's Office.

(4) Next Meeting -- A tentative date of August 19th was set for the next Task Force meeting.

THE UNIVERSITY OF KANSAS SPACE TECHNOLOGY CENTER
Raymond Nichols Hall
2291 Irving Hill Drive—Campus West Lawrence, Kansas 66045

Kansas Applied Remote Sensing Program
(913) 864-4775
KANS-A-N 564-4775

December 17, 1981

KANSAS INTERAGENCY TASK FORCE ON APPLIED REMOTE SENSING

Summary of Third Meeting
December 14, 1981
State Capitol
Topeka, Kansas

On Monday, December 14, 1981, the Kansas Interagency Task Force on Applied Remote Sensing held its third meeting. Those participating were:

Fred Allen
Kansas Association of Counties

Freeman Biery
Kansas State Board of Agriculture
Weed & Pesticide Division

Kevin Carr
Kansas Department of Economic Development

Phil Doctor
Kansas Crop & Livestock Reporting Service

Verlyn Ebert
Fish & Game Commission

Jon Flint
Kansas State Board of Agriculture
Weed & Pesticide Division

Dean Garwood
Kansas State Board of Agriculture
Division of Entomology

Raney Gilliland
Kansas Legislative Research Department

Fred Kerr
Kansas Senate

Don Kostecki
Kansas Water Office

Dave Larson
Kansas Corporation Commission

Ray Menendez
Kansas Department of Revenue
Division of Property Valuation

Tom Patton
University of Kansas -- Research & Graduate Studies

Ramon Powers
Kansas Legislative Research Department

Terri Sculley
Kansas Corporation Commission

Don Snethen
Kansas Department of Health & Environment

Rick von Ende
University of Kansas

Bob Wootton
Kansas Governor's Office

Anne Kahle
Ed Martinko
Jim Merchant
Kansas Applied Remote Sensing (KARS) Program

Dr. Edward Martinko, KARS Program, opened the meeting with a review and update of the tightening federal budget situation as it affects applied remote sensing in Kansas. He emphasized the need for state support if Kansas is to have an operational program to provide remote sensing/geographic information systems services to Kansas agencies.

Ray Menendez, Kansas Department of Revenue, reported on the meeting that a delegation of three members of the Task Force had with Governor John Carlin on September 10, 1981. Their purpose was to discuss with him the nature and accomplishments of the Task Force, to present him with a copy of the interim user needs report of the Task Force, and to request his advice in regard to alternatives for institutionalizing an operational remote sensing/GIS capability in Kansas. The delegation was composed of Freeman Biery, Director of the Weed and Pesticide Division of the Kansas State Board of Agriculture, Ray Menendez, from the Division of Property Valuation of the Department of Revenue, and Dr. Edward Martinko, Associate Director of the Kansas Applied Remote Sensing (KARS) Program. Bob Wootton, Legislative Liaison in the Governor's Office, was also present at the meeting.

Remote Sensing activities of the KARS Program were outlined to the Governor, the role of the Task Force was explained, and the future of remote sensing in Kansas was discussed. Dr. Martinko presented a summary of the capabilities of Landsat and other remote sensing systems, and displayed examples of maps and other products produced for Kansas agencies by the KARS Program since the Program was initiated in 1972. Ray Menendez briefly discussed the composition of the Task Force and outlined the way in which it is functioning. He also pointed out that, in speaking as a representative of the Task Force, he was part of an unprecedented event in that never before had a Kansas interagency task force such as this urged the funding of a facility over which no single agency would have operational control.

Freeman Biery reviewed for the Governor the ways in which his agency has utilized remotely-sensed data in the past and the manner in which he hoped to be able to work with the KARS Program in the future. Mr. Biery discussed the benefits of using remote sensing to deal with problems related to musk thistle control, and pesticide and herbicide effectiveness. The KARS Interagency Task Force interim report, entitled "A Survey of Agency Data Needs in Kansas," had been provided to Bob Wootton prior to the meeting, and a copy was presented to Governor Carlin at the conclusion of the presentation.

Mr. Wootton reported to the Task Force that the Governor's Office had reviewed the progress of the Task Force and the requirements of Kansas agencies for remote sensing services. He noted that Governor Carlin was favorably impressed with the potential of remote sensing and the benefits the technology would have for state agencies. An initial decision was made to provide $50,000 in baseline funding for the KARS Program. However, because it now appears that state revenues will fall $19-20 million dollars next year, the Governor has indicated that the funding should come from user agencies' budgets rather than from the General Fund. Mr. Wootton stressed that this should not be taken by the Task Force as an indication of lack of support for remote sensing by the Governor's Office.

Senator Fred Kerr suggested that, although difficult, it might be feasible to initiate funding for remote sensing through the legislative process. One possibility would be to attach such funding to a bill mandating action that would in part utilize remote sensing (e.g. reappraisal through the Department of Revenue). Such an action might, however, have the possibly undesirable effect of putting control of the KARS Program within a single agency. Several Task Force members noted the advantages of having the Program located within the University of Kansas in an administrative structure not tied to any single agency.

Freeman Biery, Kansas State Board of Agriculture, suggested that perhaps the legislature would consider legislation without a funding tie. Such legislation might be in the form of a resolution of support for the KARS Program and the Task Force and would enable KARS Program and Task Force representatives to

increase the legislature's awareness of remote sensing and the need for a State remote sensing program. Such a resolution might help lay the groundwork for more substantive legislation in subsequent legislative sessions. Bob Wootton concurred, noting that a resolution would be less vulnerable than a bill and could serve to establish the authority and mandate of the Task Force.

Senator Kerr suggested that he discuss with legislative research staff several alternatives for legislation. He emphasized that, although he does see the need for baseline funding for several years, he expects that after an initial break-in period user agencies would make a remote sensing program self supporting. Several Task Force members noted that local and federal agencies will also be users of KARS services and could bear some of the costs of the Program's operation

Prior to the next meeting the agencies were requested to (1) identify bills proceeding through the legislature in this session that could benefit from application of remote sensing, (2) begin to consider the nature and costs of remote sensing services which the agencies will wish to purchase in the next several years. Senator Kerr will work with legislative research to prepare a draft resolution for Task Force consideration.

Ed Martinko noted that Loyola M. Caron has joined the KARS Program staff. Loyola is a remote sensing specialist with a background in nature resource information systems technology, wildlife management and forestry. She holds a B.S. in wildlife biology and an M.S. in forestry, with emphasis on remote sensing of nature resources, from the University of Minnesota. Prior to coming to Lawrence, Loyola was Staff Associate with the National Conference of State Legislatures' Natural Resource Information Systems Project, a program which provides technical assistance to state legislators on Landsat and NRIS technology. She has also worked for North Dakota's Regional Environmental Assessment Program as the earth sciences research coordinator responsible for collecting natural science data for a state-wide automated data base. In addition to her work in the KARS Program, Loyola will pursue a degree in Geology at KU.

Jim Merchant, KARS Program, has been invited by the National Conference of State Legislatures to travel to Tennessee to participate in a briefing for Tennessee agency representatives, legislative staff, and gubernatorial advisors on alternatives for establishing a state remote sensing program in Tennessee. He will make a presentation on the work of the KARS Program and the Kansas Interagency Task Force on Applied Remote Sensing, and will review the status of remote sensing/geographic information system development in other states.

The next meeting of the Task Force will be held at 3:00 P.M., Monday, January 18, 1982 in Room 522-S, State Capitol, Topeka, Kansas.

THE UNIVERSITY OF KANSAS SPACE TECHNOLOGY CENTER
Raymond Nichols Hall
2291 Irving Hill Drive—Campus West Lawrence, Kansas 66045

Kansas Applied Remote Sensing (KARS) Program
(913) 864-4775
KANS-A-N 564-4775

January 27, 1982

KANSAS INTERAGENCY TASK FORCE ON APPLIED REMOTE SENSING

Summary of Fourth Meeting

January 18, 1982
State Capitol
Topeka, Kansas

The fourth meeting of the Kansas Interagency Task Force on Applied Remote Sensing was convened at 3:00 P.M. on January 18, 1982 in Room 522-S, State Capitol, Topeka, Kansas. Those participating in the meeting were:

Freeman Biery, Director
Kansas State Board of Agriculture
Weed & Pesticide Division

Phil Doctor
Crop Reporting Service

Verlyn Ebert
Kansas Fish & Game Commission

Jon Flint
Kansas State Board of Agriculture
Weed & Pesticide Division

Dean Garwood
Kansas State Board of Agriculture
Entomology Division

Raney Gilliland
Legislative Research

Wayne Herndon
Kansas Park and Resources Authority

Bill Kastens
Crop Reporting Service

Fred Kerr
Kansas Senate

Don Kostecki
Kansas Water Office

Dave Larson
Kansas Corporation Commission

Ray Menendez
Kansas Department of Revenue
Division of Property Valuation

Doris Nagel
Kansas Corporation Commission

Ramon Powers
Legislative Research

Edward Unrein
Kansas Park and Resources Authority

Loyola Caron
James Merchant
Edward Martinko
Kansas Applied Remote Sensing (KARS) Program

Dr. Edward Martinko, KARS Program, opened the meeting with a report on the entry regarding the KARS Program in the Governor's proposed budget for FY83. The entry reads as follows:

> *Program enhancements. It is recommended that $50,000 of general use funds be made available to finance the equipment needs of the Kansas Applied Remote Sensing Program. Reductions in federal funds available for this program require that some state funds be made available to the program to finance essential equipment needs.*

Martinko emphasized that the funds are not presently required for equipment, but are needed as baseline funding to support existing KARS staff in providing remote sensing/geographic information services to state agencies. This matter has been discussed with the Governor's office, and the misunderstanding regarding the word "equipment" has been clarified.

Martinko asked Raney Gilliland, Legislative Research Department, to comment on other questions surrounding the budget entry which have recently arisen. Gilliland noted that, while the narrative of the budget appears to indicate that funds for the KARS Program would be appropriated from the general fund, this is not, apparently, what would happen because of a discrepency in the Budget document. This discrepency became evident when it was noted that the $50,000 KARS funding did not appear in the figures of the University

of Kansas budget. Inquiries have been made of the Division of Budget in regard to the matter. It appears, at present, that the effect of the budget narrative is to provide for a $50,000 fee fund into which state agencies may place funds which would be utilized by the KARS Program to carry out service projects. Further clarification from the Division of Budget is being sought.

Senator Fred Kerr reported on a meeting which he, Raney Gillilan, Ramon Powers, Ray Menendez, and KARS staff had shortly before the Task Force meeting with Bob Wootten, Legislative Liaison in the Governor's Office. The issue of the KARS budget entry was discussed. Particular concern was voiced over the possibility that, while a fee fund may help agencies to channel funds to KARS for needed work, a $50,000 limit could be more restrictive than warranted. A fee fund without restrictions would seem to be desirable. Discussion focused on the fact that establishment of a fee fund would not, however, address either the KARS baseline funding problem caused by the termination of NASA funding or the necessity that the Program move from a demonstration mode to an operational mode in order to serve state agencies. Senator Kerr requested that the agencies make known to him their views on the matter, particularly in the event that the budget language and provisions do not change.

Verlyn Ebert, Kansas Fish and Game Commission, asked for clarification of the advantages of establishment of a fee fund as opposed to conventional contractual work. Ed Martinko noted that he believed that such a fund would help facilitate transfer of funds from the agencies to the KARS Program and would aid in eliminating some of the "red tape" currently involved in agency-KARS contractual transactions. A $50,000 limit to a fee fund would be detrimental, however. Martinko re-emphasized that an unrestricted fee fund, while helpful, would not resolve the problems KARS will encounter with baseline funding.

Freeman Biery, Kansas State Board of Agriculture, suggested that the Division of Budget (Clark Duffy), be asked to provide further clarification regarding the KARS entry in the Governor's budget. Ray Menendez, Kansas Department of Revenue, proposed that the Task Force, in the interim, proceed to consider the resolution prepared by Senator Kerr.

Senator Kerr reviewed with the Task Force a resolution which he will introduce soon in the Senate. {Note: Resolution 1644 was introduced to the Senate on January 20, 1982; it was referred to the Senate Energy and Natural Resources Committee.} The resolution (attached) formally establishes the Task Force and assigns it the mission of presenting to the Governor and the Legislature recommendations regarding the future of the KARS Program and applied remote sensing in Kansas.

Some questions were raised regarding membership and representation on the Task Force. Jim Merchant, KARS Program, noted that the Task Force as presently constituted, and as proposed in the resolution, is an interim group comprised of state agencies with which the KARS Program has worked and which seem most likely to benefit from KARS services. It is quite conceivable that, after consideration of alternatives, the Task Force may, in December 1982, recommend to the Governor and Legislature a reorganization of the Task Force membership. Senator Kerr noted that no agency will be excluded from Task Force meetings and, in fact, the Task Force will be expected to solicit and study the needs, views and interests of all concerned parties. Attendance by representatives of interested agencies, in addition to those specified in the resolution, is encouraged.

Discussion focused on the reporting dates mandated in the resolution. Ray Menendez noted that it will be important that the Task Force report at the beginning of the budget process. It was suggested that draft recommendations be completed by July 1, revised and submitted in final form to the Governor and Legislature before September 15, 1982. This will allow Task Force recommendations to be considered by the agencies in their budgetary processes.

Senator Kerr commented that the resolution is designed to provide a framework within which the Task Force may operate with some flexibility. Scheduling of meetings, administration of voting, and other such issues should be addressed by the Task Force membership as necessary. The KARS Program will provide staff support and communication services to the Task Force, as at present.

In response to a question concerning the effect of the resolution on KARS' funding situation, Senator Kerr said that if funds are to be forthcoming in this session they would have to be appropriated in Omnibus legislation. The resolution provides for a formally constituted Task Force which might recommend such an appropriation. This would be a matter for the Task Force to consider.

Ed Martinko noted that all agencies will be contacted when hearings on the resolution are scheduled, when action is taken on the resolution, when further clarification of the budgetary situation is received, and as other matters of interest to the Task Force transpire. The next Task Force meeting will be scheduled as events warrant. KARS staff will contact all Task Force members to arrange a mutually acceptable date. In the interim any Task Force member needing information or assistance is requested to contact either Ed Martinko, Jim Merchant or Loyola Caron, KARS Program.

# APPENDIX VIII

# AGENCY LETTERS OF SUPPORT

STATE OF KANSAS



OFFICE OF THE GOVERNOR
*State Capitol*
*Topeka 66612*

ohn Carlin *Governor*

May 17, 1982

Dr. Edward A. Martinko
Associate Director
Space and Technology Center
Raymond Nichols Hall
2291 Irving Hill Drive - Campus West
Lawrence, Kansas 66045

Dear Dr. Martinko:

As provided in 1982 Senate Resolution 1644 regarding the Kansas Interagency Task Force on Applied Remote Sensing, I am appointing Bob Wootton of my staff to serve as my representative on the Task Force.

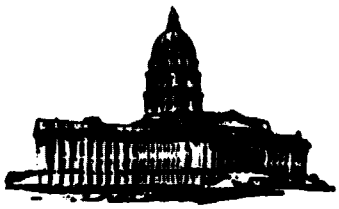
Sincerely,

JOHN CARLIN
Governor

JC:fg
cc: Shirley Allen
Secretary of State Jack Brier

JANE M. ELDREDGE
SENATOR, SECOND DISTRICT—DOUGLAS COUNTY
6304 MASSACHUSETTS STREET
LAWRENCE, KANSAS 66044

STATE OF KANSAS



TOPEKA

SENATE CHAMBER

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

February 22, 1982

Mr. Edward A. Martinko
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
901 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
901 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
Caupus 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

Harland Priddle
XWXXWXXBXXXXXX
Secretary

# KANSAS STATE BOARD OF AGRICULTURE

TOPEKA, KANSAS 66612

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
Secretary

HEP:tl

# KANSAS STATE BOARD OF AGRICULTURE

NTOMOLOGY DIVISION
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 range-land 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

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
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.

Data to accomplish the desired objective should be obtained on the basis 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, 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,

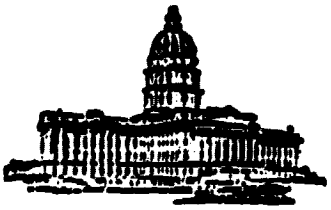
Robert C. Walters, M.A.I.
Supervisor, Real Estate
Division of Property Valuation
(913) 296-2365

RCW:skt

cc: Director

STATE OF KANSAS

RICHARD W. RYAN,
DIRECTOR
BEN F. BARRETT,
ASSOCIATE DIRECTOR
ARLIN 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

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,

Raney Gilliland

Raney Gilliland
Research Assistant

RG/aem

# Kansas Fish & Game

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

*REGIONAL OFFICES:*

*Northwest Regional Office*
*3204 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:

Northwest Regional Office
2204 Vine
Hays, Kansas 67601

Northcentral Regional Office
Box 469, 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 67901

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, 1981



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.

Kansas Hazardous Waste Management Plan.

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.

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

Tomorrow's Water Must Be Managed Today
INDUSTRY, AGRI BUSINESS, MUNICIPAL
GMD NO 3 1976

# Southwest Kansas Groundwater Management 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<br>2) Effective Recharge - water level measurements in observation well |
| Coop Ford County Ogallala Study | 1) Hydrologic Properties -<br>a) Saturated thickness<br>b) Bedrock map<br>c) Water level contour<br>2) *Aquifer Response to Pumping Stress -<br>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 Ilgner
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 IX

## COMMERCIAL CONTRACTORS THAT HAVE BENEFITED BY KARS PROGRAM PROJECTS

## COMMERCIAL CONTRACTORS THAT HAVE BENEFITTED BY THE KARS PROGRAM PROJECTS

| Project | Agency | Contractor | |
|---|---|---|---|
| Arkansas River Vegetation Analysis (CIR Aerial Photography) | Kansas Fish and Game Commission<br>U.S. Fish and Wildlife Service | Wilson Engineers, Inc.<br>Salina, Kansas | $ 5,000 |
| Monitoring of Cheyenne Bottoms Waterfowl Management Area Habitat (CIR Aerial Photography) | Kansas Fish and Game Commission | Wilson Engineers, Inc.<br>Salina, Kansas | 2,000 |
| Mapping Jamestown Waterfowl Management Area Habitat (CIR Aerial Photography) | Kansas Fish and Game Commission | Wilson Engineers, Inc. | 400 |
| Landsat Computer Identification of Wildlife Habitat in Kansas (Landsat Computer Compatible Tapes) | Kansas Fish and Game Commission | Bendix Corporation<br>Ann Arbor, Michigan | 5,000 |
| Soldier Creek Watershed "208" Planning Project (Color Aerial Photography) | Environmental Protection Agency | Wilson Engineers, Inc.<br>Salina, Kansas | 1,500 |
| County Line Lake, Missouri (Color Aerial Photography) | Missouri Natural Resources Department | M. J. Harden's Associates<br>Kansas City, Missouri | 800 |
| Musk Thistle Project (CIR Aerial Photography) | Kansas Department of Agriculture<br>Weed and Pesticide Division | Wilson Engineers, Inc.<br>Salina, Kansas | 500 |
| Sand Hills State Park (Black and White Aerial Photography) | Kansas Applied Remote Sensing Program | Wilson Engineers, Inc.<br>Salina, Kansas | 300 |
| Several KARS Projects<br>April 1972 - March 1982 | Kansas Applied Remote Sensing Program | Center for Research, Inc.<br>Drafting and Photographic Laboratory | 25,000 |
| | | TOTAL | $40,500 |

# APPENDIX X

# PROGRAM STATISTICAL DATA

## INQUIRIES AND VISITATIONS TO THE KANSAS APPLIED REMOTE SENSING PROGRAM

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

*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 |
|---|---|---|---|---|---|---|---|---|---|---|
| Number of Recipients | -- | 220 | 325 | 377 | 695 | 865 | 900 | 1,250 | 1,900 | 2,050 |

**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 |
|---|---|---|---|---|---|---|---|---|---|---|
| Faculty | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 |
| Graduate Research Assistant | 2 | 4 | 4 | 4 | 9 | 5 | 3 | 10 | 6 | 8 |
| Staff | 2 | 2 | 2 | 2 | 2 | 2 | 4 | 2 | 4 | 2 |
| TOTAL | 7 | 9 | 9 | 9 | 13 | 9 | 10 | 15 | 13 | 13 |

## REMOTE SENSING COURSES OFFERED BY THE UNIVERSITY OF KANSAS

| | 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

## EXTERNAL FUNDING FROM AGENCIES BY YEAR

| | PROJECT | AGENCY | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Kansas Land Use Map | Kansas Department of Economic Development | | $5,000 | | | | | | | |
| 2. | Cheyenne Bottoms Waterfowl Management Area | Kansas Fish and Game Commission | | | $ 550 | | | | | | |
| 3. | An Investigation of the Feasibility to Automatically Develop a Land Use Map of Kansas | Kansas Department of Economic Development | | | 6,000 | | | | | | |
| 4. | Evaluations of the Utilization of Remote Sensing by the U.S. Fish and Wildlife Service | U.S. Fish and Wildlife Service | | | | $18,000 | | | | | |
| 5. | County Line Lake, Missouri | Missouri Department of Natural Resources | | | | 800 | | | | | |
| 6. | Douglas County Land Use Mapping | Lawrence-Douglas County Planning Commission | | | | | 53,960 | | | | |
| 7. | Land Use Map of North Central Regional Planning Commission District, Kansas | North Central Regional Planning Commission | | | | | 3,000 | | | | |
| 8. | Conversion of Prime Agricultural Land to Urban Land Use | Mid-America Regional Council | | | | | 1,500 | | | | |
| 9. | Musk Thistle Mapping | Kansas Department of Agriculture - Weed and Pesticide Division | | | | | 500 | $ 500 | $ 500 | $ 500 | |
| 10. | Reclamation Program in South Kansas Strip Mine Areas | U.S. Geological Survey - Water Resources Division | | | | | 370 | | | | |
| 11. | Musk Thistle Project | U.S. Environmental Protection Agency - Kansas Department of Agriculture | | | | | | 70,000 | 75,000 | 75,000 | |
| 12. | Total Irrigation Mapping | Legislative Research Department | | | | | | | 500 | | |
| 13. | Sandsage Prairie | Kansas Fish and Game Commission | | | | | | | | 130 | |
| 14. | Wildlife Habitat Inventory for the Proposed Pine Ford Lake, Missouri | U.S. Fish and Wildlife Service | | | | | | | | | $4,931 |

## EXTERNAL FUNDING FROM AGENCIES BY YEAR

| | PROJECT | AGENCY | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15. | Land Use, Land Cover, Land Use Change, Floodplain Scour, Gully and Stream Channel Inventory of Pony Creek and Roy's Creek Watersheds, Kansas and Nebraska | U.S. Department of Agriculture - Soil Conservation Service | | | | | | | | | $ 6,487 | |
| 16. | Kansas Remote Sensing Short Courses | National Aeronautics and Space Administration | | | | | | | | | 25,000 | 17,130 |
| 17. | Crop Phenology and Landsat Based Irrigated Lands Inventory in the High Plains | National Aeronautics and Space Administration | | | | | | | | | | 30,050 |
| 18. | Applied Research and Development in Remote Sensing Applications | Farmland Industries, Inc. | | | | | | | | | | 6,500 |
| 19. | Management of Indian Owned Lands | Bureau of Indian Affairs | | | | | | | | | | 2,000 |
| 20. | Irrigated Lands Identification in the Soldier Creek Valley | Kansas Geological Survey | | | | | | | | | | 1,000 |
| 21. | Abandoned Mind Land Inventory | Office of Surface Mining | | | | | | | | | | 70,000 |
| 22. | Abandoned Mine Land Prototype Study | Office of Surface Mining | | | | | | | | | | 166,000 |
| 23. | Land Use/Land Cover Inventory of the Missouri River Floodplain | Missouri River Basin Commission | | | | | | | | | | 50,000 |
| TOTAL | | | | $5,000 | $6,550 | $18,800 | $14,170 | $70,500 | $76,500 | $75,630 | $36,418 | $342,680 |