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Preface iii

Introduction 1

A. ACCOMPLISHMENTS 1

 LANDSAT Digital Applications to Forest
 Vegetation and Land Use Classification 1

 Regional Development Commission Projects 1

 Technology Transfer 3

B. PROBLEMS 4

C. SIGNIFICANT RESULTS 4

D. PUBLICATIONS 5

E. RECOMMENDATIONS 5

F. FUNDS EXPENDED 5

G. DATA USE 5

H. AIRCRAFT DATA 6

I. PROPOSED WORK FOR NEXT QUARTER 6

 LANDSAT Digital Applications to Forest
 Vegetation and Land Use Classification 6

 Regional Development Commission Projects 7

Conclusions 10

APPENDIX A

 Adgenda A-1

 Attendees A-2

 Remarks A-4

PREFACE

The objectives of the contract are to develop a method of using LANDSAT data that will be reliable enough to be used by resource managers and planners. This method must be economical, easily used and readily available to the users. Secondly, to set up training sessions to acquaint potential users with LANDSAT data. To find out their needs and involve them in the continuing research. This involvement will result in the data collection techniques that will be accepted by the potential users.

The reporting period of this document is from 9/26/75 to 12/25/75. During this time much effort was expended in the development of a computer system for analysis of the digitally recorded LANDSAT data. An informational meeting on the applications of LANDSAT data was held primarily for state agency personnel and Regional Development Commission members.

INTRODUCTION

As discussed in previous quarterly reports, it was concluded that digital analysis of LANDSAT data on magnetic tapes should be employed in the study of LANDSAT applications to forest vegetation and land use classification in Minnesota. This conclusion was based upon the inability of numerous previous investigations to satisfy the needs of the forest land manager using only bulk imagery in various display forms.

Regions 3 and 4 Regional Development Commissions (see map, page 2) have expressed interest in applying LANDSAT products to resource information needs. The substance of these projects were outlined in meetings during July, 1975. Products obtained from these projects will be used as demonstration projects during the technology transfer sessions planned for the summer of 1976.

A. ACCOMPLISHMENTS

LANDSAT Digital Data Applications to Forest Vegetation and Land-Use Classifications in Minnesota

Much of the work performed in this quarter on this project involved continuing effort in development of a computer system for analysis of the digitally recorded LANDSAT data. Since the system is not "finished" and was initiated in the period covered by the last report, specific accomplishments cannot easily be listed.

Regional Development Commission Projects

Although the Iron Range Land Cover project for Region 3 has not been completed, several comments can be made concerning the maps and other products it will include. These products must, if they are to

MINNESOTA



Minnesota State Planning Agency, 1950

be applicable, be accurate, cost effective and compatible with the existing MLMIS classification scheme. Limited field checking of recent mining activity on the Iron Range indicates that the maps are highly accurate. The changes which have been noted and mapped can be transferred to the MLMIS system through use of a coding grid overlay. The complete evaluation of monitoring surface mining activities, including a cost effectiveness study, will be included in the final report.

Several comments on the methods used for studying water extent and quality can also be made. We are using two techniques to develop models for water quality estimation. The first measures the image density of the lake. The second involves manipulation of the CCT's. The result of both techniques will be maps of lakes with similar water quality and the model used to make the map. The image density reading techniques will estimate the average quality of an individual lake, while the use of CCT's will allow for internal variations to be identified and mapped. Use of one technique over the other will (or should) be dependent on the scale of which information is desired (large regional vs. small individual lake), and the difference in cost effectiveness. Use of the CCT's also allows an exact measurement of the lake area (or extent of surface water) to be made. Some materials on the extent of surface water in Douglas County are now in the hands of Regional Personnel for evaluation and feedback.

Technology Transfer

On November 4, 1975 the first technology transfer meeting was conducted by the Minnesota State Planning Agency. The object of this meeting was to inform state agency personnel, Regional Development Commission members and other interested persons about the LANDSAT program and the work done

by the Minnesota State Planning Agency under the NASA contracts.

A copy of the agenda and remarks are included, as well as a list of the speakers and attendees. (See Appendix A)

Dr. James Taranik, of the EROS Data Center in Sioux Falls, was the keynote speaker. We were very grateful that he could attend.

B. PROBLEMS

LANDSAT Digital Data Applications to Forest Vegetation and Land-Use Classifications

Attempts to implement the two programs obtained from Colorado State University (CSU) for reformatting the data for compatibility with RECOG have not been successful. The problems encountered have been of two major types: (1) some of the routines called by the programs were not in the computer library and card decks for them had to be obtained from CSU, and (2) the size of data matrix, or portion of the scene, which was geometrically corrected is not the same as when the program was used at CSU. Current work is proceeding on altering the parameters which must be set in the program to handle the larger matrix size.

In an effort to resolve these problems, contact was made with people at the Bendix Aerospace Division in Ann Arbor, Michigan. These people are performing analysis on the same scene in Itasca County for the Bureau of Outdoor Recreation.

Many of the difficulties have been solved, but more work will be needed.

C. SIGNIFICANT RESULTS

Daily National Weather Service Satellite photographs of the midwest have been found to be of great assistance before ordering EROS Data Center products. These weather satellite images are a quick and inexpensive record of the location of cloud masses which supplements the

percent of cloud catalogues. Savings of time and money can be made because the location of cloud cover is known before any imagery is ordered.

There were no other significant results at this time.

D. PUBLICATIONS

There were no publications during this period.

E. RECOMMENDATIONS

Other LANDSAT investigators should be informed of the usefulness of the National Weather Service Satellite photographs prior to ordering products from the EROS Data Center.

F. FUNDS EXPENDED

The amount of money expended this quarter was minimal. To date, we have not received any invoices from our sub-contractors. The Acting Coordinator's salary is being temporarily funded from the Contractor's share. Form 533M, Monthly Financial Report, shows total expenditures to date to be: \$2,235.12.

G. DATA USE

During the Spetember-December, 1975 quarter, we ordered one CCT which was not received. Also we received one CCT that was ordered last quarter.

A small amount of imagery was returned to the EROS Data Center because it was scratched. A \$50 credit was given to our account (G-20320) for some of the imagery. The remainder of the imagery is to be exchanged.

<u>Quarter</u>	<u>Value of Data Ordered</u>	<u>Value of Data Received</u>
3/25-6/25/75	\$ 224.00	\$ 56.00
6/26-9/25/75	1374.00	1142.00
9/26-12/25/75	850.00	410.00
(minus credit)	(50.00)	

The total value of account G-20320 was \$9962.00 as of 12/31/75 with orders totaling \$360 in-progress. The total value of the corresponding CCT account (G- E0320) was \$4000 as of 12/31/75 with orders in-progress totaling \$200.

H. AIRCRAFT DATA

None on this contract.

I. PROPOSED WORK FOR NEXT QUARTER

LANDSAT Digital Data Applications to Forest Vegetation and Land-Use Classification

Continued efforts will be made in developing the computer system and accomplishing the work which was planned for the October 1, 1975 - December 31, 1975 period. Necessary programming help will be acquired to help rectify the problem. This work is:

- (1) Line printer "gray maps" will be generated for selected areas in Itasca County.
- (2) The accuracy of the geometric connection will be evaluated. Inconsistencies in scale and orientation of the computer-displayed LANDSAT data will be noted.
- (3) Signatures will be extracted for several natural resource cover types from selected training sets, using cover type maps as ground truth.
- (4) These signatures will be used to train a statistical decision algorithm (Gaussian likelihood ratio) for performing a supervised classification of both training and test areas using all four spectral bands of LANDSAT data.
- (5) Classification accuracies will be determined on both the training and test sets. The confusion in classification between cover types will be considered in determining which types will be considered in determining which types will be possible to map.

Regional Development Commission Projects

Two Regional Development Commissions (3 and 4) have expressed interest in applying LANDSAT products to resource information needs. These projects were outlined by Region 4 on July 10, 1975 and by Region 3 on July 28, 1975. The product of these projects is to form the core of the technology transfer sessions during the summer of 1976. During the next reporting period, we will complete several projects and continually re-evaluate our research in terms of the needs of the various regions. The outline of these projects is included below along with a schedule of the activities.

PROJECT AREAS

A. Region 3: Iron Range Land Cover Change and Water Quality Studies.

1. Land Cover change on the Iron Range.

- a. The techniques used are similar to those used in monitoring surface water, (see "Monitoring Surface Water Dynamics in Minnesota", Dwight A. Brown, et al) except that annual changes are mapped.
- b. All work will be mapped at 1:24,000 scale. A Regional mosaic will also be made.
- c. These maps can be used by Region 3, MN Department of Natural Resources and the U.S. Geological Survey.
- d. Evaluation of the maps will be dependent upon feedback from the users and from maps supplied by the individual mining companies. This will be an ongoing process.

2. Water Quality Study of Region 3 lakes.

- a. The techniques, density reading of the imaged lakes and manipulation of CCT's, are being developed. They are transferable to any region/area of the state.

- b. Maps at a regional scale will be made, showing classes of lakes having similar water quality. The statistical models upon which these maps are based can be used for monitoring changes in lake quality over time.
 - c. The maps and models will be used by the Region 3 and Department of Natural Resources. They will be completed by June, 1976.
 - d. Evaluation of the products will be done through field checking during late summer, 1976. The evaluation will be done in conjunction with the users.
- B. Region 4: Studies of Maximum Extent of Surface Water and Water Quality.
- 1. Extent of Surface Water
 - a. The techniques used in this study are reported in "Monitoring Surface Water Dynamics", D. A. Brown, et al.
 - b. All work will be mapped at 1:24,000 and a regional scale.
 - c. The maps will be used to update information contained in Department of Natural Resource Bulletin 25, Inventory of Minnesota Lakes. Users include Department of Natural Resource, Region 4 Regional Development Commission, et al.
 - d. Evaluation will be a cooperative effort by users, based on field work.
 - 2. The Water Quality Study in Region 4 will have the same products, evaluation, and schedule as the study in Region 3. Users include the western Minnesota R. C. & D. project, Region 4 Regional Development Commission, Douglas County Planning Commission, and Department of Natural Resources.

WORK SCHEDULE

<u>Completion Date</u>	<u>Project Phase</u>
	<u>Region 3 Iron Range Land Cover Change</u>
February 27, 1976	Complete 1:24,000 quad overlays for all of Iron Range annual land cover changes 1972-1974.
March 3, 1976	Complete regional scale mapping of Iron Range land cover change.
	<u>Region 3 Lake Water Quality</u>
January 31, 1976	Develop techniques for interpreting reconnaissance level lake water quality. (This is being done on a project in the Geography Department under different funding.)
February 15, 1976	Assemble existing ground truth for model building.
March 15, 1976	Obtain necessary LANDSAT images and tapes.
	<u>Extent of Surface Water Region 4</u>
December 31, 1975	Complete mapping of seasonal maximum of water for 1:24,000 scale quad overlays for Douglas County study area.
February 15, 1976	Complete inventory comparison with MDNR Bulletin 25 for Douglas County.
March 31, 1976	Complete evaluation of products by Region 4 personnel.
	<u>Lake Water Quality, Douglas County Area (Region 4)</u>
January 31, 1976	Complete technique development -- (see Region 3 Lake Quality Study)
February 15, 1976	Assemble existing ground truth for model building.
March 15, 1976	Obtain necessary LANDSAT image and tapes

CONCLUSIONS

Work on the Regional Development Commission projects, proceeded at the scheduled pace this quarter, and it anticipated that several of them will be completed in late March, 1976.

Work on the analysis of digital tapes proceeded at a much slower than anticipated rate due to programming problems. Necessary programming help needed to rectify these problems will be acquired the next reporting period.

The informational meeting which was held in early November acquainted some state agency personnel and Regional Development Commission members with LANDSAT and the Minnesota State Planning Agency directed research with LANDSAT tapes and images.

Appendix A

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STATE OF MINNESOTA

STATE PLANNING AGENCY
100 CAPITOL SQUARE BUILDING
550 CEDAR STREET
ST. PAUL, 55101

Agenda

APPLICATIONS OF NASA SATELLITE IMAGERY

November 4, 1975

- 9:30 - 9:45 I. Introductory remarks - Don Yaeger, State Planning Agency
- 9:45 - 11:30 II. "The LANDSAT Program" - Dr. James Taranik, EROS Data Center
- A. History of the LANDSAT (ERTS) Program
- B. What EROS is
- C. Applied Research - The Red River Valley Flood Study
- D. U.S.G.S. Problem Solving Capabilities
- 11:30 - 1:30 LUNCH BREAK
- 1:30 - 2:00 III. LANDSAT Wrap-up and Questions from the Audience
- 2:00 - 3:00 IV. NASA Contracts with the Minnesota State Planning Agency
- A. Background - Pam Streed, State Planning Agency
- B. Researchers - Dr. Dwight Brown, University of Minnesota,
 Department of Geography and Dr. Merle Meyer, University
 of Minnesota, College of Forestry

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ATTENDEES OF REMOTE SENSING MEETING
November 4, 1975
given by
MINNESOTA STATE PLANNING AGENCY
CAPITOL SQUARE BUILDING
ST. PAUL, MINNESOTA

State Planning Agency Staff:

Donald Yaeger
Pamela Streed

Speakers:

Dr. James Taranik, EROS Data Center
Sioux Falls, South Dakota

Dr. Dwight Brown, Researcher
University of Minnesota (Forestry)

Roy Mead, for Dr. Merle Meyer, Researcher
University of Minnesota (Forestry)

Dr. Richard Rust, Researcher
University of Minnesota (Soil Science)

Mr. Joseph Goebel, Researcher
Minnesota Geological Survey

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FEDERAL AGENCIES

U.S.D.A. Soil Conservation Service:

Herbert A. Gottfried Jr.
John Torgerson
Howard C. Midje
Roy E. Bright

U.S.G.S.:

Lowell Guetzkow
Jerry Lindholm
Ralph Lamson

REGIONAL DEVELOPMENT COMMISSIONS

Region 1:

Eugene Abbott, Director

Region 2 - Headwaters:

John Ostrem

Region 5:

Rand Kluegel

Region 7W

Otto Schmid, Director

STATE AGENCIES

MN Department of Agriculture:

Jack Ditmore

MN Department of Natural Resources

Floodplain Management:

Mike Robinson

Forestry:

Chris Olson

Fish & Wildlife:

Rob Naplin

Minerals:

Mike Costello

Parks:

Gene Karel

Planning:	John Poate
Shoreland Management:	Bruce H. Gerbog
	Tom Mathisen
State Climatology:	Earl Kughnast
MN Highway Department:	Dick Kosmalski
Environmental Services:	Dick Toft
	Lee Markell
	Paul Walvatne
	Scott Carlstrom
	H. Agorevos
MN Geological Survey:	Matt Walton, Director
	Joseph Goebel
State Planning Agency:	Joseph Sizer, Director, Environmental Planning
	John Mohr, Assistant Director, Environmental Plann
	Les Maki, Manager, Environmental Information System
	John Malinka, Environmental Program Review
	Enid Cohn Gary, Information Systems
	Ken Pekarek, Power Plant Siting Staff
	Pete Kortright, Power Plant Siting Staff
	Vic Moore, Office of Local and Urban Affairs

UNIVERSITY OF MINNESOTA

Center for Urban and Regional Affairs:	Will Craig
	Alan Robinette
Forestry:	Dr. Merle P. Meyer
	John Merior
	Loyola Caron
	Roy Mead
	Scott Barger
Geography:	Dr. Dwight Brown
	Rob Warwick
Soil Science:	Dr. Richard Rust

OTHER

Consulting Meteorologist:	Bruce Watson
Consultant:	Carol Strong
West Minnesota RC&D	Richard L. Bolli

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Summary of Remarks

LANDSAT 1

On June 30, 1972, the Minnesota State Planning Agency was awarded a NASA investigation contract using LANDSAT 1 (ERTS 1) imagery. The prime objective of the investigation was to determine the usefulness of satellite imagery for monitoring land use and land cover data. In addition, research was to be conducted on various natural resource conditions.

The prime contract administration was done through the Center for Urban and Regional Affairs (CURA), University of Minnesota. Research work was done by the Department of Geography, College of Forestry, Soil Science Department and others at the University.

Three major findings were presented to NASA in the final report of the investigation.

Land Use/Land Cover--Several areas were investigated for land use/land cover data and a four-color map was published for the Twin Cities metropolitan area. This map was prepared in cooperation with the Metropolitan Council.

Wildlife Habitat and Land Cover--Portions of south central Minnesota were investigated for the inter-relationships between wildlife habitat areas and the changing patterns of land cultivation. This investigation was done in cooperation with Minnesota Department of Natural Resources personnel. Of critical importance was the timing and amount of field plowing.

Surface Water Dynamics--In cooperation with the Minnesota Department of Natural Resources and the U.S. Fish and Wildlife Service, investigations were made on detecting and measuring amounts of standing water. These detected water areas were compared with several previous inventories, primarily U.S.G.S. topographic maps and Department of Natural Resources' Water Bulletin #25.

The LANDSAT 1 investigation ended on December 31, 1974.

LANDSAT FOLLOW-ON CONTRACT

Because of the findings in the LANDSAT 1 investigations, the State Planning Agency has received a second NASA contract. The contract calls for two major phases of work: (1) to continue research on selected topics and (2) to provide training sessions for many potential users of the data.

During the research phases, which work primarily with computer tapes of the imagery, resource managers and planners will be continually involved with the various researchers. Research will include continued study of natural phenomenon on selected images, plus attempt will be made to do time series studies. Topics to be studied include: standing water; extent of flooding; moving water; land disturbance (e.g. mining, urban expansion); changes in cultivated land; forest types; geologic investigation, and others.

Extensive training sessions throughout the state, designed to initiate public employees and officials in the uses of satellite imagery will be conducted late in the summer of 1976.

Termination of the contract with NASA will be on December 25, 1976.

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