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16. Abstract

Research continued during this period. The digital analysis of LANDSAT data on magnetic tapes for identifying forest vegetation and for land use classification continued. An inventory and cataloging of LANDSAT data holdings at the University of Minnesota was completed but not printed in final form.

20320

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Figure 2. Technical Report Standard Title Page

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 12/26/75 to 3/25/76. During this time effort continued to be expended in the development of a computer system for analysis of the digitally recorded LANDSAT data.

There were visits to EROS Data Center by several members of this research group, which ranged in scope from use of the Image 100 system to spending a day finding cloud free coverage of the state through the Data Reference Files. In each instance the visit greatly aided work in progress.

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 possibility of giving Region 3 a small grant to help them study the applications was discussed.

A. ACCOMPLISHMENTS

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

Work was continued on a project which began in July, 1975, to evaluate the usefulness of LANDSAT MSS digital data for mapping forest types in northern Minnesota. The work accomplished in the preceding six months on the project can be briefly summarized. First, a study area which included all of Itasca County, Minnesota, was selected and the digitally-recorded LANDSAT data for three scenes (October 7, 1972, May 29, 1973, and July 17, 1974) including this area were ordered. Second, a battery of computer programs for pattern recognition were imported from another University and implemented on the CDC Cyber 70 computer system at the University of Minnesota. Third, several preprocessing operations were performed on the digital data to: (1) reformat the data for compatability with the available computer programs; (2) geometrically correct, deskew, and rescale the data; and (3) temporally register the data for two scenes. Color infrared metric photography at a scale of 1:80,000 was also flown for the study area by another College of Forestry project.

Preliminary "graymaps" were generated for three areas in the vicinity of Bowstring Lake, Ball Club Lake and Tamarack Point. These areas were selected for several reasons: (1) presence of most of the important natural resource types in the entire area; (2) easily located in relation to lakes or other landmarks; and (3) they included large lakes with distinctive shorelines which, especially on the infrared channels, were helpful in evaluating the precision of the scale, geometric corrections and temporal registration. Evaluation of the geometric quality of the processed/corrected data was the first activity performed, utilizing the graymaps produced with the University of Minnesota computer system. It was found that the imagery was "stretched" in the north-south direction due to the line printer density of 6 lines per inch. When the density was changed to 8 lines per inch, the graymaps "matched" the scale of the 1:24,000 U.S.G.S. quad maps and were directly comparable. That is, the height and width of the map was represented by a whole number of lines and columns in the digital data respectively. Furthermore, the lines and columns were oriented in the proper north-south and east-west manner.

The temporally-registered data for the May 29, 1973, and the July 17, 1974, scenes (which were processed at the Jet Propulsion Laboratory, Pasadena, California) were analyzed individually as well as in combination on the GE Image 100 at the EROS Data Center, Sioux Falls, South Dakota. The Image 100 is only capable of utilizing four spectral bands simultaneously, thus various combinations of bands from both dates of imagery were tried. When attempting to display the data from both scenes on the screen, it was apparent that the registration was off approximately 1½ pixels on some areas. The misregistration was most apparent around the edges of lakes. No evaluation of the effect of the misregistration on the classification was performed. However, it was assumed to be negligible for the first-cut classification, and was assumed to be the best possible fit (considering the state-of-the-art for this extremely new technique).

Training sets for various natural resource types were selected from interpretation of the CIR photography and by utilizing cover type maps. Thus, using a supervised approach and a level slice algorithm, the classifications for each class were performed several times using various training sets. The results of these classifications suggested some variability in possible signatures for individual classes. Also, these results illustrated the subjectiveness introduced into the classification through selection of training sets. The final classifications were displayed on the cathode ray tube (CRT) and photographed. Also, graymaps were printed for the classifications as well as being stored on magnetic tape.

Training areas were selected with the aid of forest type maps. However, due to the inconsistency in the classification systems used by different agencies, some field checking was necessary.

Further work this quarter included review of the slides and graymaps produced on the Image 100, establishing data files, and planning work for the next quarter.

Regional Development Commission Projects

Activities during the reporting period have been directed toward two research development needs of regional commissions. The first is the development of cover change mapping procedures to monitor land cover change associated with mining development in the Mesabi Range. The second is development of appropriate methods to carry out a reconnaissance level monitoring process for lake water quality; first in Douglas County and second in the Arrowhead Region. These latter procedures are being developed largely under other support for the Twin Cities area.

The surface cover changes in the Mesabi area are being mapped at 1:24,000 quadrangle scale on an annual basis. A second product, a small scale area map showing 1972-1975 changes is also being developed. The quadrangle scale work is nearly complete except for the 1975 data. This work should all be completed during

the spring, and final products will include 29 quad overlays to be evaluated by Region 3, Department of Natural Resources and United State Geological Survey personnel working in the area.

Quaternary Geology Project

This is the first quarterly report on the progress of compiling a map of the Quaternary deposits of the State of Minnesota based on previous work and the interpretation of LANDSAT imagery.

The purpose of this project is to synthesize previous investigations of the Quaternary geology of the State of Minnesota. A map is to be compiled at a scale of 1:500,000. Furthermore, it will be used as a guide to a more systematic and detailed mapping of the same materials at a scale of 1:250,000. Once the literature has been reviewed and assembled, it is proposed that LANDSAT imagery be used to apply information gained in those areas studied intensively to other areas with few or no investigations to date. The LANDSAT imagery should also assist in the resolution of conflicting interpretation in areas where more than one study has been done.

The first step in the project involved the acquisition of approximately 700 references related to the geology of the unconsolidated deposits of the State. The data gathered from these references were then converted to various overlaps at a scale of 1:500,000 to facilitate comparisons between different sources of information. Special subject maps were compiled including: soils, geomorphic provences, natural vegetation, peat sites, lakes and rivers, topographic contours, two previous statewide surficial geology maps and a map replicating the numerous smaller studies, referenced on an index map.

LANDSAT imagery covering the entire State in three seasons was ordered (see G-Data Use). Early spring coverage at a scale of 1:1,000,000 was selected in a

false color composite to depict "leaf-off" characteristics. This will provide a better understanding of poor drainage and color changes which result from variations in geologic materials. Since the coverage during the spring season was to be the basic interpretive tool, a 1:500,000 scale copy of Band 7 was requested.

False color composite transparencies, scale 1:1,000,000 were selected with "leaf-on" coverage at the time of the year when drought stress would be most noticeable. It was anticipated that this would assist in the selection of sites with coarser textured materials which would be highlighted by drought conditions.

Midwinter, Band 7, black and white transparencies, scale 1:1,000,000 were selected. Due to the high latitude for the State of Minnesota, the sun angle is low during this season. During winter, Minnesota is usually covered with snow. Coupling snow with a low sun angle, a prominent clear shadow is cast emphasizing subtle topography.

It is felt that with the foregoing information available, a reasonably useful interim map can be produced in a relatively short time.

A spinoff of the Quaternary map has been to subdivide peat deposits into categories which assist the understanding of the materials. Interest in the utilization of peat as an energy source is growing rapidly in the State of Minnesota. Thus, it became apparent that this map can contribute specific information of sound programs for the peat resources. It was decided to group peat into at least two or three classes that could be discerned from the LANDSAT images. With this in mind, a peat area was selected and classified on the Image 100 system at the EROS Data Center in Sioux Falls, South Dakota. A bog with three areas differing in their spectral response was selected and subdivided on this basis. Then, the adjoining area was classified on the same basis. This served to train the interpreter who will attempt to identify the characteristics of the subdivisions and also to project the classification onto unclassified photos.

B. PROBLEMS

The development of methodologies for reconnaissance of lake water quality is still hampered by lack of adequate access to a competent computer programmer. Thus far non digital methodologies have shown mixed results. It is now thought that stratifying the inventory by color will possibly make a great improvement in our ability to predict lake water clarity. The water data for the study areas has been assembled and will be utilized just as soon as the digital data processing is evaluated. The final model development and application to at least one test area for one time period should be completed during the spring.

C. SIGNIFICANT RESULTS

There were no significant results at this time.

D. PUBLICATIONS

There were no publications during this period.

E. RECOMMENDATIONS

There are no recommendations at this time.

F. FUNDS EXPENDED

The amount of money expended this quarter was minimal. Invoices were received from our sub-contractors during this quarter, but were processed during April. These figures will appear in next quarter's report. Form 533M, Monthly Financial Report, shows total expenditures through March 31, 1976 to be $5,233.94.

G. DATA USE

During the December, 1975 to March, 1976 quarter, we ordered imagery that would provide statewide coverage for three seasons. One set involved paying for the generation of the false color composites which greatly increased the cost of the imagery.

A small amount of imagery was returned to the EROS Data Center and a $20 credit was given to our account (G-20320) for the imagery.

Quarter	Value of Data Ordered	Value of Data Received
3/25-6/25/75	$ 224.00	$ 56.00
6/29-9/25/75	1374.00	1142.00
9/26-12/25/75	850.00	410.00
(minus credit)	(50.00)	
12/26/75-3/25/76	1994.00	351.00
(minus credit)	(20.00)	

The total value of account G-20320 was $9,711.00 as of 3/31/76 with orders totaling $1,851.00 in process. The total value of the corresponding CCT account (G-B0320) was $3,800.00 as of 3/31/76 with no orders in process.

H. AIRCRAFT DATA

None at this time.

I. PROPOSED WORK FOR NEXT QUARTER

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

Work planned for the next quarter includes the selection of training sets, performing the classifications, and continued field checking; which, includes taking the classifications to the field user-cooperators for review.

Regional Development Commission Projects

Two Regional Development Commissions (3 and 4) have expressed interest in applying LANDSAT products to resource information needs. 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. Also, terms were discussed for making a small grant from the NASA account to Region 3 to assist their evaluation of LANDSAT products.

Quaternary Geology Project

Basically, the program involves completion of the map. This will include an index map of areas which were previously studied. The bibliography of references to the surficial geology of the State of Minnesota will be completed. A map will be compiled with the information from the various areas that have been investigated and mapped. The map will be reviewed by those people available and knowledgeable of the material and the area. It will be drafted in a form ready for copying. A description of the mapping units will be written.

CONCLUSIONS

Work on the Regional Development Commission projects proceeded at the scheduled pace this quarter.

Work on the analysis of digital tapes for forest vegetation analysis proceeded at a much faster pace this quarter since necessary programming help was acquired.

LANDSAT imagery has shown that it will be a useful tool for the compilation of a statewide map of unconsolidated materials. LANDSAT imagery can facilitate the identification and delineation of surficial features such as topography, vegetation changes and the color of geologic materials.