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Quarterly Progress Report

Digital Processing of Landsat MSS and Topographic Data to Improve Capabilities for Computerized Mapping of Forest Cover Types

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Prepared by: Laboratory for Applications of Remote Sensing
Purdue University
West Lafayette, Indiana 47906

Technical Monitor: Dr. D. L. Amsbury
NASA Mail Code SF5
Exploratory Investigations Branch
Houston, Texas 77058

Principal Investigator: Dr. Roger M. Hoffer
Ecosystems Program Leader
LARS/Purdue University
West Lafayette, Indiana 47906

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TABLE OF CONTENTS

I. OVERALL STATUS AND PROGRESS TO DATE

Work during the past quarter centered on preparation of the data for the central Washington test site prior to starting the analysis of the combined Landsat and topographic data set. In addition, a field trip to the area was completed to familiarize LARS personnel with the characteristics of the test site and the cover types present. The report concerning the final results for the Colorado study site was completed and is being reviewed by NASA personnel prior to publication. The fourth major activity during this quarter involved the completion of the study to evaluate the applicability of the P-1 procedure for analysis of the Washington data set.

Although several problems were encountered in obtaining and processing both the Landsat and topographic data for the Washington test site, these problems have been overcome and work is progressing satisfactorily.

IA. Preparation for Analysis of the Washington Test Site Data

As reported in the previous quarterly report, a study site in central Washington was selected for verification of the analysis procedures defined in the Colorado phase of the study. The study site involves a total of 24 townships (8 twps N-S x 3 twps E-W), and is located in the west half of the Okanogan quadrangle.

Since the Washington DNR (Department of Natural Resources) had the Landsat data for this area available in their files, they provided Purdue with a duplicate copy of the data. It was found, however, that the data contained on the tape for this date and frame number did not correspond to the imagery that had been obtained from EROS. The problem was that the data on the tape had been shifted to the north by approximately 600 lines from where it should have been located. The next frame had also been shifted north, but by approximately 350 lines. This created a data gap of 250 lines which included the central portion of the test site. In talking to personnel at the EROS Data Center, it was discovered that such a problem had occurred in a few other situations, and that the Landsat data would have to be re-ordered through the Goddard Space Flight Center. The data was, therefore, ordered again, and the correct frame of Landsat digital data was finally obtained through the EROS Data Center. The data has now been reformatted and geometrically corrected by LARS data processing personnel.

After previous discussion with Washington DNR personnel, and after evaluating the quality of the DMA data in Colorado, it was hoped that a better quality digital topographic data set could be obtained for the Washington test site. Washington DNR personnel checked out various possibilities, and it was determined that digital data from the USGS (which is being produced in conjunction with their orthophoto mapping projects) has been available since 1977. However, since the orthophotos of the Washington test site area had been produced prior to 1977, digital data from this source was not available. It was, therefore, determined that DMA would again be the only data available for the entire test site area. Accordingly, DMA elevation data was ordered for the west half of the Okanogan quadrangle. This was received

by LARS, and it was then found that the format had changed since the time that the Colorado data had been formatted and processed. This required several additional software modifications to the LARSYS programs. The DMA elevation data is again having to be rotated 90^{o}. The selection of check points from the Landsat data and the topographic data set will be completed and the two data sets overlaid during the next quarter.

One of the major activities during this past quarter has involved the programming necessary to handle the Washington GRIDS data. Discussions with the Washington DNR personnel revealed that the GRIDS data tape in their system contained the data points for all DNR land in the western half of the Okanogan quadrangle. This involved some 44,000 GRIDS points whereas the 24 townships of the test site area contained approximately 18,000 GRIDS points. It was also noted that some data points had been updated, so a corrected data file had been added to the original file. Thus, the data set as it currently exists has some GRIDS points entered twice, first with the original data set, and secondly with the updated data file. Therefore, the software had to be revised to check for duplication of the GRIDS files. This and other software modifications and developments for handling the GRIDS data have been completed and the data has been placed in a disc file on the LARS computer. Development of the topographic distribution model using this GRIDS data is expected to be completed during the next quarter.

In addition to developing the software to handle the GRIDS data set, a transformation program had to be developed to convert the Washington State Plane Coordinates to Landsat X-Y Coordinates. The reason for this is that the Washington GRIDS data points are identified using a State Plane Coordinate System, and in order to combine the Landsat spectral data with the GRIDS data set, such a transformation had to be developed. This software is in the process of being generated. Upon completion, a compressed data block containing all the GRIDS data points and the associated Landsat reflectance values, as well as DMA topographic data, and selected GRIDS information will be generated. The GRIDS data also contains topographic data, including aspect to the nearest 10^{o} increment, slope data for slopes from 0-5% and then in 10% increments, and elevation data to the nearest 100 feet. The Topographic Distribution Model will be developed using the GRIDS topographic data. Use of the GRIDS topographic data rather than DMA data will preclude errors in the model due to possible inaccuracies in the Landsat + DMA + GRIDS data overlay.

Detailed plans for the analysis of the spectral/topographic data set have been developed, based upon the results obtained in the Colorado study, and the characteristics of the Washington data set. The procedures defined will be as follows:

1. The Topographic Distribution Model will be generated using cover type and topographic data contained in the GRIDS data set. In developing the model, the GRIDS data set will not be divided into quadrangles for purposes of stratifying to define the training and test data. Rather the entire set of 18,000 GRIDS data points in the test site will be stratified on the basis of topographic position and a random sample from each strata will be selected for the development of the Topographic Distribution Model. A

sample of the remaining data points will be defined as test pixels and used for evaluating the classification results.

2. Classification of the data will involve use of only the Layered classification approach. However, two different techniques will be used in developing spectral training statistics, and classifications will be run with different combinations of topographic data (i.e., none, elevation, all). These are outlined in Table 1 below. Classifications 1, 2 and 3 will involve the Multi-Cluster Blocks approach for developing spectral training statistics and the Topographic Stratified Random Sample approach using DMA topographic data for the topographic training statistics. Classification 1 will be based upon spectral data only, and therefore will again be limited to a Level II or Major Cover Type classification. Classification 2 will involve spectral data plus elevation data, and Classification 3 will use spectral data and topographic data (elevation, aspect and slope). Classifications 4, 5 and 6 will be based upon a supervised GRIDS data set for the spectral training data but will use a layered classification approach in which the first layer will involve only the spectral data and the second layer will use topographic data based upon the Topographic Stratified Random Sample. Classification 4 will involve spectral data only but at a Level III (Individual Forest Cover Type) degree of detail. Classification 5 will involve spectral data plus elevation, and Classification 6 will involve spectral plus topographic data. It is anticipated that the development of the spectral training statistics in the classifications will be carried out in conjunction with personnel from the Washington DNR, who will come to Purdue for this phase of the analysis in order to become more familiar with our analysis procedures and to assist in obtaining the best possible output product.

IB. Field Trip to the Washington Test Site

To familiarize LARS personnel with the Washington test site, a field trip to the area was conducted during the period June 11-15. Roger Hoffer and Mike Fleming from Purdue traveled to Olympia, and on Monday, June 11, met with Washington DNR personnel, including Roger Harding, Bob Scott, Tim Gregg, Larry Sugarbaker, Eric Barthmaier, and Bob Aulds. The morning was spent in a general review of the project and discussing problems that had or that could occur in working with Landsat, DMA, or GRIDS data sets. In the afternoon, Gregg, Sugarbaker, Barthmaier, Aulds, Fleming and Hoffer all flew to Omak, Washington. Before landing at the Omak airport, we flew over the test site and obtained a good introductory familiarization with the area. On Tuesday, John Calhoun, District Manager, spent the day providing on-the-ground familiarization with the test site, a review of forest management objectives, and the practices used for managing the various cover type groups, as well as discussing forest inventory requirements in this area. On Wednesday, Bob Aulds provided an in-depth review of the GRIDS field procedures, including such items as their photo-interpretation practices, field measurements, coding procedures, methods for locating GRID points in the field in relation to the aerial photos, and use of the GRIDS data. We also

Table 1. Classification Sequence for the Washington Test Site[1/]

Data to Be Used	Spectral Training Statistics Obtained Using:[2/] Multi-Cluster Blocks	GRIDS Data Points
Spectral Data Only	1 (Level II)	4 (Level III)
Spectral + Elevation	2	5
Spectral + Topographic (Elevation, Slope, and Aspect)	3	6

[1/] All classifications will use the Layered classification procedure to combine topographic and spectral data in the analysis sequence.

[2/] Topographic training statistics will be based upon the Topographic Stratified Random Sample technique.

reviewed the Washington DNR procedure for permanent plot inventory. This work was continued on Thursday and special problems of concern (such as primary species codes 94 and 95) were examined. In the afternoon, the group returned to Olympia. Hoffer reviewed the progress of the week with Harding and Scott, and then returned home on Friday. Fleming remained in Olympia all day Friday to go over some of the details of the analysis procedures with Gregg, Sugarbaker,and Barthmaier.

The entire week's activities were extremely beneficial. As Principal Investigator in the project, Hoffer expressed particular gratitude and appreciation for the effort put forth by the Washington DNR personnel in arranging for the field trip and providing such a thorough in-depth review of their procedures in obtaining field data, as well as the insight concerning their forest management practices, and the familiarization with the characteristics of the test site area.

It is clear that this area is very different in many respects from the western Washington region. In central Washington they do not follow clear-cutting practices but use an uneven-aged management system. Intensive management in this area has also caused many of the species to occur over a wide range of elevations -- a wider range than would probably be the case under

purely natural conditions of occurrence. In some of these respects, it is anticipated that this test site will be more difficult to work with than was the case in Colorado.

IC. Technical Report on the Colorado Study of Landsat + Topographic Data

The report concerning the final results of the spectral/topographic data analysis for the Colorado test site has been completed and is in the process of being reviewed by the Technical Monitor for the contract at NASA/JSC. Upon completion of this review, revisions will be made, as necessary, in the report and it will be duplicated and distributed. This will be completed during the next quarter.

ID. Evaluation of the P-1 Procedure for Potential Application to the Washington GRIDS Data

As indicated in the last quarterly report, a study was undertaken to evaluate the use of P-1 for possible application to the Washington GRIDS data set. This study was completed by Ross Nelson as part of the requirements for his Master's Degree in Forestry. The study basically involved two phases. First, a parameter study was conducted to determine which parameters could best be used with the P-1 analysis procedure when applied to a forested area. The results of the parameter study were then applied to another area in the Colorado test site region and a series of classifications were carried out comparing P-1 and the Multi-Cluster Blocks approach. A number of key results were achieved which can be summarized as follows:

1. P-1 parameters which may be effective for one study site cannot be applied without modification to another area, even though the distance between the two sites is not large and the cover type characteristics of the area do not appear to be very different (i.e., the signature extension problem).

2. Classification results revealed that the Multi-Cluster Blocks approach and the P-1 Procedure both gave maximum classification performance among the six methods tried. Furthermore, there was no statistically significant difference between the Multi-Cluster Blocks and the P-1 Procedure when an unseeded iterative analysis sequence was used.

We therefore conclude that the P-1 approach would be appropriate for the Washington data set, provided the geometric fidelity of the data is accurate enough. This will be evaluated during the initial phases of the Washington analysis sequence.

II. PROBLEMS ENCOUNTERED

As indicated in Section IA above, a number of problems were encountered in obtaining and reformatting all three data sets with which we are working, i.e., the Landsat data, the DMA data, and the GRIDS data. To work with both the DMA and the GRIDS data, software has had to be developed or revised in order to effectively process the data set. Nearly all of these software modifications have been completed and the work is progressing very close to schedule in spite of the delays encountered in obtaining the data and reformatting it. No major problems are anticipated during the next quarter.

III. PERSONNEL STATUS

The personnel actively involved in this project during this reporting period (April 16, 1979-July 15, 1979) were as follows (average percentage of time over the three months):

Dr. V. Anderson	6%
Dr. L. Bartolucci	25%
R. Crosley	21%
S. Davis	15%
M. Fleming	96%
Dr. R. Hoffer	50%
N. Kline	4%
Dr. D. Landgrebe	3%
R. Latty	13%
R. Nelson	50%
Dr. J. Peterson	4%
B. Prather	23%

IV. EXPECTED ACCOMPLISHMENTS

During the next quarter, it is anticipated that (a) the final report on the analysis of the Colorado data will be published, (b) Washington DNR personnel will visit Purdue/LARS to assist in the developing of training statistics and analysis of the Washington data set, (c) final classification will be completed on the Washington data, and (d) the results of the P-1 study will be submitted to NASA/JSC for review and approval for publication as a technical report.