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MAPPING OF AGRICULTURAL LAND USE FROM ERTS-1 DIGITAL DATA

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ABSTRACT

A study area was selected in Lancaster and Lebanon Counties, two of the major agricultural counties in Pennsylvania. This area was delineated on positive transparencies on MSS data collected on October 11, 1972 (1080-15185). Channel seven was used to delineate general land forms, drainage patterns, water and urban areas. Channel five was used to delineate highway networks. These identifiable features were useful aids for locating areas on the computer output.

Computer generated maps were used to delineate broad land use categories, such as forest land, agricultural land, urban areas and water. These digital maps have a scale of approximately 1:24,000 thereby allowing direct comparison with U.S.G.S. 7.5 minute quadrangle sheets.

Aircraft data were used as a form of ground truth useful for the delineation of land use patterns.

I. INTRODUCTION

An area approximately 300,000 acres in size was selected for analysis within Lancaster and Lebanon Counties in southeastern Pennsylvania. This area was selected because it is one of the most important agricultural areas in Pennsylvania with a wide variety of agricultural land use. The agricultural fields are small, variable in shape, and have diverse cropping systems. Therefore, this area, with one of the most complicated agricultural land use patterns in the United States, was deemed a suitable test site to determine the abiltiy of ERTS multispectral digital data for automatic computer mapping.

II. PROCEDURES

Imagery collected on October 11, 1972 (1080-15185) was selected for analysis. Optimum conditions for the study of agricultural land use do not exist in the fall, with most of the crops harvested and the fields often littered with crop residues. However, this was one of the first good images of the area suitable for computer analysis. Three days prior to data gathering, approximately one inch of rain was recorded and the first frost of the fall occurred on the night before the ERTS pass.

Positive transparencies were overlaid on a 1:1,000,000 scale map to locate Lancaster, Denver, Blue Ball and Lititz, Pennsylvania, on the imagery. The test site was selected using the positive transparencies and subsets were made of the NASA digital tapes. Remotely sensed units, as delineated by line and element number, were related to geographic location by means of a computer generated brightness map (1). In the computer program used to generate this map a symbol is chosen for a selected brightness range within an individual channel or for all four channels simultaneously.

A 35 mm slide of the geology of the area was projected onto the digital brightness map to relate geology to brightness patterns.

The digital data was classified using both supervised and unsupervised classifiers. The supervised classifier approach involves the use of two programs, STATS and DCLASS (1). STATS develops a variety of basic statistical values and determines signatures of selected training areas. Training areas can be irregular polygons or straight lines. A single signature can also be developed from a number of discontinuous areas. DCLASS is a mapping program that utilizes signatures developed in STATS as input. Output consists of a digital map of the selected area and/or a table of Euclidean distance between the inputed signatures. The unsupervised classifier (DCLUS) will randomly select up to 900 points and form up to 10 separable categories with a minimum critical Euclidean distance between categories chosen by the user (2.). Output is in the form of a map of the area, a table of the spectral signatures of the categories, and a table indicating the Euclidean distance between the formed categories.

III. RESULTS

Highway networks, urban areas and vegetative patterns were delineated on positive transparencies. These features were useful for relating line and element numbers to geographic area. Transparencies were also used to locate possible target areas for computer analysis.

An area representing approximately 6 percent of an ERTS image (500 lines by 585 elements) was subset from the original NASA tape. Computer generated brightness maps, using either individual channels or a combination of channels, of selected target areas were visually related to the transparencies by pattern association.

Sandstone ridges, limestone valleys, drainage patterns and some cultural features were determined from the brightness map. The ridge and valley patterns were visually related to geology maps and U.S.G.S. 7.5 minute quadrangle sheets. Bright areas were associated with bare fields and quarries and a dull area was associated with a swampy area.

For classification purposes, an area 100 lines by 240 elements in size was selected. Using an image size of 100 by 100 nautical miles, the computer output has an approximate scale of 1:18,000 across the lines and 1:22,000 down the lines. Each remotely sensed unit is approximately

1.2 acres in size.

Training areas were selected from the brightness maps in conjunction with uniformity maps. These signatures were used to map areas using a supervised classifier (DCLASS). Results of this mapping were inconclusive because of lack of any recognizable patterns. This was probably a result of using too short an Euclidean distance or the signatures were of unique features that were unidentifiable without adequate ground truth.

Because of the problems encountered with supervised classification, the data was next analyzed with an unsupervised classifier (DCLUS). Five widely separated categories were delineated using the unsupervised classifier. The first two categories were related to the forested sandstone ridges. The areas delineated agreed very closely with the vegetated areas indicated on the U.S.G.S. 7.5 minute quadrangle sheets. The third category corresponded to various bodies of water such as swamps, farm ponds and streams. The last two categories occurred in cultivated areas with one category having a high response in channels five and six and was tentatively assigned as bare soil areas. The other category in the cultivated areas was considered to be dead vegetation. Some areas did not fall into any of these categories and they were not classified.

After initial separation of these widely separated categories, additional classification within some of these categories were made using DCLUS. The water signature was further subdivided into three categories, namely, "clean water," "dirty water," and "vegetated water." Within the forested and cultivated categories many additional subcategories were delineated. At present, their identification is pending additional ground truth collection.

Various other special features were also identified. Using a known limestone quarry as a target area, three signatures were found that would adequately map quarries. Areas that were not quarries were also delineated. Some of these appear to be limestone covered parking areas.

The town of Denver was also used as a target area in an attempt to develop a signature for small communities. This was successful to only a limited extent probably due to the fact that a large percentage of Denver is vegetated.

Efforts were also made to develop signatures to map individual agricultural fields. This has been generally unsuccessful due to the small fields (generally less than five acres), most of which are on the contour and the wide variety of agricultural practices.

This study has been greatly facilitated by the aircraft program. Land use patterns on the aircraft data were related to the computer output. The aircraft data has been very useful as an interpretive aid.

IV. CONCLUSIONS

The use of ERTS digital data for the automatic mapping of land use appears very feasible. Forest land, cultivated land and water were classified within a 25,000 acre area. Additional classifications were also made within these categories and their identification is pending confirmation with ground truth.

The Pennsylvania State University programs for analyzing remote sensing

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are capable of high speed operation. For example, a single run for any of the classifier programs generally takes less than 15 seconds for a 25,000 acre area and a turn around time of less than ten minutes on a remote job terminal.

The results reported here are those of a pilot study to evaluate automatic classification of the digital data. These results were obtained over a one month investigative period. It is anticipated that improvement in results will be obtained with additional study.

V. REFERENCES

1. Borden, F. Yates. 1972. A digital processing and analysis system for multispectral scanner and similar data. Remote Sensing of Earth Resources, Vol.I. The University of Tennessee, Tullahoma, Tennessee. p.481-507.
2. Turner, Brian J. 1972. Cluster analysis of multispectral scanner remote sensor data. Remote Sensing of Earth Resources, Vol. I. The University of Tennessee, Tullahoma, Tennessee. p.538-548.