CR-136170

Bi-Monthly Progress Report

Period: September 1 thru October 31, 1973

A. Title of Investigation: A Study of the Utilization of ERTS-1 Data from the Wabash River Basin

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C. Problems

Small agricultural field sizes and difficulty of locating fields in ERTS data continues to be a problem; however, rotated and geometrically corrected data has made the problems much less severe. LARS capability to correct and rotate CCT data was reported in previous reports.

D. Accomplishments

Crop Species Identification: ERTS MSS CCT data from an area in Southeast Idaho near Pocatello taken on August 26, 1972 is being analyzed for several agricultural crops using ground truth supplied by the Statistical Reporting Service of the U.S.D.A.. The availability of ground truth from the SRS dictated use of this area since crop recognition experiments cannot be conducted without it. No results are available from this work. A crop recognition experiment has been started in the SRS Northwest Crop Reporting District of Indiana utilizing August 1973 ERTS MSS CCT data. Ground truth is being collected by LARS personnel and analysis will begin by December 1973.

Mapping of Soil Associations: Soil association classifications of ERTS MSS CCT data were extensively studied to compare the results with existing soil maps. Color digital display images of classification results color coded for the various soil associations were enlarged to match the scale of soil association maps traced on transparencies. These products are being used in the evaluation process. The MSS CCT data used to make the classification images was geometrically corrected at LARS to have a uniform scale in each direction and rotated to a top North orientation. Some of this work was reported at the 1973 Annual Meeting of the American Society of Agronomy in Las Vegas, Nevada November 11, 1973.

Earth Surface Features Identification: Development of the methods reported in the June 1973 Type II report for comparing ERTS MSS

data classification results and ground truth data base information continues. Fair performance (75% agreement) of the forest classification comparison led to work to improve the quality of both the ERTS and ground truth data base classifications. A temporal overlay of MSS data was generated for data from September 30, 1972 and June 9, 1973 and this 8 channel data set was used to reclassify forest in the Tippecanoe County test site and visual checking against topographic maps indicated great improvement in accuracy. The overlayed ERTS data was geometrically corrected and rotated to North and reproduced at a 1:24000 scale. This enabled 1 to 1 comparison of the classification results with 1:24000 topo maps. Also, 60,000 feet altitude color IR photography was enlarged to 1:24000 scale and used to further evaluate the ERTS classification results. No results are yet available.

Water Resources Research: Both ERTS MSS data and ERIM multispectral aircraft scanner underflight data has been analyzed for Indiana test sites. A discussion of these efforts is presented here.

ERTS-1 MSS Data Analysis

Spectral Classes of Water in Lake Shafer and Freeman: ERTS-1 MSS data collected over Northern Indiana on May 4, 1973 were analyzed. Six spectral categories were defined by the non-supervised classifier (*CLUSTER) and later used as training classes for the supervised classifier (*CLASSIFYPOINTS). The six spectral classes correspond to:

(1) Lake Shafer water
(2) Lake Freeman water
(3) Banks (edge of water bodies)
(4) Crops
(5) Forest
(6) Soils

The spectral characteristics of the waters from Lake Shafer and Lake Freeman are very similar, as indicated by a separability or divergence value of 146 between these two water bodies. This is a very low value of separability, and we therefore have concluded that the waters of both lakes have spectral responses that are too similar and should be defined as a single spectral class.

In order to improve the acreage estimates of surface water, a spectral class was introduced as "banks" (edge of water bodies). A significant improvement in acreage estimates was observed when the "banks class" was counted as water. This

result is illustrated in Table I.

TABLE I

	Acreage Estimate from ERTS-1	1971 USGS[1] Data	% Error between Estimate & Data
One water class	1108 acres	1547 acres	28% underestimated
Water class + Banks class	1488 acres	1547 acres	4% underestimated

However, the very wet soils of the area were misclassified as banks (shortly before the spacecraft passed overhead, it had rained). Therefore, the original Banks spectral class (edges of water bodies) was subdivided into an Edge class and a water-plus-soils class. Thus, the final classification contained the following spectral classes:

(1) Lake Water
(2) Water Edge
(3) Water plus Soils
(4) Crops
(5) Forest
(6) Bare Soils

ERTS-1 MSS Data Analysis

Spectral Classes of Water in Lake Freeman: Multispectral scanner data was gathered in 12 bands by the ERIM scanner system over Lake Freeman approximately an hour after the ERTS-1 overpass on May 4, 1973. These data were collected at 10,000 feet altitude.

Procedures: The aircraft scanner data were classified using training fields selected on the basis of photointerpretation of color, color IR and B & W photography taken simultaneously

[1] For several years records of the water-surface elevations of many of the lakes in Indiana have been collected by the Geological Survey under cooperative agreement with the Indiana Department of Natural Resources. Surface area (in acres) of the lakes is that surface area at the established level, where, the established level is that elevation set by the courts to which the average level of the lakes is to be held; it is normally set at about the average level that has prevailed for a number of years prior to the establishment of the level.

with the scanner data. The set of training fields include forests, crops, and soils. However, in order to define water spectral classes, it was necessary to perform a nonsupervised classification of just water. Thus, 7 separable spectral categories of water were defined.

Discussion: It should be noted that the 7 spectral classes of water in Lake Freeman have an unusual spectral response, that is, in every reflective channel the 7 classes of water have a response that ranges from high to low; they don't show a complicated signature as a function of wavelength band. However, it is interesting to note that this is not the case with the thermal band (9.3-11.7μm), in fact, there seems to be no difference in radiant temperatures between the 7 categories of water.

The result of the classification shows a particular spatial distribution of the 7 classes of water. It was noted that the classes of water were distributed from E-W showing the brightest classes at the East side of the lake and the darkest on the West side. This pattern is unlikely due to either water depth or water quality. A close inspection of the photography taken simultaneously with the scanner data showed that the glare (specular reflection) due to the surface roughness had an intensity distribution similar to the pattern shown in the classification. This suggests that the 7 spectral classes of water defined by the cluster algorithm define different intensities of specular reflection, which are a function of the "scanner look angle". However, in channel 12 (9.3-11.7) or thermal band the same scan line does not show any changes as a function of scanner look angle; thus, suggesting that the scanner look angle effect is important in the reflective wavelengths, especially in the visible region of the spectrum, less important in the near infrared, and it does not affect the thermal response.

In summary, when strong winds are blowing over water bodies, the effects of the specular reflection from the water wavelets as a function of the scanner look angle override any other spectral characteristic of the water bodies that might be due to either depth or water quality.

Urban Features Identification: The classification of features in Marion County, Indiana described in the June 1973 Type II Report was refined and a quantitative evaluation of accuracy was obtained. A sampling method was employed in which small test plots were chosen and visually evaluated for agreement with ground truth maps and photos. Overall classification accuracy for eight categories (commerce/industry, single-family (newer) residential, woodland, water, cloud, cloud shadow, multi-family (older) residential, and grassy) was 87.1%. This work was reported at the Purdue Conference

on Machine Processing of Remotely Sensed Data, October 16-18, 1973.

Technology Development Tasks

Analysis Technique Development: Work on the use of context for classification of objects in multispectral images was completed and documented. This work was presented at the 1973 telecommunications Conference November 1973 and at the Purdue Conference cited above. Work on layered classifier and adaptive classification continues.

Reformatting and Temporal Overlay: During the period 44 frames of ERTS CCT data were reformatted and temporal overlay of subframe pairs and geometric correction operations continued. No problems were encountered.

E. Significant Results

In soil association mapping, computerized analysis of ERTS MSS data has yielded images which will prove useful in the ongoing Cooperative Soil Survey program, involving the Soil Conservation Service of USDA and other state and local agencies. In the present mode of operation, a soil survey for a county may take up to 5 years to be completed. Results indicate that a great deal of soils information can be extracted from ERTS data by computer analysis. This information is expected to be very valuable in the premapping conference phase of a soil survey for a county, resulting in more efficient field operations during the actual mapping. It is expected to result in greater accuracy of mapping and decrease the time required to produce the soil survey.

In the earth surface features mapping effort it was found that temporal data improved the classification accuracy of forest classification in Tippecanoe County, Indiana.

In water resources study a severe scanner look angle effect was observed in the aircraft scanner data of a test lake which was not present in ERTS data of the same site. This effect was greatly accentuated by surface roughness caused by strong winds.

Quantitative evaluation of urban features classification in ERTS data was obtained. An 87.1% test accuracy was obtained for eight categories in Marion County, Indiana.

F. Publications

Several reports of work done were made at conferences. The texts for these reports will be forwarded for approval to be released to the public as soon as finish copies are available. The titles of the reports are:

1. "Extraction of Classification of Objects in Multi-spectral Images", T. V. Robertson.

2. "Mapping of Soil Characteristics by Computer Analysis of ERTS MSS Imagery", J. E. Cipra, D. P. Franzmeier, G. C. Steinhardt.

3. "Comparison of Indiana Soil Associations and Earth Resources Technology Satellite Imagery", G. C. Steinhardt, D. P. Franzmeier, J. E. Cipra.

4. "Mapping Soil Associations using ERTS MSS Data", J. E. Cipra.

5. "Land Use Classification of Marion County, Indiana by Spectral Analysis of Digitized Satellite Data", M. F. Baumgardner, W. J. Todd.

6. "Urban Land Use Identification in the Gary-Hammond Area by Computer Analysis of Multispectral Satellite Data", W. J. Todd.

G. Plans for Next Period

The November-December period will be spent refining results and preparing documents and illustrations for the ERTS reviews in November and December 10-14, 1973.

H. Other

No image descriptor forms were completed.