LARS Information Note 111774

Computer Analysis of ERTS-1 Imagery and Mapping of Surficial Deposits in a Test Area Within the Monticello North Quadrangle, Ind.

B. A. Follestad

The Laboratory for Applications of Remote Sensing

Purdue University, West Lafayette, Indiana

1974

LARS Information Note 111774

COMPUTER ANALYSIS OF ERTS-1 IMAGERY AND MAPPING OF SURFICIAL DEPOSITS IN A TEST AREA WITHIN THE MONTICELLO NORTH QUADRANGLE, INDIANA, USA.

by

Bjørn Andreas Follestad*

Laboratory for Applications of Remote Sensing,
Purdue University, West Lafayette, Indiana, USA.

*The Norwegian Geological Survey
Postbox 3006, N-7001 Trondheim,
Norway.

Abstract

Surficial deposits with and without vegetative canopies have been mapped using automatic data processing techniques developed at LARS on ERTS-1 multispectral data. Due to the reflectance patterns in an area covered by vegetation the resulting map suggests details that cannot be obtained by conventional air photointerpretation of color IR (scale 1:120,000) photography. In addition different scales of reproduction of ERTS-1 data maps are also discussed.

This study was sponsored by the Norwegian Geological Survey and the Royal Norwegian Council for Scientific and Industrial Research. Computer time used in the analysis was provided by NASA, Contract No. NAS914016.

Fig. 1. Location map. The arrow shows the Monticello north quadrangle area in the state of Indiana.

Introduction

The pattern of the surficial deposits in a test area of the Monticello north quadrangle (Fig. 1) has been analyzed by the use of multispectral scanner data collected by ERTS-1 (LARS Run 73033710; June 9, 1973) for the purposes of:

1. Comparing the automatic data processing techniques of LARS with traditional air-photointerpretation methods used in mapping.
2. Evaluation of the resolution of ERTS-1 data for mapping at various scales.

Data Processing

The LARSYS software system is a package of computer programs which has been designed for the analysis of remotely sensed multispectral data (Landgrebe, 1974). The advantage of this system is that it enables an analyst to undertake problems involving quantities of data too large to be efficiently interpreted by regular photointerpretation techniques. As with the standard methods for photointerpretation, the automatic recognition of patterns requires development of training areas. These training areas can either be obtained through field studies, former mapping/field descriptions or through contemporary photointerpretation.

Otherwise, the function of the automatic classifying system of LARS is quite different from conventional photointerpretation (Cardillo and Landgrebe, 1966). The automatic recognition of patterns is based on a statistical evaluation of reflected energy in the electromagnetic field. In the LARS system, the analyst instructs the computer to analyze the magnitude and variance of the spectral responses of the material identified in the training areas and then to identify all areas in the rest of the scene with similar signatures.

Four channels of digital MSS data were analyzed [channel 4 (0.5 - 0.6 μm), channel 5 (0.6 - 0.7 μm), channel 6 (0.7 - 0.8 μm)

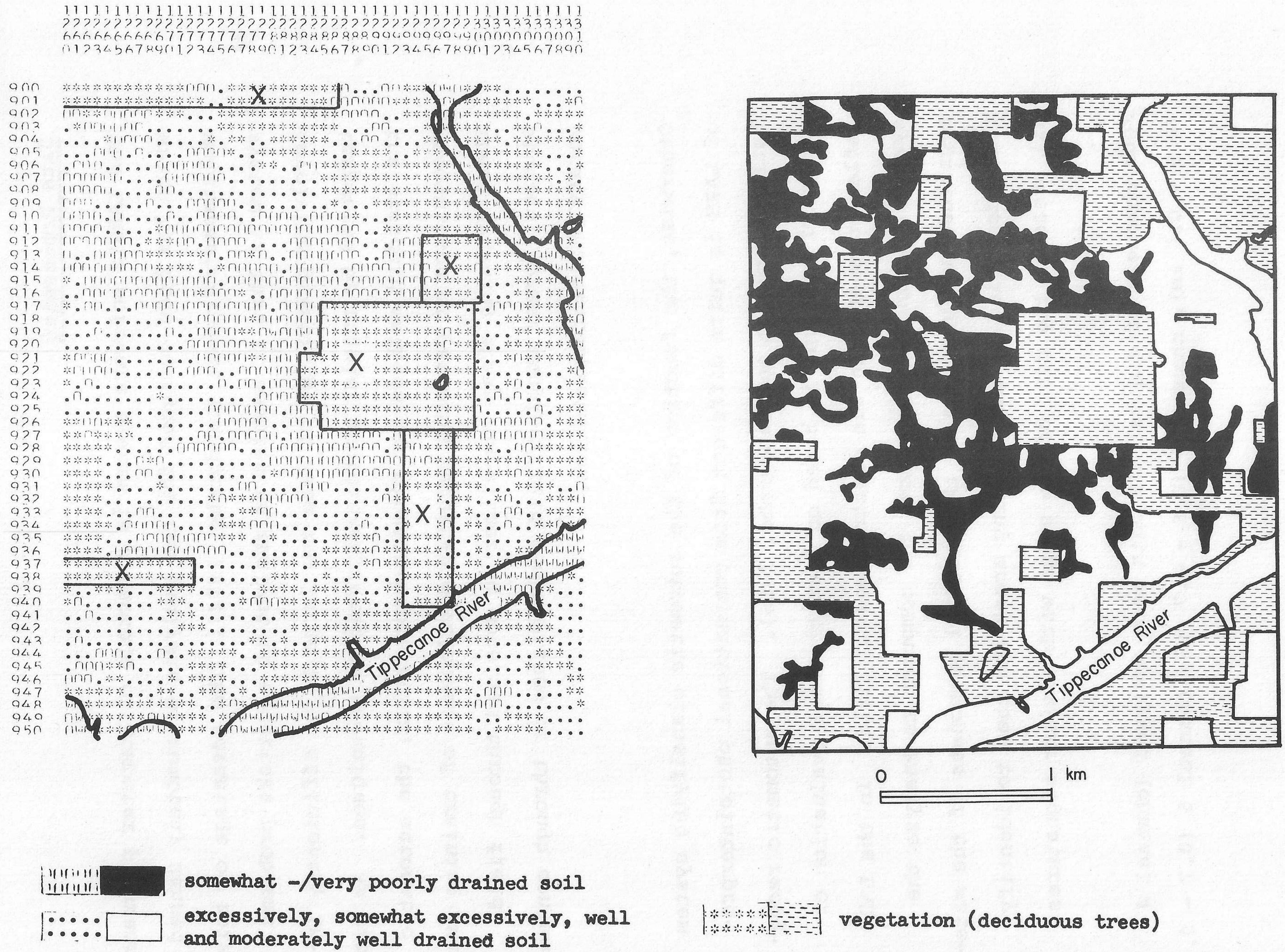
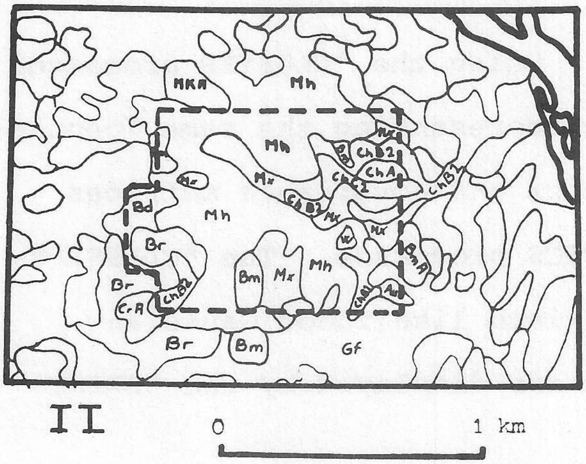


Fig. 2. Comparison of initial computer map (left) and photo-interpretation map. Outlined areas in the computer map (X) are reprocessed through the cluster processor and the results displayed in Fig. 3 and Fig. 4.

and channel 7 (0.8 - 1.1 μm)]. Using the *CLUSTER processor of LARSYS (Swain, 1972), units representing the same "populations" are grouped. Mean vectors and covariance matrices are calculated by the *STATISTICS processor. The *CLASSIFY-POINTS processor performs a maximum likelihood Gaussian classification and the results are displayed by the *PRINT-RESULTS processor.

Discussion of the Results

As shown in Fig. 2 the computer processed map and the map constructed by the use of the ordinary methods of photo-interpretation are similar. In both cases the same marked rectangular feature is seen in the central parts of the maps. This feature represents an area of deciduous trees. Neither the methods used in traditional air-photointerpretation nor the (first) automatic data processing could detect any reflectance patterns due to the underlying surficial deposits. However, different types of deciduous trees may reflect different characteristics in the various surficial deposits (Hoffer and Johannsen, 1969; Kristof, 1970). The surrounding areas of somewhat poorly and very poorly drained soils (Baumgardner, et al., 1970; Kristof and Zachary, 1971) indicate that these soils also appear inside this area. For the purpose of solving this problem, the rectangular area (line 917-926; column 1285-1298 and line 921-924; column 1284-1285 in Fig. 2) was repro-



II

Soil: **Drainage:**

		excessively	somewhat excessi.	well	moderately well	somewhat poorly	very poorly
Au:	Aubbeenaubee fsl					X	
Bd:	Brady fsl					X	
Br:	Brookston cl						X
Bm:	Brems lfs				X		
BmA:	Brems lfs				X		
CrA:	Crosier l					X	
ChC2:	Chelsea fs	X					
ChB2:	Chelsea fs	X					
Gf:	Gilford fsl						X
MkA:	Metea lfs			X			
Mh:	Maumee lfs						X
Mx:	Morocco lfs					X	
W:	Water						

```
          111111111111111
          222222222222222
          888889999999999
          567890123456789

917       FCCCCCCDCCCBBDA
918       FCCCBBCCBBCDDDA
919       FDCCCCCCCCDFFDA
920       FDCCCCCCCCCCFDA
921     FDCCCCCCCCCCCCCCD
922     FCBBBBCCCCCBCCCCD
923     FCBBBBCCCCBBBFCCA
924     DCCBBBDDDCBCBBBBD
925       FDBBDDDBBBCCCBD
926       FABBBDDCCCCCBDF
```

I

0 1km

Number of points per cluster:

Cluster	1	2	3	4	5
Symbol	A	B	C	D	F
Points	6	36	75	27	14

Cluster points means

		CH(1)	CH(2)	CH(3)	CH(4)
1	6	38.83	39.50	51.33	25.67
2	36	27.94	17.83	56.75	32.94
3	75	26.43	16.63	50.81	30.69
4	27	31.37	23.04	48.52	26.70
5	14	31.07	26.07	36.00	18.57

Cluster variances :

	CH(1)	CH(2)	CH(3)	CH(4)
1	11.77	37.50	7.47	6.27
2	2.63	3.86	3.22	2.68
3	1.33	1.70	5.24	3.49
4	4.47	8.35	10.26	4.91
5	7.61	23.46	23.69	11.19

Separability information:

I	J	D(I,J)	D(I)	D(J)	D(J)+D(I)	QUOT
1	2	25.891	10.724	4.533	15.257	.697
1	3	26.508	11.643	3.126	14.769	1.795
1	4	18.323	12.357	6.623	18.980	0.965
1	5	22.935	7.990	10.252	18.242	1.257
2	3	6.639	4.333	4.954	9.287	0.715
2	4	12.063	4.308	6.541	10.850	1.112
2	5	26.736	4.300	10.251	14.550	1.837
3	4	9.312	3.286	6.065	9.352	0.996
3	5	21.844	4.328	9.930	14.258	1.532
4	5	15.236	6.829	10.379	17.208	0.885

Fig. 3 - I. Reclustered area (line 917-926, column 1285-1298; line 912-924, column 1284).
II. Present soil map.

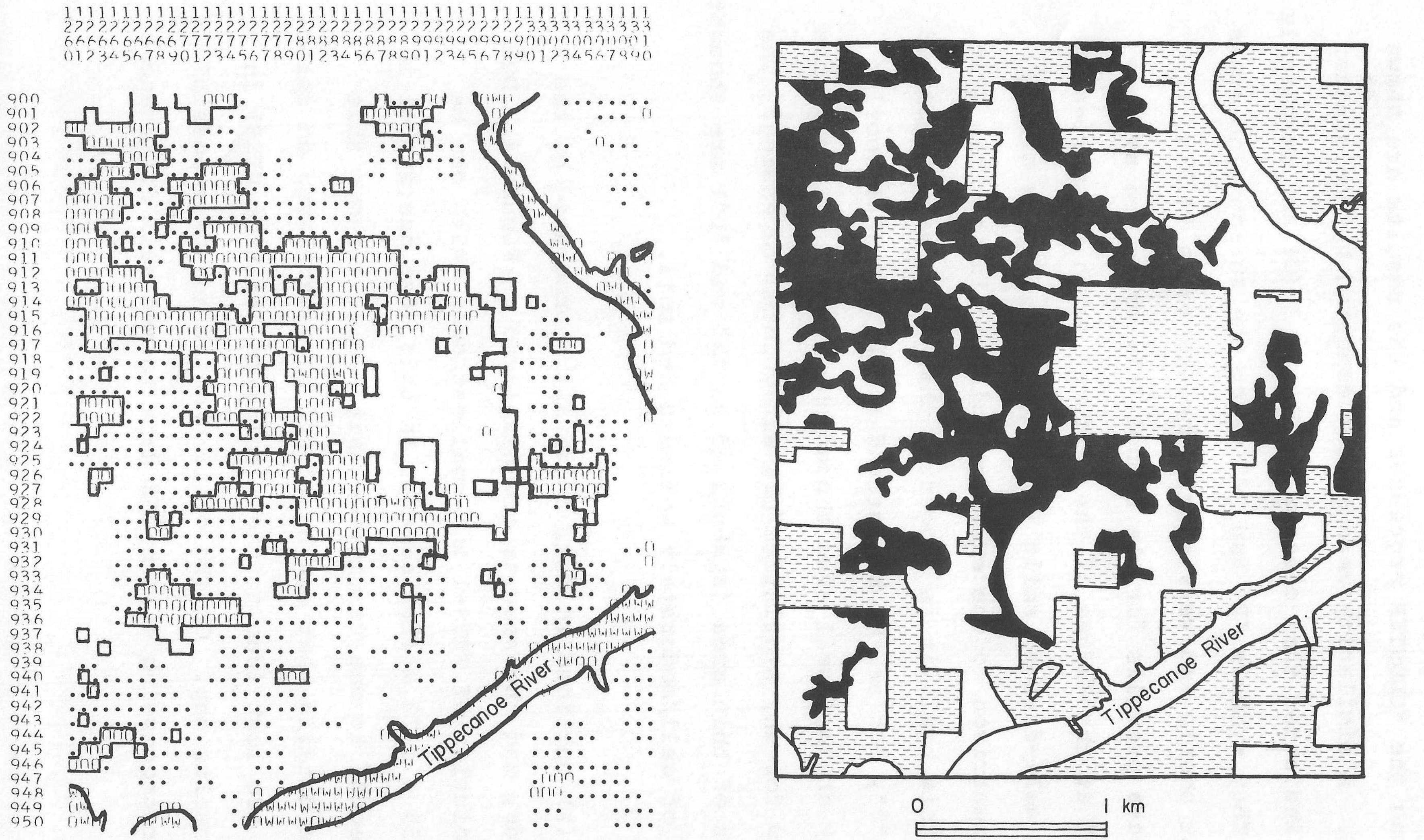
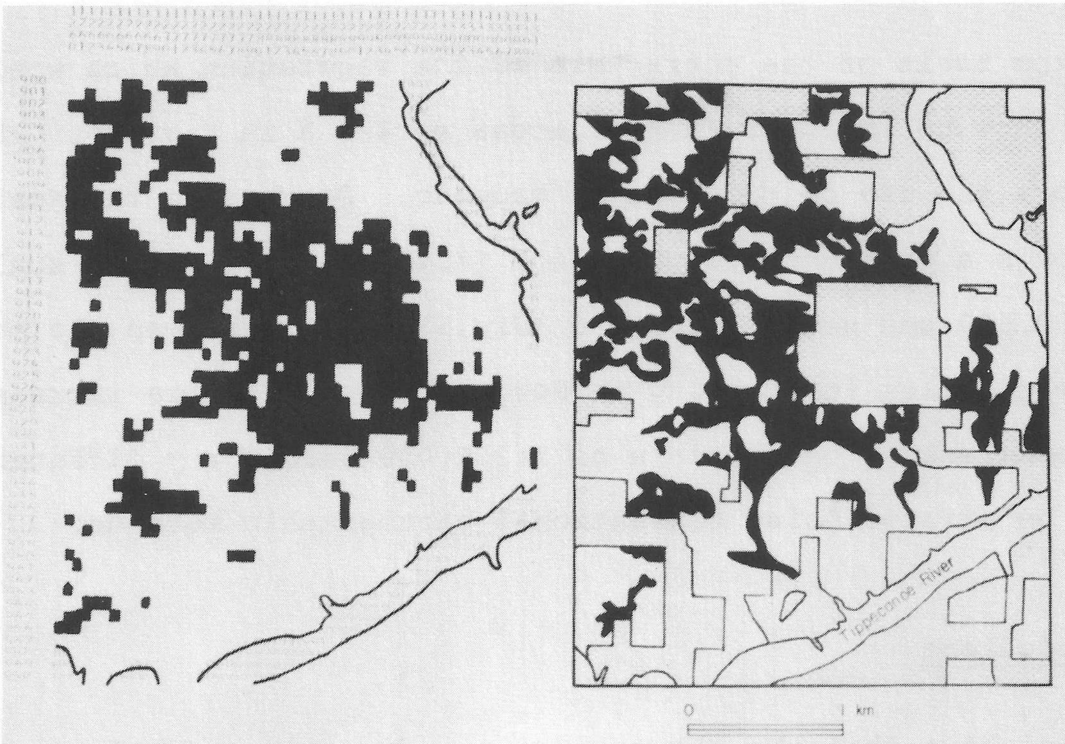


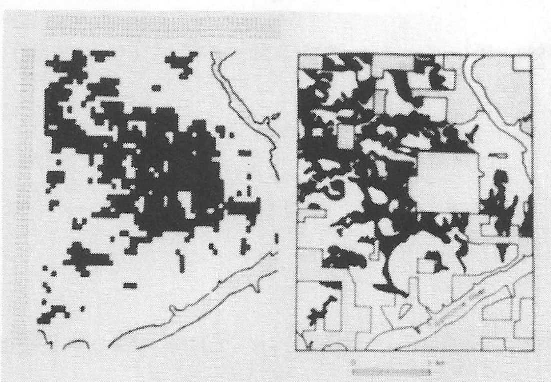
Fig. 4. Comparison of the final computer map and photointerpretation map (original scale 1:24 000). It should be noted that areas blanked in the *PRINTRESULTS map are suggested to represent sandy soil. Inside the boundary of the areas marked "O" the sandy soils are wet (somewhat poorly and poorly drained). For further legend, see Fig. 2.

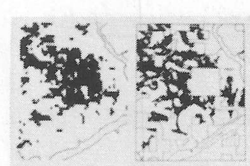
cessed using the *CLUSTER processor and the results are shown in Fig. 3I. A similarity measurement computed by the cluster processor indicated that classes 2 (B) and 3 (C) are spectrally similar. They symbols "B" and "C" match the surrounding areas of somewhat poorly and very poorly drained soils in Fig. 2. The same case prevails for the symbol "F", while the symbols "A" and "D" at the "edges of the feature" match the well-and moderately well-drained soils (cf. Fig. 2). This is also shown by comparison to the existing soil map in the area (Fig. 3II). On this basis it is suggested that the areas symbolized as either "B", "C" or "F" be matched to the somewhat poorly/ very poorly drained soil even though the numbers of the points are too few for any statistics/classifypoints processing. The other parts of this area (symbolized as "A" and "D") are thought to consist of well/moderately well-drained soil.

The areas (X) outlined in Fig. 2 are all reprocessed by the same methods, and the results are displayed in Figure 4. Due to the resolution of ERTS-1 the smallest area which can be "seen" is 59 m x 73 m (1.1 acre). In this case one symbol in Fig. 4 is equal to one resolution unit. Fig. 4 shows that some of the details that can be traced in a map based on color IR imagery are lost (due to the resolution areas of ERTS) in the printresults map. On the other hand it has been possible through a reprocessing of the MSS data to map soil differences



Scale 1 : 50 000





Scale 1 : 100 000 Scale 1 : 200 000

Fig. 5. The mapped area reprocessed photographically in different scales. For legend, see Fig. 2.

on the basis of the characters of the vegetation which would not show up in color IR (cf. areas marked A in Fig. 4). This favors the use of MSS data in mapping. Decreasing the scale through a photographic processor [i.e. scale 1:50,000, scale 1:100,000 and scale 1:200,000 (Fig.5) which has been the most common scales for mapping in Norway] these two maps increase in similarity. At a scale of 1:200,000 hardly any differences can be printed using conventional cartographic methods.

Conclusions

It is shown that the automated data processing techniques developed at LARS on ERTS-1 multispectral data are a useful supplement to conventional photo interpretation of the surficial deposits. In this case the data collected by ERTS-1 seem to favor small scaled maps, but can also be successfully used in large-scale mapping.

Acknowledgement

Acknowledgement is made to J. E. Cipra, Ph.D., Associate Program Leader for Earth Sciences; D. Levandowski, Ph.D., Associate Head of the Department of Geosciences; B. R. Schenck, Graduate Research Assistant and other LARS staff for assistance and guidance in the different aspects of remote sensing.

REFERENCES

Baumgardner, M. F., S. J. Kristof, C. J. Johannsen and A. L. Zachary. 1970. "Effects of Organic Matter on the Multispectral Properties of Soils." LARS Information Note 030570. Laboratory for Applications of Remote Sensing. Purdue University.

Cardillo, G. P. and D. A. Landgrebe. 1966. "On Pattern Recognition." LARS Information Note 101866. Laboratory for Applications of Remote Sensing. Purdue University.

Hoffer, R. M. and C. J. Johannsen. 1969. "Ecological Potentials in Spectral Signature Analysis." University of Georgia Press Athens. Library of Congress Catalog Card No. 70-90552 SBN 8203-0235 - X. US.

Kristof, S. J. 1970. "Preliminary Multispectral Studies of Soils." LARS Information Note 043070. Laboratory for Applications of Remote Sensing. Purdue University.

Kristof, S. J. and A. L. Zachary. 1971. "Mapping Soil Types from Multispectral Scanner Data." LARS Information Notes 061471. Purdue University.

Landgrebe, D. A. 1974. "Research in Remote Sensing of Agriculture, Earth Resources and Man's Environment." Final Report of NASA Grant NGL 15-005-112. Laboratory for Applications of Remote Sensing. Purdue University.

Swain, P. H. and Staff. 1972. "Data Processing I: Advancement in Machine Analysis of Multispectral Data." LARS Information Note 012472. Laboratory for Applications of Remote Sensing. Purdue University.