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Photographic Data Extraction from LANDSAT Images

Lithographic film and diazo processing were used to produce tonal signatures from the several spectral bands of LANDSAT imagery.

"The volume of data generated by remote sensing rapidly is exceeding the capability of trained image interpreters to reduce the data into needed information" (Estes and Senger, 1974)[1]. This statement is particularly true of the images generated by the LANDSAT satellites. Not only are large areas being imaged but they are being imaged in four bands for the multispectral scanner and for many parts of the world on repeated occasions. An ideal answer to this problem today is the use of both digital and analog computers, particularly those operating with fully interactive systems. For repeatability, digital systems are the more reliable.

Although it brings many advantages, especially speed and versatility, the establishment of adequate computer facilities is an expensive operation. For this reason much work with images from LANDSAT-1 and LANDSAT-2 has been done by conventional "eyeball" methods with single-band images or color composites. Within this area work has been carried out with the aid of photographic enhancement, the recent paper by Rodriguez-Bejarano[2] being but one example of photographic enhancement applied to aerial photography.

This paper describes the use of photographic methods to produce land-use maps from LANDSAT images. The concept of tonal signatures is now well accepted and it it this concept which is developed using photographic methods. The equipment required for the process is a contact frame, normal darkroom facilities for developing and, for proofing and enlargement by overhead projector, a diazo printer with ammonia developer is desirable. Such a printer can, of course, also produce false color composites of the LANDSAT scenes by printing Band 4 on yellow film, Band 5 on magenta film, and Band 7 on cyan film. The results are very effective and inexpensive when used with the 1:1,000,000-scale images.

Early experiments using the diazo processor involved the use of colors other than those listed above in an attempt to enhance certain features. For example, by copying a Band 7 positive in cyan and a Band 7 negative in magenta, lakes and dams (widely used in Australia for watering livestock) were enhanced. The use of the other bands tended to be rather disappointing due to their lower contrast.

To overcome this problem, Kodak lithographic film was used and developed in Kodalith developer. Bands 4 and 5 still remained difficult to handle but with experience reasonably consistent results were obtained. Unfortunately the grey scales on the original transparencies from the EROS Data Center seemed of limited use for this purpose.

Lithographic negatives of the original transparencies were made for Bands 4, 5, and 7 and, from these lithographic negatives, positives were obtained. Various color combinations were tried. Those giving the best results were

Band 5	Positive	Magenta
Band 5	Negative	Yellow
Band 7	Positive	Green
Band 7	Negative	Cyan

The use of these colors enables seven distinct categories of land use to be mapped. These are

1. Rain forest	Purple
2. Wet sclerophyll forest	Dark red
3. Dry sclerophyll forest	Green
4. Unimproved grassland	Dark green

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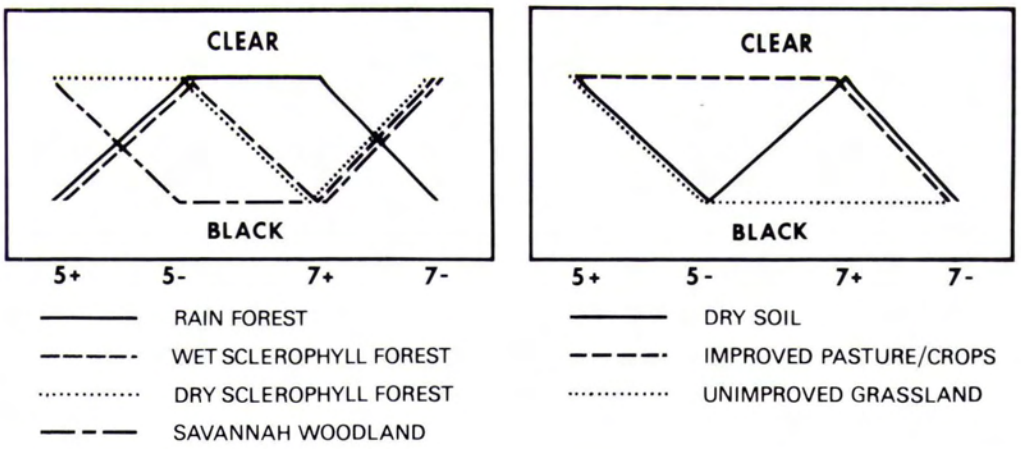

FIG. 1. Tonal signatures.

5. Improved pasture/crops	Blue
6. Savanna woodland	Yellow/green
7. Bare soil	Black

The tonal "signatures" related to each grouping are shown diagrammatically in Figure 1.

After testing the results with the diazo process, printing plates were made of the four lithographic films. The results are illustrated in Plate 1 which shows LANDSAT-1 scene 8114123131 of the New England area of New South Wales, Australia. The use of lithographic film makes screening the images unnecessary though it would produce a lighter toned copy.

The images used are the only ones currently available for the area, and date from December 1972. Ground verification may therefore not be as good as one would desire but the correlation with available air photographs, a forestry map produced by the New South Wales Forestry Department, and other sources for specific areas is particularly good.

The major problems of the method are those present in any photographic enhancement system. To maintain consistency from one image to the next is particularly difficult in the normal darkroom. However, the slow rate of development of the lithographic film which can be watched under a safelight is particularly helpful. Mosaicking adjacent scenes is not too difficult in the same run provided they were taken on the same date. Scenes in adjacent runs prove more difficult, particularly if the time lapse is more than a month. While the detail may change, the basic pattern tends, at least in that part of eastern Australia studied to date, to remain fairly constant. The method of producing the bulk-processed images results in scan lines being visible on the originals and at times the lithographic film records this. On the image given, the magenta image of the positive of Band 5 shows a certain amount of noise. Again the use of a half-tone screen ought to reduce this.

There are clearly many other applications of this technique, for instance in monitoring flood areas, the green wave effect in those latitudes where it occurs, and changing land-use patterns. The method also introduces a practical way of demonstrating the value of tonal signatures in automated interpretation for student use.

ACKNOWLEDGMENTS

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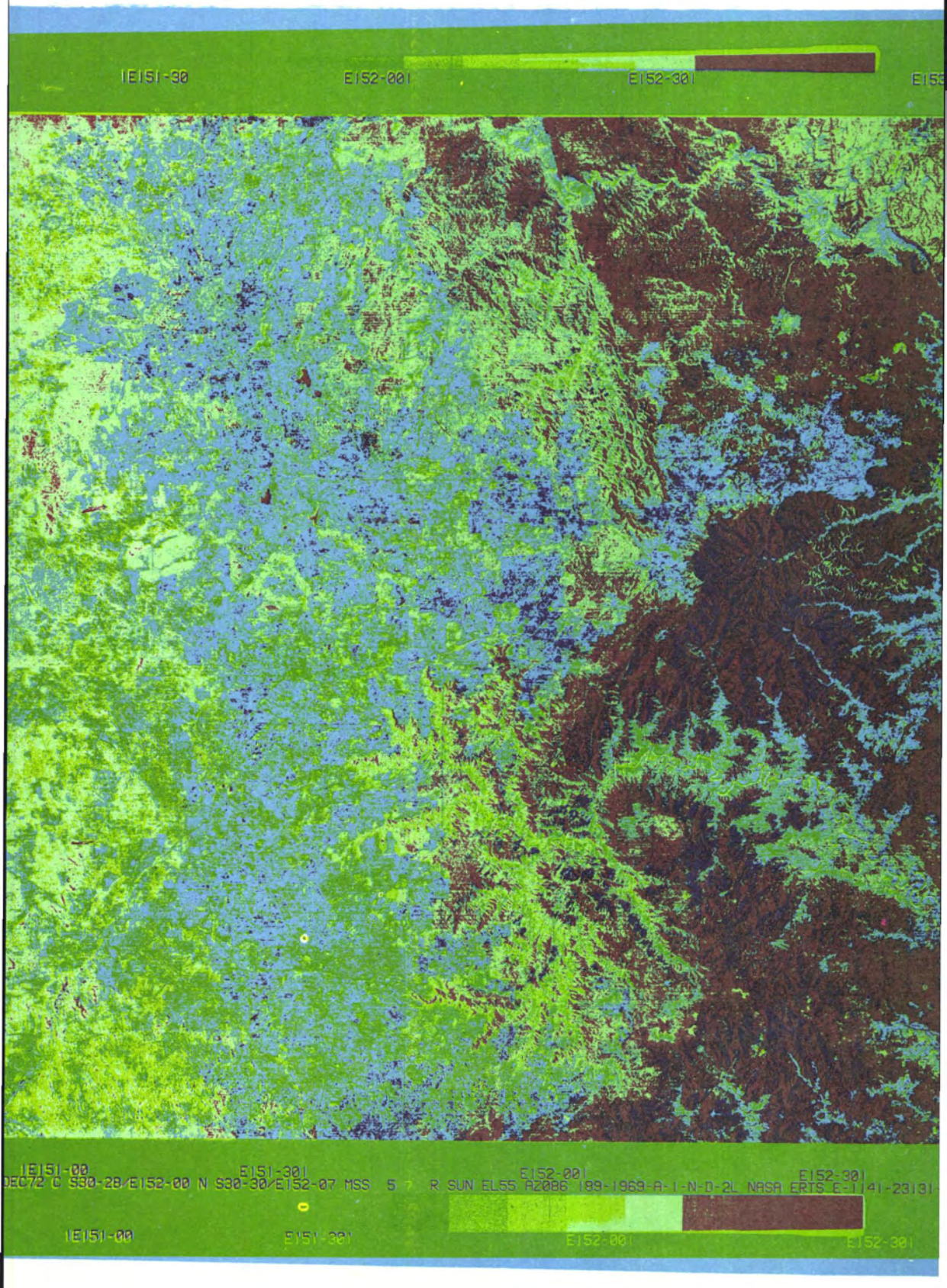
REFERENCES

1. Estes, J. E., and L. W. Senger (Eds), *Remote Sensing*, Hamilton, 1974 p. 51.
2. Rodriguez-Bejarano, D., "Density Slicing Applied to Forest Type Delineation", *Photogrammetric Engineering and Remote Sensing*, Vol. 41, No. 8, August 1975, pp. 1029-37.

PLATE 1. Land use, New England area of New South Wales, Australia.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