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ERTS REGIONAL-SCALE OVERVIEW LINKING LAND USE AND ENVIRONMENTAL PROCESSES IN CARETS

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ABSTRACT

A mosaic of ERTS images of the CARETS region has been used to partition the region into zones on the basis of similarity of tones and textures visible at a regional-scale overview. The resulting patterns were compared with existing small-scale maps of the region representing relief, land surface forms, geology, soils, vegetation, forest types, and land use. The ERTS-derived zones most closely resemble the patterns on the small-scale land use map, suggesting that, at least in a highly-developed region such as CARETS, "land use" is an indicator or resultant surface expression of several interacting environmental processes. These results lend support to the CARETS model of inter-disciplinary regional analysis, whereby remote sensor-derived data sets on land use and land use change become the basic data entry into a regional information system to serve regional planners and land managers.

ERTS images of the Central Atlantic Regional Ecological Test Site (CARETS) were examined at a variety of scales ranging from the "contact" scale of the 70 mm film chips supplied to the investigator (scale 1:3,300,000) to enlargements of more than 33 times (scale 1:100,000). There are advantages attendant upon the use of each particular scale, stemming from the hierarchy of scales of the environmental processes that have shaped the visible landscape.

One procedure found useful for a regional-scale overview is to obtain good contrast black-and-white prints of the MSS 5 band ERTS images at a scale of 1:1,000,000, piece them together into an uncontrolled mosaic, and view the whole thing at arm's length rather than with a magnifying glass. This was done for the CARETS region and some of the surrounding territory with ERTS images ranging in dates from September to

Original photography may be purchased from:
EROS Data Center
10th and Dakota Avenue
Sioux Falls, SD 57198

December 1972. The following images were used to make the mosaic:

E-1045-15243-5, 6 Sept. 72
E-1045-15245-5, 6 Sept. 72
E-1045-15252-5, 6 Sept. 72
E-1079-15131-5, 10 Oct. 72
E-1079-15133-5, 10 Oct. 72
E-1080-15185-5, 11 Oct. 72
E-1080-15192-5, 11 Oct. 72
E-1080-15194-5, 11 Oct. 72
E-1133-15144-5, 3 Dec. 72.

The ERTS mosaic displays, almost at a glance, the major geological and hydrological features of the region, extending from the folded Appalachians to the Atlantic Ocean (Figure 1). The chain of major metropolitan centers--Philadelphia, Baltimore, Washington, Richmond, and Norfolk--can be seen in relation to the hinterland mountain features, and particularly to the waterways of the Chesapeake and Delaware Bays and their tributary estuaries.

Closer examination reveals more subtle geological and hydrological controls to the land pattern such as regional outcrop trends, folds and faults, and major stream patterns. After accounting for the effects of these major geological and hydrological features, there remains a residual of landscape patterns which at this regional-scale overview are integrated by the sweep of the ERTS scanner into distinctive tones and textures. Each segment of the land surface reflects a pattern made up of forested tracts, farms, clusters of habitations, roads, and other paraphernalia of man's intensive occupance of this region.

A basic hypothesis of the model of interdisciplinary regional analysis used in the CARETS investigation is that "land use" at least in a highly-developed region, is an indicator or resultant surface expression of several interacting environmental processes; further, of all the environmental and socio-economic processes which contribute to the surface patterns, "land use" is the one with data sets most accessible to ERTS sensors.

To give this hypothesis a rudimentary test, the ERTS photomosaic of the CARETS region was visually partitioned into zones or "photomorphic regions" on the basis of similarity of tones and textures (Figure 2). This process could be made much more rigorous by employing a variety of

automatic scanning or pattern recognition techniques. The resulting patterns were compared, again visually, with the following small-scale maps in the National Atlas of the United States: relief, land surface form, tectonic features, geology, soils, vegetation, forest types, and land use.

All of these small-scale maps were compiled and prepared in final form long before ERTS became a reality. A cursory comparison indicated that the ERTS-derived patterns most closely resembled those of the National Atlas land use map (Figure 3). These results lend a measure of support to the CARETS hypothesis, and suggest further research to explore the linkages between data sets on land use as observed from ERTS and data sets on processes of the physical environment such as those affecting the geologic structure, lithology, surficial materials, hydrology, soils, vegetation, and climate. These linkages will be explored in the next phase of the CARETS project investigation, during which data sets on land use and land use change derived from both satellite and aircraft imagery will become the basic entries into an experimental regional information system to serve regional planning and land management agencies. An essential element of this information system is that user retrieval of the land use data is made compatible with correlative information on geology, topography, hydrologic factors, and population and economic data so that the land use patterns can be "calibrated" in terms of their probable environmental impact and their relationships to other factors that the planners must consider in allocating portions of the region to future land use changes. Bringing remote sensor-derived land use information together with the other data sets as required by the analytical and forecasting models of the planners calls for a computer-based geographic information system, which is being provided as part of the CARETS investigation.

The ERTS-derived zones of similarity are hypothesized to be sub-regions of similar land use characteristics. When land use data sets derived from ERTS imagery have been incorporated into the digital file for the region, retrieval and aggregation according to the outlines of the photomorphic regions obtained from the mosaic will make possible detailed quantitative comparisons of the land use regions with the ERTS tonal regions. In the meantime, areas assigned to each of the ERTS photomorphic regions were compared to areas from the National Atlas land use map, and the results are displayed in Table 1.

The map units of each correspond roughly as shown; more detailed mapping units were derived from the photomorphic region map. With the exception of the category where urban areas are included, the two maps show an intriguing correspondence. The similarities in pattern of the two maps are of course not shown by this crude area comparison method of map correlation.

The payoffs in regional-scale analysis of ERTS data seem to be of two major kinds. First, partitioning of ERTS data into subsets or photomorphic regions may provide a very economical sampling strategy for selecting sites for more detailed field measurements if, as is suspected, many other environmental variables turn out to be correlated with the similarity of patterns on ERTS imagery. Second, and of most importance in the long run, regional-scale sequential analysis of ERTS imagery, and that of follow-up systems capable of monitoring environmental change, may provide an increase in our basic knowledge of the complex of interwoven environmental processes which shape man's habitat.

Figure 1. Uncontrolled photomosaic of 9 ERTS MSS images covering the Central Atlantic Regional Ecological Test Site (CARETS). Polaroid reduction from mosaic scale of 1:1,000,000.

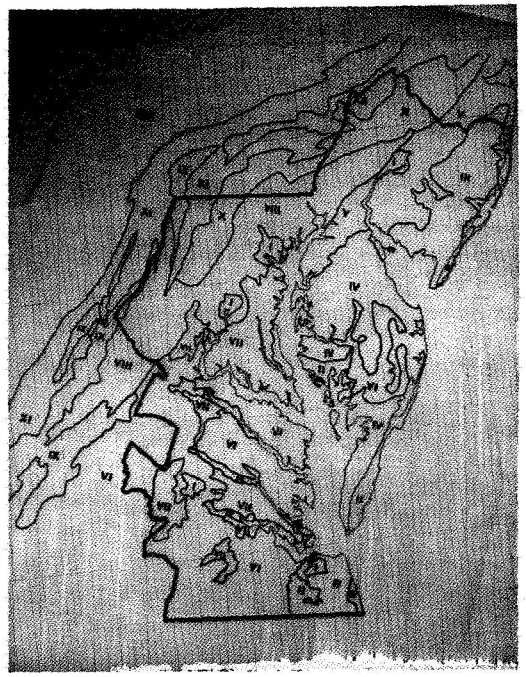

Figure 2. Photomorphic regions derived visually from ERTS photomosaic of CARETS Numerals arbitrarily assigned to units of similar tone and texture.

Figure 3. Land use in CARETS, from National Atlas of the United States; original Atlas scale 1:7,500,000. Key to map units in Table 1.

Table 1. Comparison of CARETS Map Units, National Atlas Land Use Map and ERTS Photomorphic Regions.

LAND USE MAP		ERTS PHOTOMORPHIC REGIONS	
MAP UNIT*	% AREA COVERED	% AREA COVERED	MAP UNIT
3	44	42	IV V VIII X XI
5	34	31	V
6 & 7	10	22	III VII IX XII
13 & 14	3	4	II
16	8	1	I

*Key to National Atlas Map Land Use Units: 3-Cropland with pasture, woodland, and forest; 5- Woodland and forest with some cropland and pasture; 6- Forest and woodland grazed; 7- Forested and woodland mostly ungrazed; 13- Swamp; 14- Marshland; 16- Urban areas as defined by U.S. Bureau of the Census.