N73-28308

Paper L 12

LAND USE OF NORTHERN MEGALOPOLIS

Robert B. Simpson, David T. Lindgren, *Dartmouth College, Hanover, New Hampshire*

1. INTRODUCTION

The major objective of our project is to map and digitize the land use of northern Megalopolis, that is the states of Massachusetts, Connecticut, and Rhode Island, and to evaluate ERTS as a planning tool for megalopolitan areas. The southern New England region provides a good test of ERTS's capabilities because of its complex landscape. Not only are there great differences in the degree of urban development, but in relief and vegetative cover as well.

At the time of the first-look seminar last September Bob Simpson presented a land-use map of Rhode Island (Figure 1) which we had compiled from a single CIR transparency. The image was the widely distributed one taken over southeastern New England on 28 July. That image suffered not only from the presence of clouds over such critical areas as downtown Providence, but from faulty rectification as well. Nevertheless, working at a scale of 1:250,000, that is a four-times magnification of the Rhode Island portion of the ERTS image, the 1200 square miles (3100 square kilometers) of Rhode Island were mapped in less than 40-manhours. The land use legend for that map consisted of eight categories including three residential categories, a combined commercial-industrial category, transportation, agriculture, woodland, and water. Our conclusion was that the objectives stated in the project proposal were feasible, providing cloud-free coverage became available.

2. PRESENT EVALUATION

In the months since the first-look seminar we have received a number of good quality, cloud-free images covering our study area, in particular those from the mid-October orbits. Those images became available to us in working form, that is as four-times enlargements (1:250,000 scale), during the first week of January. An intensive land use mapping program has been in progress since that date, and although the map-making part of our project is still incomplete we now have sufficient working experience with ERTS imagery to provide a realistic appraisal of its capabilities.

Working primarily with CIR transparencies, a decision made after a careful evaluation of the four MSS bands, and with occasional reference to MSS band 5 images, the mapping has been largely completed for Rhode Island and Massachusetts . The mapping technique consists of interpreting

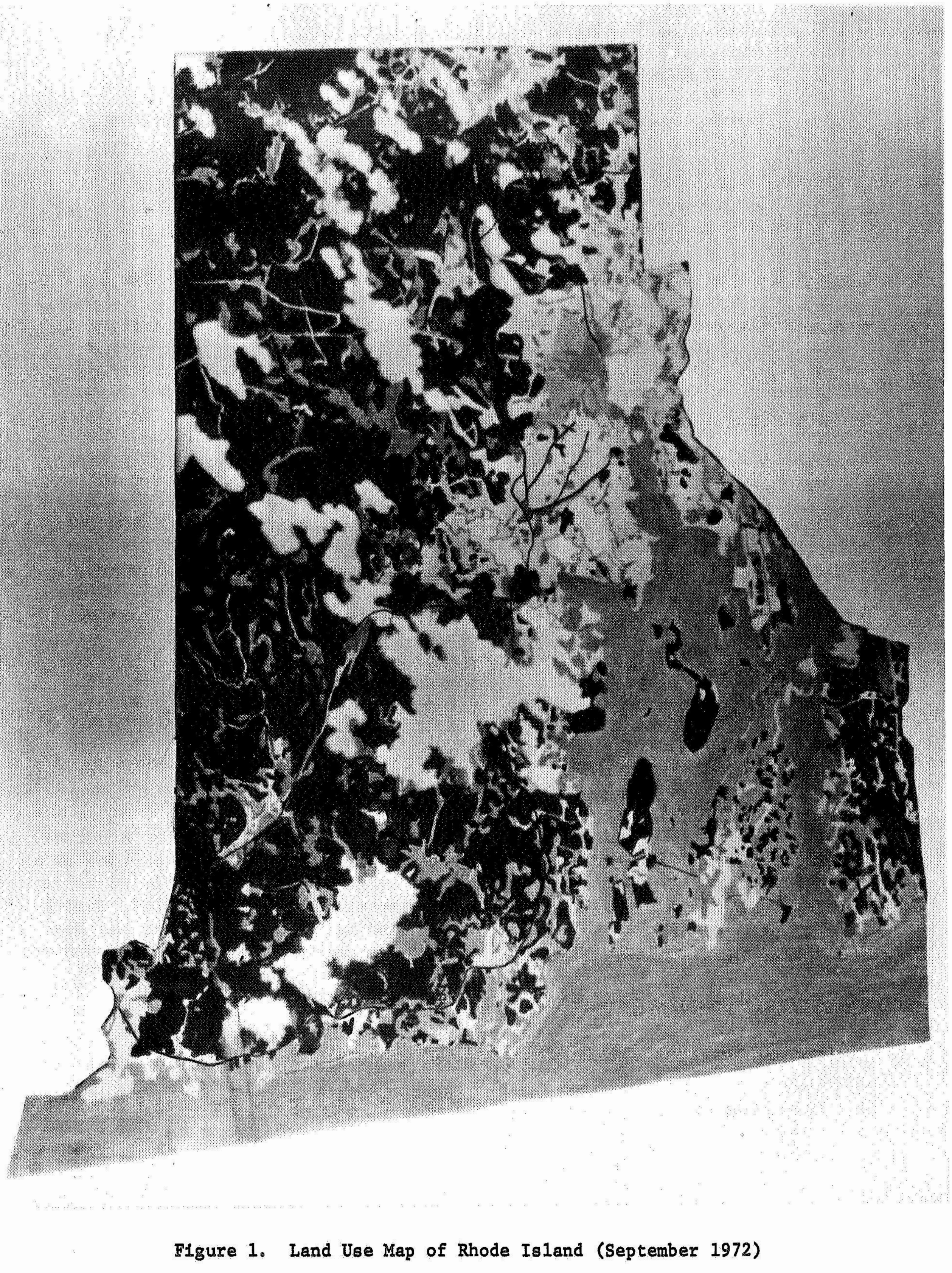


Figure 1. Land Use Map of Rhode Island (September 1972)

land use directly on mylar overlays to the 1:250,000-scale ERTS enlargements. The data are then transferred, block by block, to a more permanent mylar base. This base, which includes many control features traced from USGS 1:250,000 topographic quadrangles, provides the final land use map with considerable locational and scalar accuracy.

The present land use legend which was derived in accord with the guidelines suggested by the Department of Interior was increased from the eight categories used in the preparation of the Rhode Island map of September 1972 to eleven categories for the present map (Figure 2). The three additional categories include Marshland, Beach, and a third category called Restricted Open Space. The latter refers to such land uses as golf courses, cemeteries, and parks which on ERTS imagery are visible primarily within builtup areas where they appear salmon pink against an otherwise bluish background. Two changes were also made in the legend. The Single-Family Residential category was changed to Low-Density Residential, the Multifamily and Mixed Residential to High-Density Residential. While it is arguable the difference may only be one of semantics, the new terms do in fact better reflect what is actually being observed on the ERTS imagery.

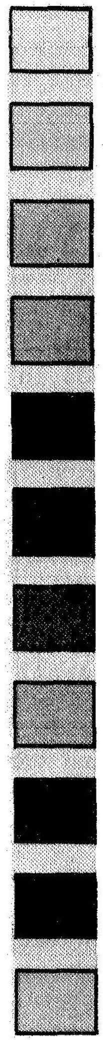
As a means of evaluating the capacity of ERTS to provide land use data we have produced the following chart illustrating the range of land use identifications from the most simple to the most complex (Figure 4). At the most simple level, that is the delineation of water from land, ERTS is extremely effective. The CIR composite, as well as MSS bands 6 and 7, reveal the presence of water bodies as small as 300 feet (100 meters) in diameter. While some very marshy areas may appear as water bodies and therefore be included under the Water category, overall this category can be accurately applied.

Of the land categories Woodland can also be identified with great accuracy. Small patches of woodland may be lost in suburban areas, but such losses are compensated for by the inclusion of small clearings into the Woodland category.

In the non-wooded areas the Builtup categories can be easily differentiated from the Non-Builtup categories. In fact, if one were interested in builtup areas as a whole, ERTS would be the most effective medium for displaying them. The degree of accuracy at this point is very high. However, as the Builtup category is subdivided into more detailed categories, the degree of error begins to increase.

Within builtup areas the residential categories are unquestionably the most difficult to differentiate. The High-Density Residential category in effect refers to those areas of multifamily and mixed housing found primarily within the central cities and inner suburbs of metropolitan regions. As distance from the central city increases, however, housing density declines and light-density, single-family housing becomes dominant. The line separating the two is difficult to determine not only from aerial photography but in the field as well.

ERTS LAND USE CLASSIFICATIONS



First-Look Seminar	Present
SINGLE FAMILY RESIDENTIAL	LOW DENSITY RESIDENTIAL
MULTI-FAMILY AND MIXED RESIDENTIAL	HIGH DENSITY RESIDENTIAL
OPEN LAND AND RURAL RESIDENTIAL	OPEN LAND AND RURAL RESIDENTIAL
COMMERCIAL AND INDUSTRIAL	COMMERCIAL AND INDUSTRIAL
TRANSPORTATION	TRANSPORTATION
AGRICULTURE	AGRICULTURE
WOODLAND	WOODLAND
WATER	WATER
---------	MARSHLAND
---------	BEACH
---------	RESTRICTED OPEN SPACE

Figure 2. ERTS Land Use Classification

WATER	XXX	XXX	XXX	XXX
LAND	WOODLAND	XXX	XXX	XXX
	NON-WOODED	BUILTUP	RESIDENTIAL	LOW-DENSITY RESIDENTIAL
				HIGH-DENSITY RESIDENTIAL
			NON-RESIDENTIAL	COMMERCIAL AND INDUSTRIAL
				TRANSPORTATION
				RESTRICTED OPEN SPACE
		NON-BUILTUP	DEVELOPED	AGRICULTURE
				OPEN LAND AND RURAL RESIDENTIAL
			UNDEVELOPED	MARSHLAND
				BEACH

Figure 3. ERTS Land Use Identification Scheme

As for differentiating residential areas from the CBD, this can be done with a fair degree of accuracy. A problem arises in the delimitation of the outer edge of suburban development from surrounding open countryside just as it does in the field. Where residential areas merge with woodland October imagery is better than summer imagery because fewer leaves obscure the houses. However, where suburbs merge with open fields the July imagery is preferred because of the greater contrast between fields and housing.

Non-residential land uses within builtup areas are easier to identify than housing. For example, the urban industrial-commercial areas are consistently identified. Some transportation land uses are consistently identified. Major highways, airfields, and bridges can be identified with considerable accuracy, but railroads and powerlines can only occasionally be observed.

The category Restricted Open Space is utilized only in urbanized areas where such features as golf courses and cemeteries are identifiable. In rural areas this category cannot be applied meaningfully because such features tend to merge with open fields.

In the non-builtup areas most categories can be effectively applied. Agriculture refers exclusively to row crops and plowed fields. The only major difficulty is encountered in the Connecticut River Valley of Massachusetts where such fields are occasionally confused with commercial-industrial areas. Ultimately it was found that the commercial-industrial areas could best be identified on the July imagery when the fields were pink.

The Open Space and Rural Residential category proved to be very useful. In general it reflects a common feature of the New England landscape - rural roads bordered by open hayland and occasional dwellings.

The Undeveloped categories are relatively easy to identify. Major areas of marsh show well since CIR is a particularly useful medium for this purpose. Beaches are a minor land use but the category allows for their identification since in New England they are a popular recreational feature.

Overall the land use classification developed was applied with relatively good accuracy. Several categories, particularly the Non-Builtup ones were identified with great accuracy, while the Builtup categories have several areas of difficulty. Nevertheless, our experience to this date has been that ERTS can provide greater land use detail than we originally anticipated. And as our experience using ERTS imagery increases so too should our ability to use it effectively.

3. CONCLUDING REMARKS

When the color-coded land use map of northern Megalopolis is completed, a digital computer version will be compiled in order to permit a variety of spatial-analytical investigations. Map-to-computer conversion will be done manually by superimposing a UTM-oriented grid over the map and inputing land use data to the computer cell by cell. At present we are thinking in terms of one square-kilometer cells, subdivided into quarter kilometers in critical areas. Even on the square-kilometer basis there will be some 38,000 cells.

With the computer data bank it will be possible to explore on a quick, first-look basis the possible utility of ERTS to several land use related planning concepts. These include

(1) the delineation of the rural-urban interface, a phenomenon of interest to the Bureau of Census in defining SMSA's;

(2) the identification of sinks and sources of population "energy" in terms of a positive and negative deviation from average population densities;

(3) a look into the possibility of predicting population growth trends from ERTS imagery.

Although these investigations will be little more than "first looks", they will hopefully provide some insight into the capabilities of ERTS to solve recognized planning problems.

Finally, we have given some thought to the cost effectiveness of ERTS for making land use maps. We estimate that ERTS is less expensive by a factor of 10 than comparable mappings from aircraft. In fact it appears reasonable to say that the differences in cost of land use mapping, as between medium-altitude aircraft, high-altitude aircraft, and satellite platforms, and assuming a "state-sized" area, are similar to the differences in the scales of their imagery (Figure 4).

(LAND USE MAPPING)

ESTIMATE OF
COMPARATIVE COSTS (1)

Platform	Scale	Ratio	Minimum Cost Estimate
Medium Altitude Aircraft	1:20,000	1	$ 350,000
High Altitude Aircraft	1:100,000	1/5	70,000
ERTS-1	1:250,000	1/12.5	28,000

(1) Assuming an 11-category legend and a "state-sized" area.

Figure 4. Estimate of Comparative Costs for Land Use Mapping