N73-28316

Paper L 21

DIGITAL LAND USE MAPPING IN OAKLAND COUNTY, MICHIGAN

Irvin J. Sattinger and Robert D. Dillman, *Environmental Research Institute of Michigan, Ann Arbor, Michigan*

ABSTRACT

ERTS-1 data for a portion of Oakland County, Michigan was computer processed to produce a map of water, urban areas, wooded areas, and other vegetation. Comparison with RB-57 photography of the area shows a good correspondence of the two sources of data. Preliminary evaluation indicates that this type of four-category map derived from ERTS data will be useful for conceptual studies of large geographic areas in recreational planning.

1. INTRODUCTION

The objective of this investigation is to use and evaluate ERTS data in continuing studies of land use in the seven-county area surrounding Detroit, with special emphasis on identifying and evaluating land that should be acquired and preserved for open space and recreational use and to maintain the environmental quality of the area. A major portion of the study is being concentrated on test sites in Oakland County, which is characterized by the presence of a number of lakes as well as wetland and wooded areas. Although the development of methods is concentrated on sites of limited size, it is expected that ERTS data will ultimately be used for studies of regional scope. The investigation emphasizes computer processing of ERTS-1 multispectral scanner imagery to observe and map a number of fundamental factors which determine the suitability of land for recreational use or open space. Photographic and scanner imagery from aircraft flights, ground truth, and other data sources are being used where available to supplement and evaluate the ERTS imagery.

2. DATA ANALYSIS

The only usable ERTS-1 coverage of Oakland County to date was obtained on 28 September 1972 (Observation ID 1067-15643). The usefulness of the data is limited by partial cloud cover, but at least some sections of Oakland County and adjacent areas in Southeast Michigan are cloud-free and usable (Figure 1). Since this was the only coverage of the test site obtained while foliage is visible till the spring of 1973, the data analysis has begun with usable sections of the frame.

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

Black-and-white photos of the ERTS frame in all four bands have been studied to identify major features of interest and to decide on subsequent steps for data processing. The large number of lakes in Oakland County show up well in Bands 6 and 7. Major roads, subdivisions, and wooded areas are also clearly visible in Bands 4 and 5. The southwest corner of the frame, constituting about one-sixteenth of the total frame, was printed out as a gray map by digital computer. The area printed out corresponds closely to Oakland County. This printout was studied along with existing RB-57 photography of the area and other sources of information to select a smaller area for intensive computer analysis. This area was selected at a location free of cloud cover and includes surface features of particular interest for the study objectives. The area selected is approximately nine miles northwest of Pontiac (Figures 2 and 3). It includes Big Lake, Pontiac Lake, the Pontiac Lake State Recreation Area, and the Huron Swamp, which is the site for a new 2,000 acre park, the Oakland Metropolitan Park, recently announced by the Huron-Clinton Metropolitan Authority. The park will be used to preserve a natural wild area and provide picnic areas, a trail system and an outdoor conference area.

The area supports a variety of vegetation. Figure 2, which is a vegetative map of Oakland County, indicates that vegetation in the outlined area includes mixed hardwoods, lowland hardwoods, oak-hickory stands, upland brush, grass, and crops. Continuing studies of the area will determine the capability for using ERTS data to discriminate these individual vegetation types.

The computer map in Figure 4 was prepared by using Band 5 and Band 7 data. In Band 5, certain areas, distinguished by their light tone, include residential areas with little vegetation, and bare areas, such as sand and gravel pits or major highways. Figure 4 was prepared by printing these light areas of Band 5 in red, designating them as Urban. The areas at the bottom of the map, symbolized as Urban, are actually areas of cloud cover, which also register as light in Band 5. These areas could have been separated out by level slicing of Band 5. In Band 7, water areas are consistently dark in tone, forest areas light, and other vegetated areas intermediate. For areas not printed in red, level slicing of Band 7 was performed to print out Water in blue, Forest in dark green, and Other Vegetation in light green. A comparison of Figure 3 with Figure 4 indicates that water and wooded areas are consistently mapped. The more developed residential areas with substantial tree and lawn cover tend to be mapped as Other Vegetation. This category also includes a wide variety of vegetative cover in non-urban areas. For studies which require a limited number of land use and land cover categories, this use of level slicing is a rapid and economical method for computer processing.

In verifying the accuracy of the ERTS-1 computer map, an up-to-date record of the current distribution of surface features is absolutely essential. RB-57 photography is very appropriate for this purpose, because it has adequate resolution for identifying surface features and because the use of color photography aids in the interpretation of spectral characteristics. During the initial studies reported here, RB-57 photography acquired in September 1969 and in June 1972 was available. In the 1972 photography, the test area was partially obscured by haze and clouds. Therefore, the 1969 coverage was normally used for image verification. The more recent coverage was needed, however, to study those areas where incomplete recognition occurred or where there were discrepancies between the computer map and the 1969 RB-57 photograph. Without the up-to-date coverage, no reliable determination could be made as to whether incorrect recognition was occurring or an actual change in land use had taken place.

Our original intention was to conduct the initial study over an area where we had previously acquired C-47 scanner coverage. However, this area on the ERTS frame is obscured by clouds and we are proceeding without this information, relying solely on analysis of the spectral data from the ERTS-1 tape. As soon as ERTS-1 coverage can be obtained for an area where C-47 scanner imagery is available, it will be used for diagnosis of the ERTS-1 computer mapping process. Although the C-47 flight will not be coincident in time with the ERTS-1 pass, it is expected that the comparison of data will not be seriously impaired. Because of its quantitative nature and higher resolution, scanner data will enable us to analyze and better understand the computer recognition process for known types of surface features. Direct comparison of C-47 and ERTS-1 spectral measurements will be helpful in understanding the manner in which the computer process recognizes both pure and mixed signatures, and will also indicate any modification of the spectral characteristics resulting from atmospheric effects.

The same area was also subjected to further computer processing to produce a map in which more detailed types of land use and surface cover were recognized. This work has not yet reached a stage where confirmed results can be reported; consequently, this discussion is limited to reporting the current state of this work. This effort at surface mapping used maximum likelihood-ratio processing to distinguish nine types of surface features. For this purpose, nine training sets were selected and analyzed, including two residential areas, three areas of lake surface, two forest areas, and two grass-covered areas. Using statistical data derived from spectral signatures of these areas, the four channels of ERTS data were processed to produce a computer printout.

After several preliminary maps were run, a printout was obtained in which nearly 70% of the resolution elements fell into one of the nine classes. A general examination of the results and comparison with

available RB-57 photography indicated that the areas recognized were for the most part properly classified as to general type of surface (e.g., built-up area, water, or vegetation). The areas not recognized were generally water surfaces and residential areas, indicating that the training sets for these two types of surface were too restrictive. It is clear that a broader categorization of water will produce more complete and consistent recognition. However, the training sets chosen make possible a more detailed analysis of water quality and underwater features. The results mentioned here represent only initial attempts at maximum likelihood ratio processing. It is expected that substantial improvement will be obtained with further experience.

3. APPLICATION OF ERTS-1 DATA

A preliminary evaluation of the utility of ERTS data for recreational land studies has been made from the examination of these early results by staff members of the Lake Central Region office of the Bureau of Outdoor Recreation and staff members of the Oakland County Planning Commission. It is believed that the general land use and land cover maps such as are shown in Figure 4 can be used in performing conceptual studies for large recreational developments. Examples of recent studies for which ERTS data could have been used include the Maumee Wild and Scenic River Study (in Northern Ohio and Indiana), study of the recreational potential of the Michigan shoreline of Lake Erie, and selection of corridors for an interstate scenic trail. The ERTS data can be valuable in affording a broad look in the preliminary stages of large area studies. The general patterns of land use, vegetation, and surface water are of immediate interest and provide sufficient information to identify promising sites for more detailed study. The regional office has taken steps to acquire and study ERTS imagery in its continuing evaluation of the Maumee River basin.

4. CONTINUING STUDIES

It is planned to continue with the preparation of recognition maps for this and other areas, with a view to improving the accuracy and increasing the detailed information content of these maps. The maps will be evaluated with respect to the composition and consistency of surface features recognized under a single category. Aerial photography and airborne multispectral scanner data will be used for this purpose wherever available.

In parallel with the preliminary data analysis described above, the types of information which it is hoped to derive from ERTS data are

being further defined. The investigation will concentrate on attempting to identify the specific types of surface features and conditions listed below. Distribution of emphasis on the features to be studied will depend on which are most useful for the study of recreation land and open space and on early indications of the feasibility of observing these features.

Vegetation (See Figure 2). Major categories of vegetation (e.g., deciduous forests, coniferous forests, herbaceous vegetation, cropland). Individual tree species.

Urban Areas.

Rural/Urban Boundaries.

Water Bodies. Mapping of surface extent of lakes, ponds, streams. Shallow water, sediment or pollution, aquatic vegetation.

Shorelines. Vegetation, beach, and residential development.

Wetlands. Distribution of wetlands and general classification, as described in USDI Fish and Wildlife Service Circular No. 39.

River Valleys. Water course, streamside vegetation.

As additional results are obtained, they will be reviewed with the staff of the Oakland County Planning Commission, the Bureau of Outdoor Recreation, and other interested parties to evaluate the usefulness of the resulting information for studies of recreational land and open space.

FIGURE 1. ERTS-1 PHOTOGRAPH OF OAKLAND COUNTY
(ERTS-1 Frame 1067-15643, Band 7, 28 September 1972)

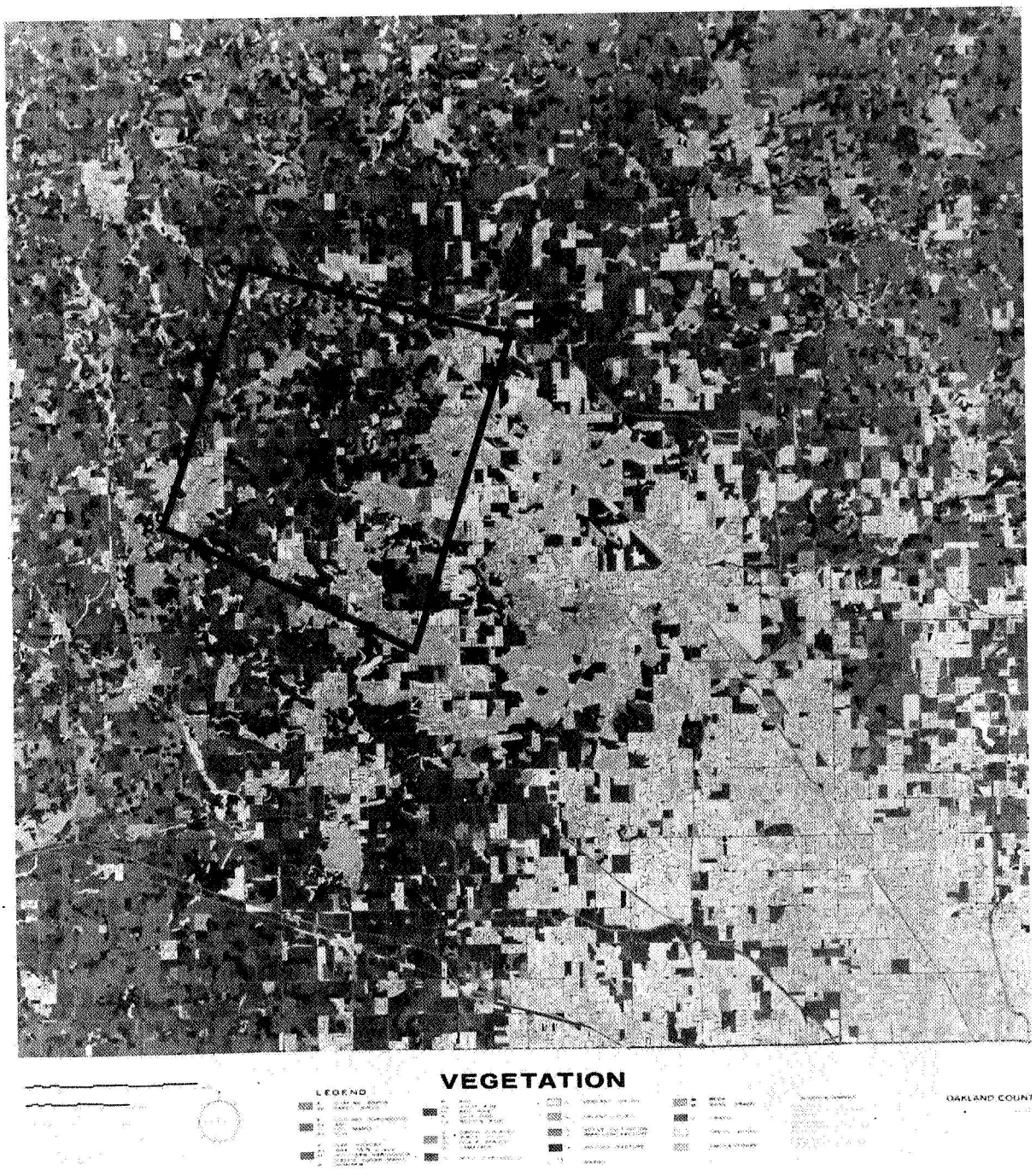
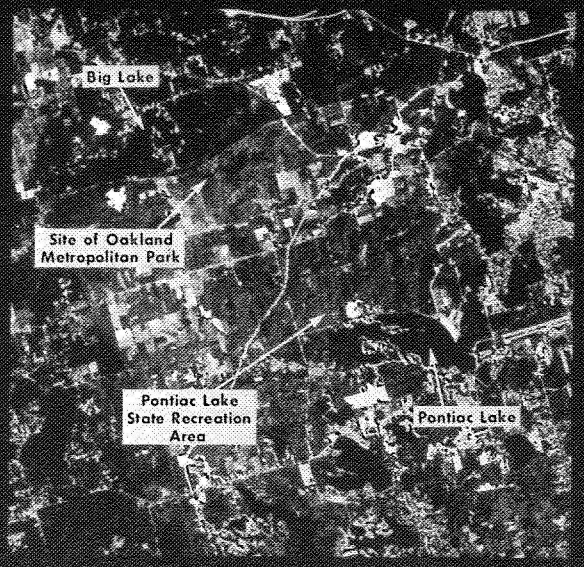


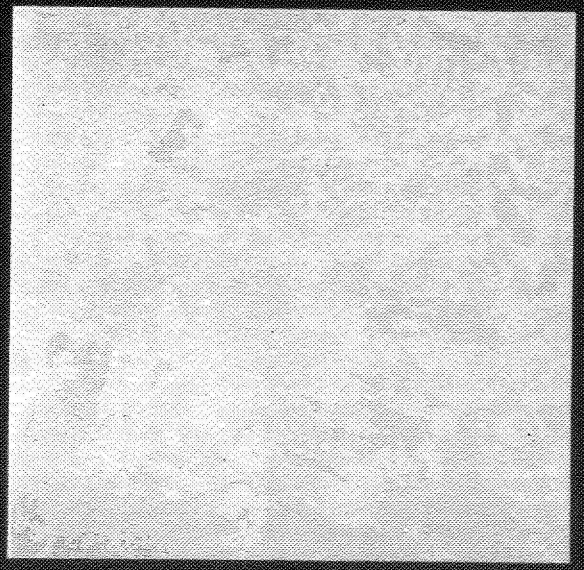
FIGURE 2. VEGETATION MAP OF OAKLAND COUNTY

FIGURE 3

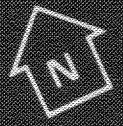


RB-57 Photograph

FIGURE 4



ERTS-1 Digital Map



Blue = Water Dk. Green = Forest
Red = Urban Lt. Green = Other Vegetation

ERTS-1 DIGITAL MAP, OAKLAND COUNTY, MICHIGAN
28 SEPTEMBER 1972

ERIM