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MULTIDISCIPLINARY APPLICATION OF ERTS-1 DATA TO NORTH CAROLINA NATURAL RESOURCE MANAGEMENT

Charles W. Welby, J. O. Lammi, Robert J. Carson, *North Carolina State University, Raleigh, North Carolina*

Introduction

That ERTS-1 imagery provides a synoptic view of a region is well understood. Conveying to planners, managers, and politicians a macroimage of the region in a dynamic mode, the imagery emphasizes the interrelations of cultural geography and physical geography together with the interdependence of many natural resource and environmental factors. Two examples of the use of ERTS-1 data are monitoring of man's activities affecting the forest resource and pinpointing sources of sediment load in streams and rivers.

Forest Resources

The forests of North Carolina provide the raw material for the state's third largest industry; planning for use and management of this natural resource requires a variety of information. It appears that ERTS-1 imagery can furnish important data about distribution of forest-cover types and about activities within the forested areas. Repetitive images from ERTS-1 allow resource managers to monitor changes in the forested areas. Examples of such changes are clear-cutting activities and expansion of urban and suburban developments into forested areas.

In North Carolina most forest harvesting is done by the clear-cutting method. Imagery enlarged to a scale of approximately 1:300,000 provides a spectacular display of bare lands and affords a method for rapidly taking inventory of the total clear-cut acreage in a given region. Furthermore, the repetitive coverage even if only at seasonal intervals, provides a method for monitoring this activity. In the absence of a permit system for cutting there is no other means of acquiring this type of information within reasonable economic and time constraints. Knowledge of the amount of clear-cutting activity going on is of great value to those concerned with forest resource management as well as to regional planners and others concerned with the broad aspects of the physical and economic well-being of North Carolina.

The MSS-5 imagery at an approximate scale of 1:300,000 was compared with 1:63,360 scale airphoto index sheets of the U. S. Agricultural Stabilization and Conservation Service. In the several forest areas studied openings of about five acres are clearly visible on the ERTS-1 imagery, and somewhat smaller cleared tracts can usually be recognized.

Although forests are usually regenerated either naturally or by planting immediately after harvest, many areas lie bare because of neglect or because of an intent to convert land to other uses such as agricultural or urban. Cleared areas are often subject to soil erosion and may be sources of sediment to streams, lakes and estuaries. Use of ERTS-1 imagery can help those charged with resource planning and management to keep abreast of rapid changes and to determine those places where their efforts and limited resources should be concentrated so as to accomplish their responsibilities most effectively.

Within an urban complex the expanding activities of man destroy much of the wooded area as the periphery of the city expands. In the vicinity of Raleigh, North Carolina, conversion of suburban forests to industrial, commercial, and non-wooded residential areas has been traced on ERTS-1 imagery. Within the older parts of the city the paucity of trees signifies changing land-use patterns and a general lowering of the quality of life for the residents.

Figure 1 (1045-15254-5; Sept. 7, 1972) illustrates the different types of wooded areas within the city of Raleigh and the extent of the wooded areas around the city. In the southeast quadrant (top of photograph is north) residential areas, indicated by the gray to black tones, are closely interspersed with commercial-industrial developments shown in white. In the north and northwest part of the city the residential areas are indicated by the dark tones associated with the trees. Lighter gray tones indicate less dense tree cover. Growth of the city north and northwestward is documented. The figure graphically shows the demolishing of the woodlands surrounding the city, and with a minimum of effort the major areas from which significant amounts of sediment are being eroded may be delineated. Some knowledge of cultural relationships in the area must be brought to bear in interpreting the various reflectances.

The relationship of the Uwharrie National Forest to the High Rock Lake-Badin Lake complex on the Yadkin River is shown in the lower righthand corner of Fig. 2 (Image 1046-15313-5; Sept. 7, 1972). The National Forest is represented by the dark tone near the edge of the picture and Badin Lake by the medium gray tone to the left (west) of it. Other forested areas (dark tones) and their geographical relationships to the works of man are also shown by this figure. The contrast between the open fields (light-colored) and the darker forested areas are clearly brought out. It is possible to gain a better appreciation

of the physical relationships of the various natural resources from this image than from a map and to view in perspective man's effect on the forest and water resources.

Sediment Pollution

Determination of suspended sediment load in rivers, lakes, and estuaries was early recognized as a possible use of ERTS-1 type data. The U. S. Geological Survey's network of gaging stations can provide some information about sediment load to streams and lakes; however, the synoptic view can be obtained only from high altitude photography or satellite imagery. Included in the synoptic view is the distribution of major sources of sediment. Some are point sources; others are tributaries to the major streams.

Images of two rivers and chains of reservoirs along them provide an opportunity to evaluate ERTS-1 imagery as a tool to monitor sediment sources as well as loads of sediment.

Figure 3 (1080-15201-5; Oct. 11, 1972) is part of the Buggs Island Lake-Lake Gaston-Roanoke Rapids Reservoir (west to east) chain of lakes on the Roanoke River at the North Carolina-Virginia border. Soils on the North Carolina side of the lakes are rated as moderately to severely erodible.

A three-day period of rain ending on October 6 preceded the pass of the satellite and produced the influx of sediment. The white in the lakes represent sediment plumes. Most of the sediment in the western end of Buggs Island Lake has come through the Roanoke River drainage system. Tributaries to the lake are also supplying sediment, pointing to areas where some consideration should be given to erosion control. Interestingly enough, the Nutbush Creek arm of the lake, which extends southward into North Carolina toward the city of Henderson, shows no sediment influx. This is a relationship which exists in other views of this area.

Downstream from Kerr Dam on Buggs Island Lake considerable sediment influx can be seen near the midpoint of Lake Gaston. Contributing drainage basins lie both north and south of the lake. Little or no sediment appears to have reached the Roanoke Rapids Reservoir.

Along the Yadkin River in central North Carolina a series of dams impound water for electrical power generation. An ERTS-1 image (1046-15313-5) of September 7, 1972, shows the sediment plume entering the uppermost of the lakes, High Rock Lake (Fig. 2). A three-day rain storm preceded the passage of the satellite. Suspended sediment in the Yadkin River measured at Yadkin College, about 25 miles up-

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stream from High Rock Lake Dam, increased from 90 ppm on September 5 to 242 ppm on September 6 and decreased to 189 ppm on September 7. River discharge increased from 1,870 cfs on September 5 to 3,380 cfs on September 6 and decreased to 2,360 cfs on September 7. The plume is shown also on the band 6 imagery, although in this band it does not appear so extensive.

Along the course of the Yadkin River there are numerous light areas suggesting sediment sources. If the imagery were to be enlarged sufficiently,it might be possible to quantify the sediment input from these areas by densitometric methods. In addition the many fallow fields interspersed with the scattered wooded areas (dark) and covered fields (medium gray) are possible sources of sediments. Developed areas surrounding Winston-Salem are other possible sources.

Small light areas adjacent to Badin Lake, downstream from High Rock Lake, suggest possible sediment sources, but the areas adjacent to the lake are wooded, the east side of the lake being part of the Uwharrie National Forest, the top of which appears at the edge of the photograph.

In sharp contrast to the sediment influx into High Rock Lake is the apparent absence of a sediment load in Lake Norman, about 50 miles southeast of High Rock Lake. One part of the reason for the difference is probably the difference in land use upstream from the lake, along the Catawba River as well as adjacent to the lake. Most of the Catawba River is dammed, and immediately adjacent to the river wooded and grassed areas predominate. Along much of the Yadkin drainage the land is intensively used for both commercial and agricultural purposes.

Since many of man's major resource management activities are on a scale sufficiently large to be monitored by ERTS-type imagery, considerable cost economies over conventional data gathering seems possible. Land managers accustomed to working with large-scale air photos may belittle the utility of the ERTS imagery, both in terms of cost and available detail. However, our studies of the ERTS imagery suggest that ERTS-1 is not so much a way of acquiring detailed geological, hydrological, and biological data as a method of observing relationships between man and his natural resources. The benefit-cost evaluation is then one of the satellite system alone rather than in comparison with alternatives that do not really exist. We have attempted to show by our examples the utilitarian aspect of ERTS data in two natural resource management problems.

Conclusion

Although this paper has concentrated on only a few types of

natural resource phenomena which can be observed on the ERTS-1 imagery, the interrelationship of these with urbanization and intensity of land use can be seen. Certainly, critical areas requiring priority natural resource management action can be identified, and the updating of information about a region will prove valuable in effective planning and management of the natural resources.

Not to be lost in the concentration upon the potential usefulness of the information available on the ERTS-1 imagery for operational planning and management is the fact that the synoptic view shows to policy makers, whether elected or appointed, the possible effect of a given action or decision about one region or area upon adjacent regions or areas.

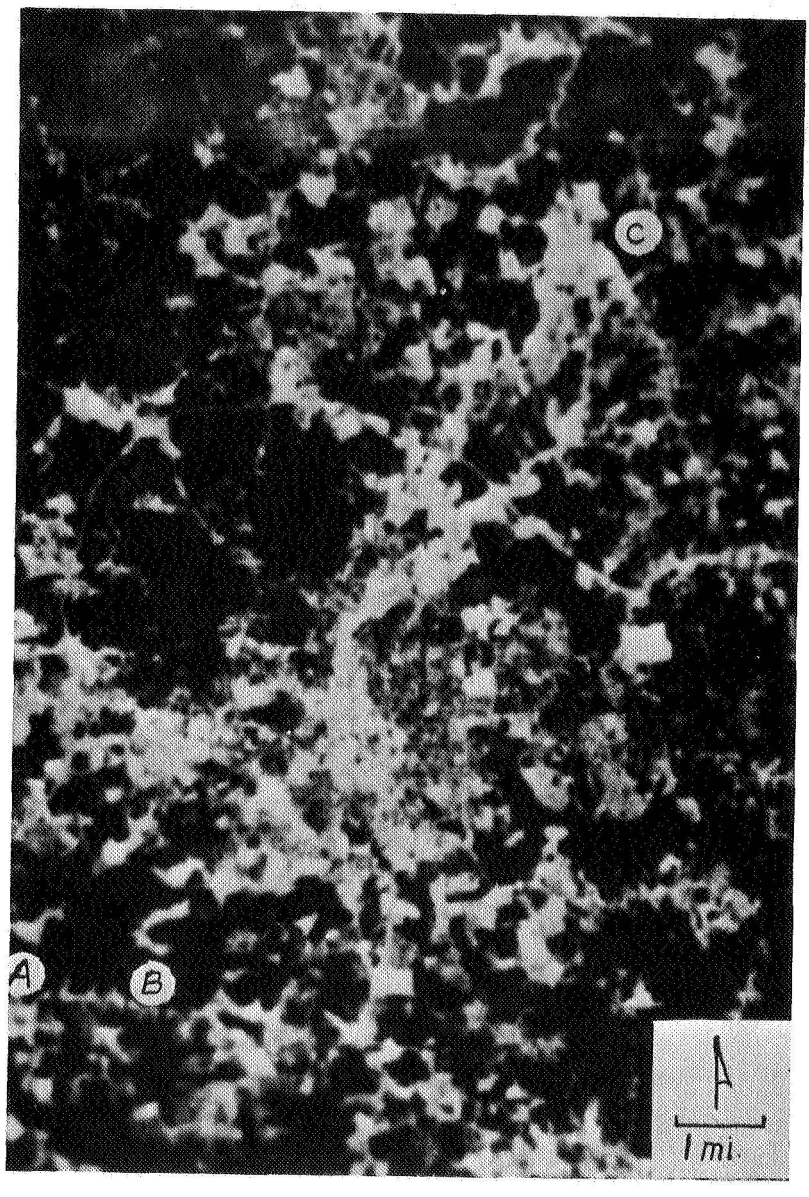

Fig. 1. Raleigh, N. C., showing the growth of the city into the surrounding wooded areas. Two highly silted water supply reservoirs (A and B) reflect in very light gray tones; developing residential-commercial area in the northeast quadrant (C). Image No. 1045-15254-5; Sept. 7, 1972

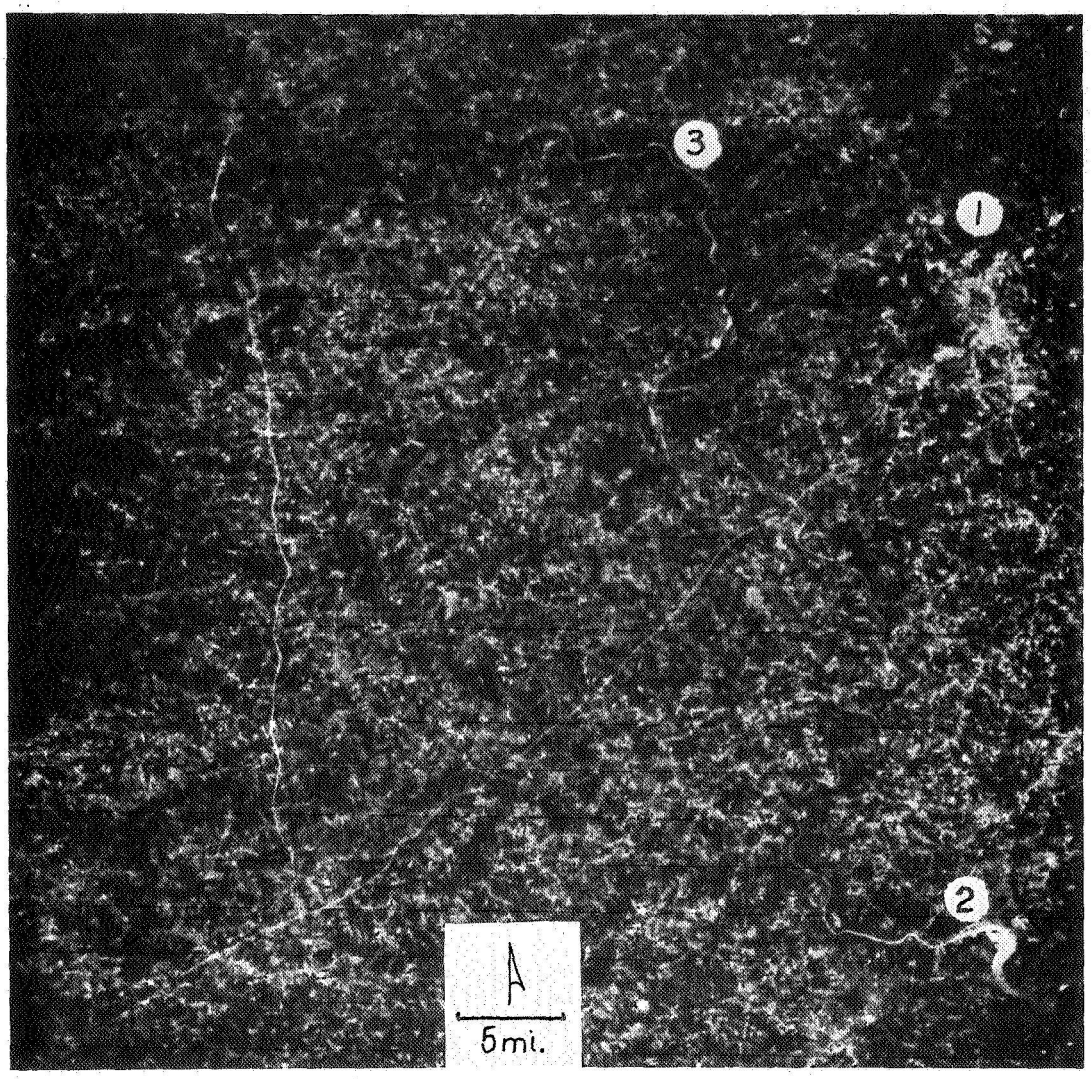

Fig. 2. Yadkin River and High Rock Dam Sediment Load. The light colored area is High Rock Lake following sediment influx from Yadkin River drainage basin. Uwharrie National Forest dark tones at edge of picture.
1. Winston-Salem 2. High Rock Lake 3. Yadkin River.
Image No. 1046-15313-5; Sept. 7, 1972

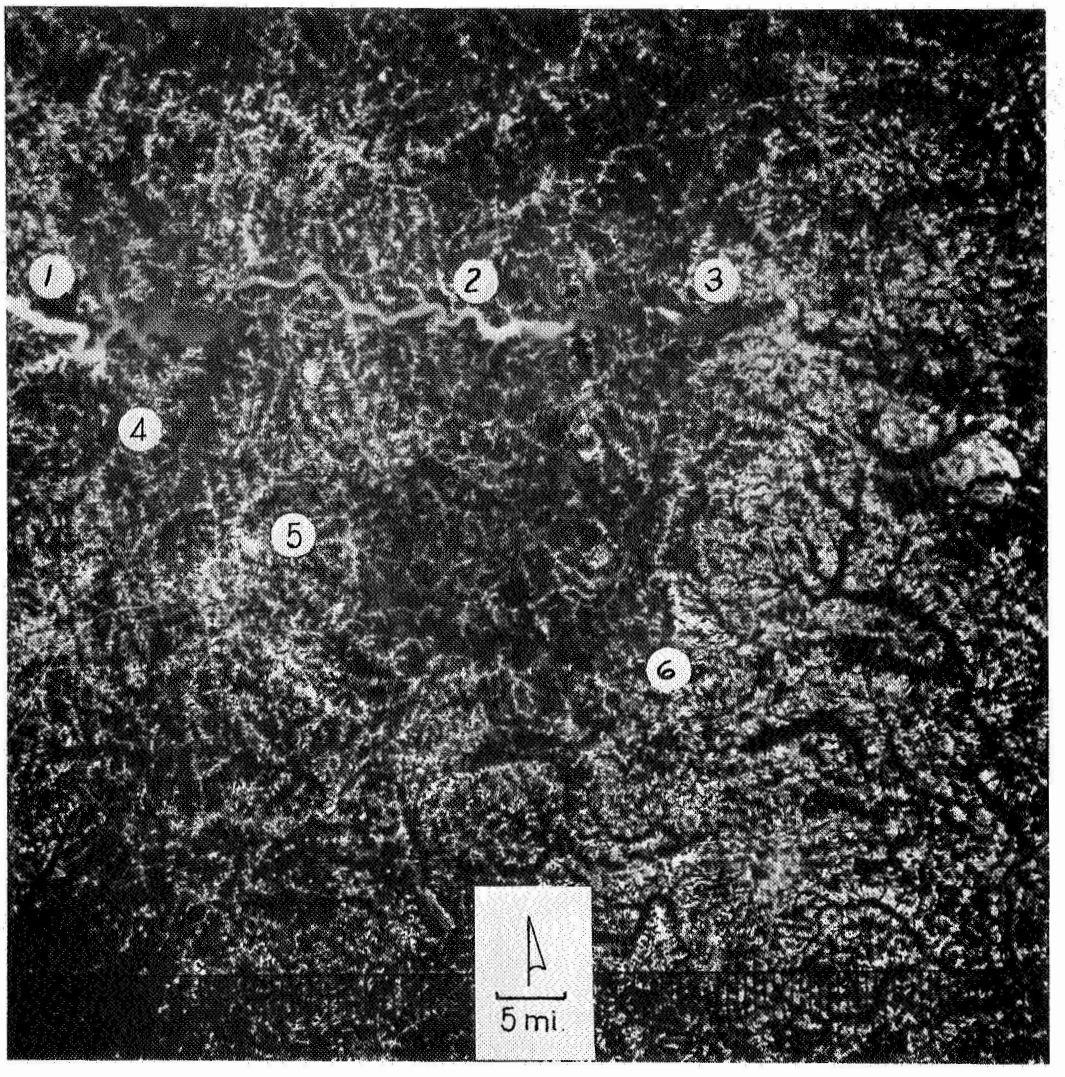

Fig. 3. Buggs Island Lake-Lake Gaston-Roanoke Rapids Lake. Sediment entering Buggs Island Lake appears as light tone.
1. Buggs Island Lake 2. Lake Gaston 3. Roanoke Rapids Reservoir 4. Nutbush Creek 5. Henderson, N. C.
6. Fall Line.
Image No. 1080-15201-5; Oct. 11, 1972