ERTS DATA USER TYPE-1 PROGRESS REPORT FOR JULY/AUGUST 1973

Project Title/Objective: Relevance of ERTS to the State of Ohio

Proposal Number: MMC No. 87

Contract Number: NAS5-21782

BCL Subcontract Number: 72-17/G-1793

Principal Investigator: Dr. David C. Sweet

I. DATA COLLECTION

ERTS-1 data received from NASA during this reporting period are summarized in Table 1. In addition to the imagery described in the Table, computer compatible tape data have also been received for most of these same scenes. Figure 1 illustrates the present status of usable repetitive ERTS imagery of the various portions of Ohio. Some of the multispectral color composites that have been requested for most of the useable ERTS scenes of Ohio have also been received.

No aircraft underflights of the Ohio ERTS study sites were flown during this reporting period but a field radiometric and photographic ground truth survey of the Zeleski State Forest study site was conducted during the ERTS-1 overpass of Ohio on July 30, 1973.

II. DATA ANALYSIS

The major task performed during this reporting period focused on the preparation of a paper titled "Application of Remote Sensing to Resource Management at the State Level" which will be presented at the symposium on management and utilization of remote sensing data at Sioux Falls, South Dakota during October 29-November 2, 1973. A copy of this preprint has been attached as an appendix to this report. This paper summarizes and pictorially displays the usefulness of orbital survey data to contemporary resource management problems faced by various departments and agencies of the State government in Ohio.

TABLE 1. COVERAGE AND QUALITY OF ERTS-1 DATA OVER OHIO RECEIVED DURING THIS REPORTING PERIOD

Date	Time		Quality Comments*
		TRACE 1	
6/5/73	15361	NE Ohio and Western Lake Erie	Good
6/5/73	15363	Eastern Ohio and Western Pa.	Fair
6/5/73	15370	SE Ohio and West Virginia	Fair
6/5/73	15372	SE Ohio, West Virginia & Ky.	Fair
6/23/73	15360	NE Ohio and Western Lake Erie	Fair
6/23/73	15365	SE Ohio and West Virginia	Fair
7/29/73	15353	NE Ohio and Western Lake Erie	Poor
7/29/73	15355	Eastern Ohio and Western Pa.	Very Poor
7/29/73	15362	SE Ohio and West Virginia	Very Poor
7/29/73	15364	SE Ohio, West Virginia & Ky.	Poor
		TRACE 2	
5/1/73	15424	NE Ohio, Lake Erie and Canada	Very Poor
5/1/73	15430	Eastern Ohio	Very Poor
5/1/73	15433	SE Ohio and Kentucky	Very Poor
6/24/73	15414	NE Ohio, Lake Erie, and Canada	Poor
6/24/73	15420	Columbus and Eastern Ohio	Fair
6/24/73	15423	SE Ohio	Good
6/24/73	15425	SE Ohio and Kentucky	Fair
7/30/73	15411	NE Ohio, Lake Erie and Canada	Poor
7/30/73	15414	Columbus and Eastern Ohio	Fair
7/30/73	15420	SE Ohio	Good
7/30/73	15423	SE Ohio and Kentucky	Fair
		TRACE 3	
5/20/73	15475	NW Ohio, Lake Erie and Michigan	Fair
6/7/73	15474	NW Ohio and Lake Erie	Excellent
6/7/73	15480	Columbus and Western Ohio	Good
6/7/73	15483	SW Ohio, Indiana and Kentucky	Good
6/25/73	15472	NW Ohio and Lake Erie	Excellent
6/25/73	15475	Columbus and Western Ohio	Excellent
6/25/73	15481	SW Ohio, Indiana and Kentucky	Excellent

Table 1 Continued

		TRACE 4	
6/8/73	15532	NW Ohio, Michigan and Indiana	Excellent
6/8/73	15534	Western Ohio and Eastern Indiana	Very Good
6/8/73	15541	SW Ohio, Indiana and Kentucky	Good
7/14/73	15525	NW Ohio, Michigan and Indiana	Fair
7/14/73	15532	Western Ohio and Eastern Indiana	Fair

* Quality relates to general cloud cover condition over area covered by satellite photography.

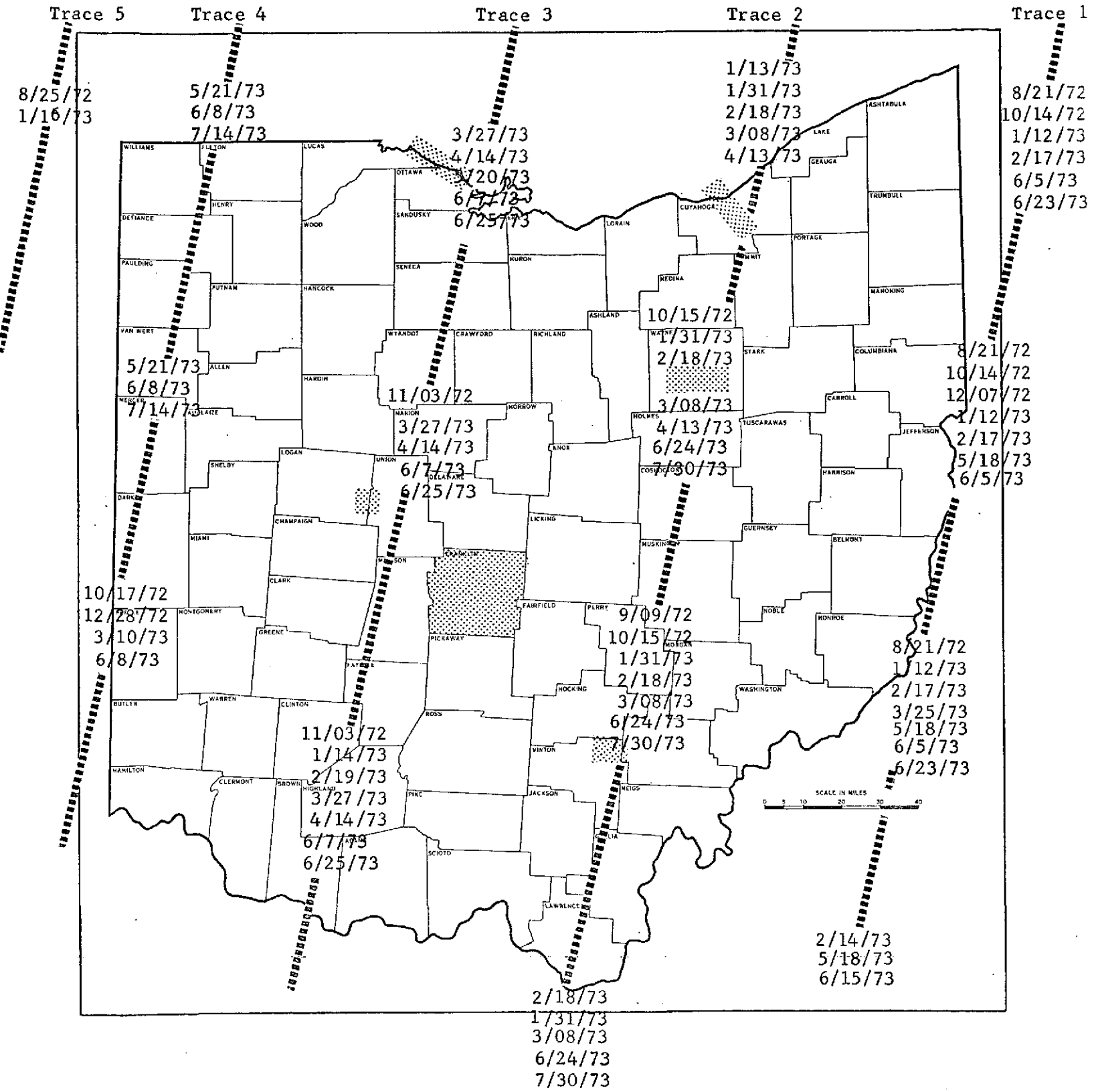

Fig. 1. Status of Usable Repetitive ERTS Imagery for Ohio

Data analysis activities continued on the preparation of a demonstration product emphasizing ERTS land use planning implications for Ohio during this reporting period. This demonstration product will be similar in format to the demonstration product of the applications of satellite survey data to surface mining activities in Ohio and will be completed during the next reporting period. The purpose of such demonstration products is to prepare draft reports documenting ERTS user applications identified for distribution to State officials and planners, initially for information purposes but ultimately for their evaluation of planning and legislative relevance and potential cost-saving benefits.

III DCS/DCP EFFORT

The DCP, having been repaired and returned by the NASA-Wallops Station, following apparent lightning damage, was reinstalled on July 2, 1973. It functioned satisfactorily until July 27, when it ceased transmitting. Investigation has revealed that in this case lightning is not a possible cause of the station outage. Thorough checking has shown that sensor signal inputs to the platform are normal, and the cause of the outage is undetermined.

It has been decided to discontinue the use of the platform, rather than shipping it to the NASA-Wallops Station a second time for repair. This decision was made for the following reasons:

(1) The purpose of the platform in the Ohio-ERTS program has been to demonstrate the utility of the ERTS Data Collection System. The use of the platform with the Schneider water quality monitoring equipment has been an ad hoc arrangement which was dictated by the availability of that equipment, and there has been no actual requirement for or use made of the specific data which has been collected.

(2) Although all the activity planned for the DCP has not occurred (e.g.-interfacing of air quality sensors), the principal objective, as indicated in (1) above, has been accomplished. Experience has been gained in the installation and use of the DCP; a prototype interface device, suitable for future use has been designed, fabricated and utilized; and several months data demonstrating the data processing capabilities of the DCP and DCS, as well as the "traffic handling" capability of the DCS, have been accumulated.

(3) In view of the above, the little, if any, additional value that would accrue to this experiment by its continuance does not warrant the cost of the man-hours that would be involved.

It is planned to prepare an ERTS Utility Demonstration Product describing and summarizing the results of this experiment, for the use of state personnel in evaluating the potential operational utility of the DCS.

IV. DATA UTILITY ASSESSMENT

During July and August some sixty visitors with varying areas of interests representing state and local governmental agencies as well as 15 foreign countries toured the Battelle ERTS data analysis facilities. These visits have been encouraged to familarize user personnel with both ERTS photography and state-of-the-art image analysis equipment. Also selected demonstration items such as 35mm slides, color polaroid prints, and black and white enlargements of ERTS imagery were made for selected individuals for subsequent review and evaluation. Figure 2, a black and white enlargement of a portion of an ERTS-1 photo, is a representative sample of such a demonstration photograph.

A follow-up questionaire to the Ohio-ERTS Data User Handbook is also now being designed to determine user reaction to orbital survey data across a broad spectrum of state environmental and resource management decision making and/or problem solving applications.

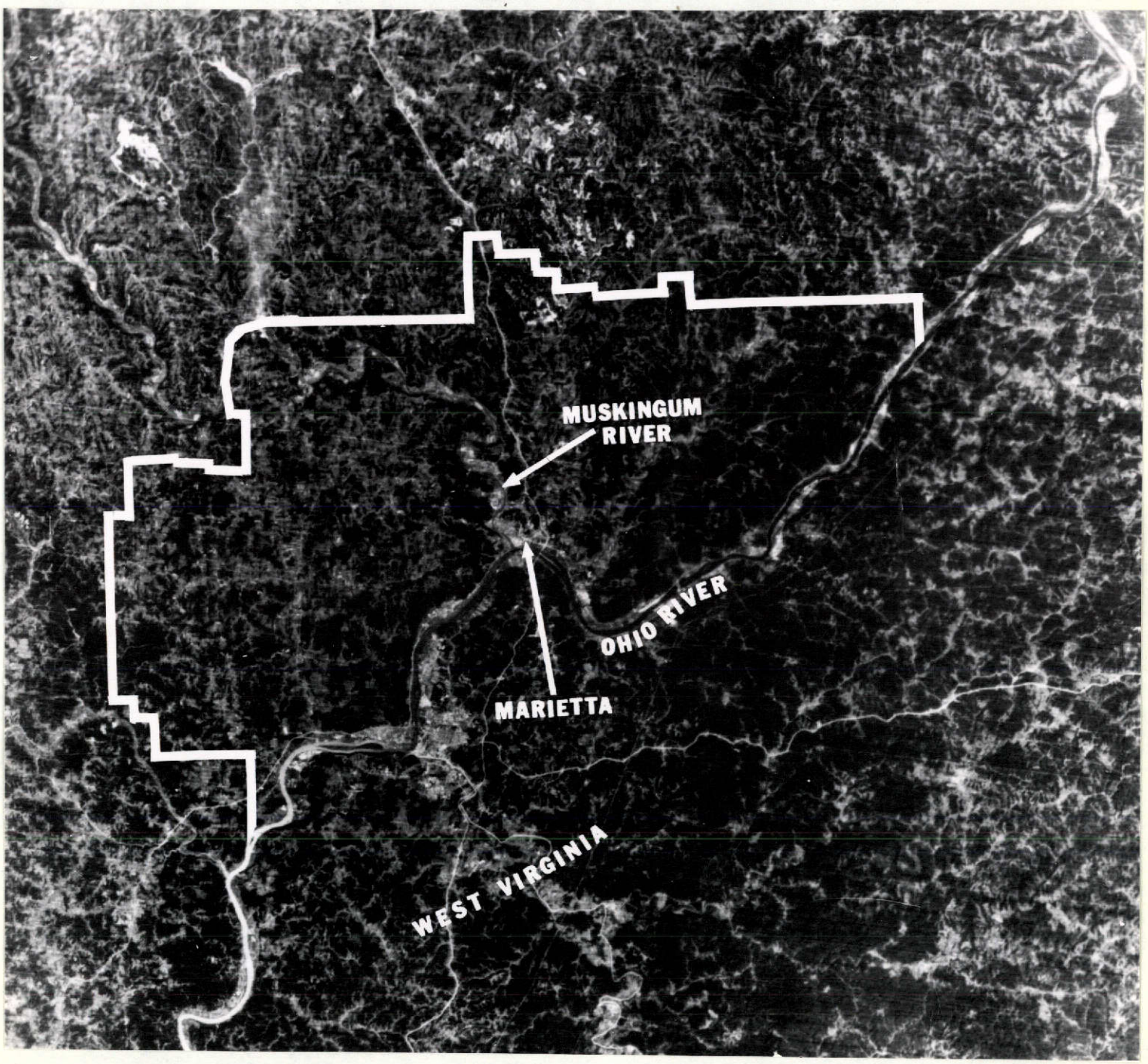

Figure 2. Typical Ohio-ERTS Demonstration Photo Showing an enlarged portion of an ERTS-1 MSS Band 5 (6,000-7,000 Å) photo of 21 August 72 Washington County, Ohio and surrounding areas.

V. SIGNIFICANT RESULTS

A significant result during this report period was the fabrication of an image transfer and comparison device. During any analysis task a major concern is the ability to extract qualitative and quantative information from ERTS imagery with a given time frame. Another major concern, however, is the ability to transfer the enlarged, enhanced, filtered, overlayed, color encoded, etc., imagery or portion thereof to a map, overlay, report, viewgraph, etc.

To avoid problems and high costs encountered in manual drafting methods, Battelle staff members have fabricated an inexpensive, yet effective, technique for transferring ERTS analysis displays from the Spatial Data 32-Color Viewer to maps and/or aircraft imagery (see Figure 3). In brief, the image transfer-comparison device consists of a 2-way mirror which functions similar to a zoom transfer scope. However, the device permits multiuser viewing and real-time photographic recording (35-mm and Polaroid) of enhanced ERTS imagery superimposed over maps and aircraft photography.

Thirty-five mm, 70 mm, and 4" x 5" photographs are taken of 80 percent of the TV screen of the Spatial Data Density Slicing Viewer. The resulting black and white and color imagery is then used in transparent overlays, viewgraphs, 35-mm and 70-mm transparencies, and paper prints for reports and publications. Annotations can be added on the TV screen or on the finished product.

VI. MISCELLANEOUS

The Ohio ERTS program was featured in a full page article of the August 20, 1973 edition of the Cleveland Plain Dealer. Also an exhibit shown in Figure 4 describing the Ohio-ERTS imagery was prepared and displayed at the Ohio State Fair (August 23 - September 3, 1973) by the Ohio Department of Transportation.

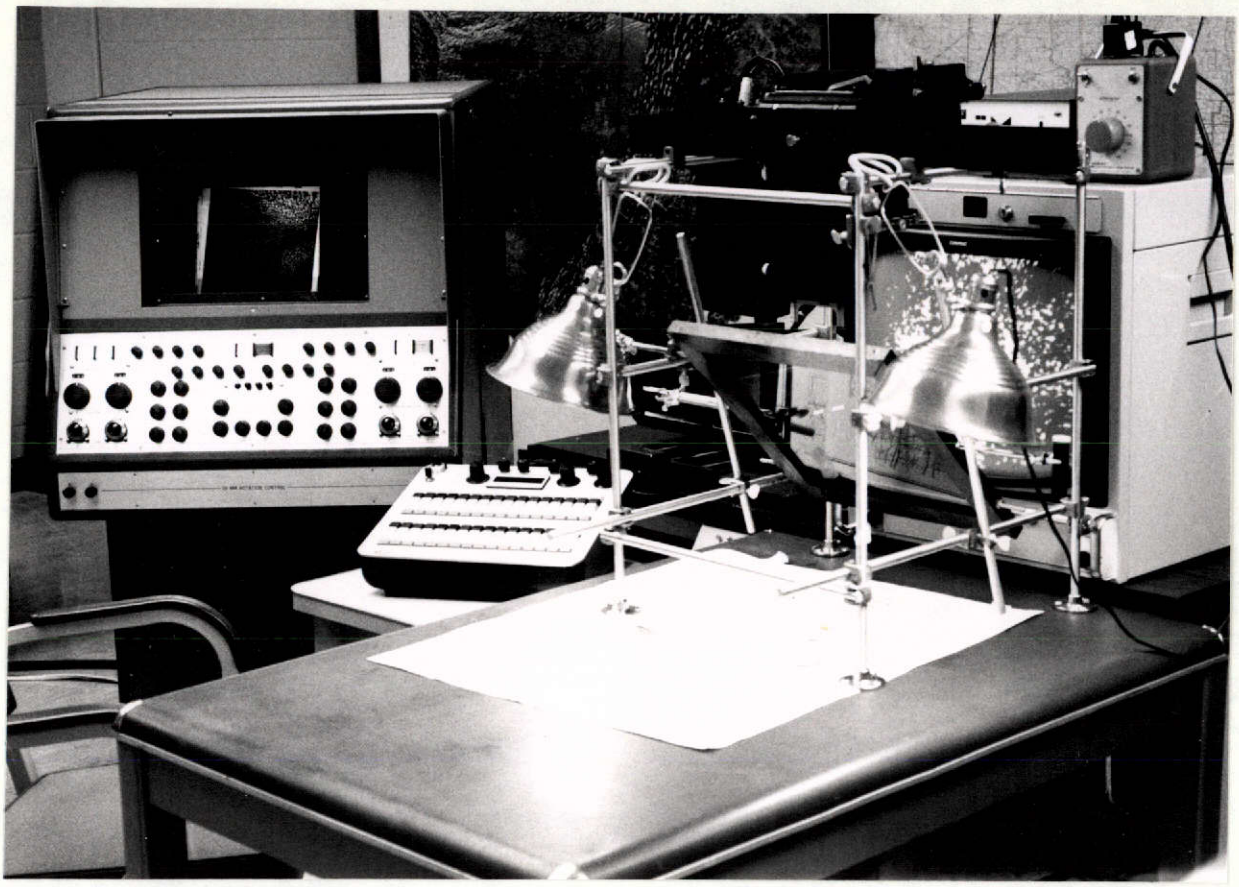

FIGURE 3. ERTS IMAGE TRANSFER AND COMPARISON DEVICE

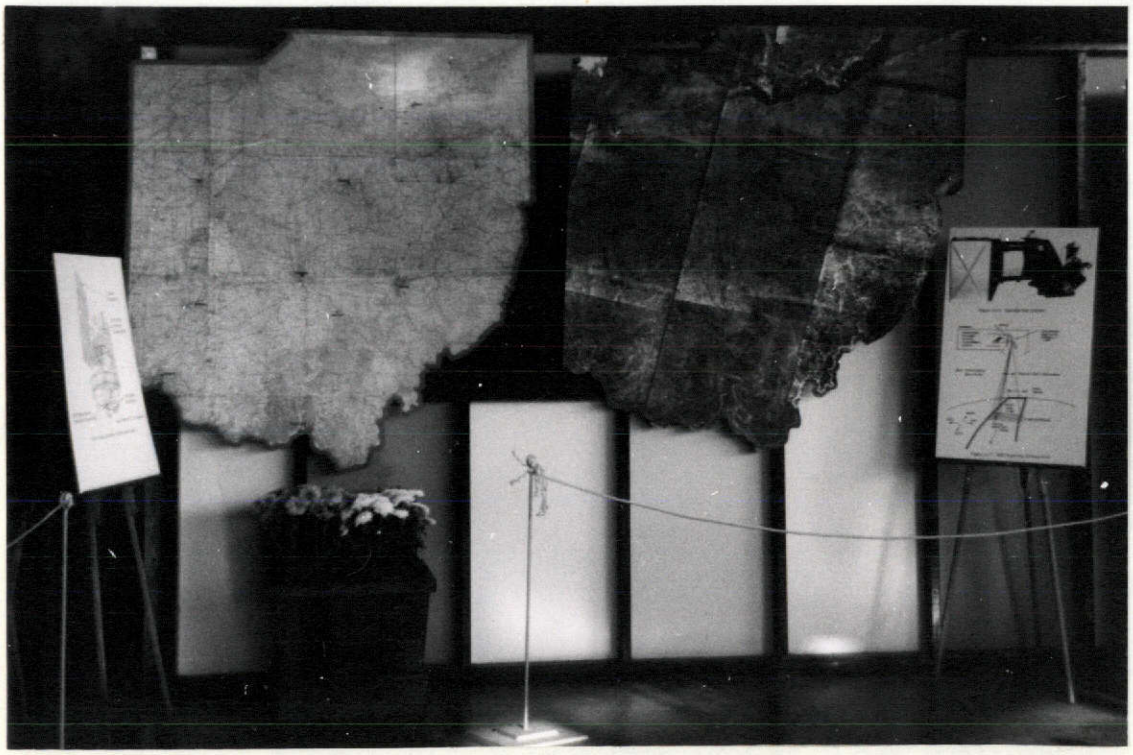

FIGURE 4. OHIO-ERTS PROGRAM DISPLAY AT THE OHIO STATE FAIR

State and Battelle personnel have participated with NASA Lewis officials in formulating a presentation of the Ohio-ERTS program for later presentation to the Governor. 35-mm slides of Ohio orbital survey data, data acquisition and analysis equipment, and orbital survey demonstration products were given to NASA Lewis officials for their presentation.

The State of Ohio currently has requested several 40" x 40" color composites of Ohio so that a mosaic of the entire state can be composed for planning purposes.

During this reporting period, Battelle staff members have also assisted members of the Ohio Biological Survey in their Scioto River Valley land use study. Work also continued on a joint Ohio State University, Ohio Environmental Protection Agency and Battelle Lake Erie study proposal to be presented to the Federal Environmental Protection Agency.

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APPENDIX

12

APPLICATIONS OF REMOTE SENSING TO RESOURCE MANAGEMENT AT THE STATE LEVEL

by

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ABSTRACT

Techniques utilized and progress made toward applying orbital survey data (ERTS/Skylab) to (1) planning and enforcing recently passed strip-mine legislation in Ohio; (2) preparing inputs useful for multiagency and multilevel (state, regional, local) land-use decision making; and (3) real-time problem-solving activities throughout various Ohio governmental agencies in general are summarized. State-level application candidates found inappropriate based on analysis of available imagery scales and suggestions for other uses of remotely-sensed data from higher resolution spacecraft or low-altitude aircraft are noted. And finally, general conclusions regarding current user views as to the opportunities and limitations of operationally using remotely-sensed data at the state level are provided.

INTRODUCTION

The purpose of NASA's ERTS and Skylab/EREP programs is to assess remote sensing from a satellite as a technique for inventorying, monitoring, and eventually managing the earth's resources. The tremendous success of these programs

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(1) Department of Economic and Community Development
(2) Department of Natural Resources
(3) Ohio Environmental Protection Agency
(4) Department of Transportation

Preprint for Symposium on Management and Utilization of Remote Sensing Data, American Society of Photogrammetry, Sioux Falls, South Dakota, October 29-November 2, 1973.

to date in generating unique data on natural and cultural resources the world over is well known. However, how much and how soon the public benefits from this space capability depends upon how effectively this new data resource can be absorbed into the mainstream of all government, public, and private planning and decision making functions bearing on the utilization and management of earth resources.

The purpose of this presentation is to summarize progress and limitations encountered in using satellite data for resource management in a state such as Ohio having highly diversified industry, agriculture, and geography as well as limited remote sensing experience and capabilities.

Ohio, with NASA funding assistance, is making a comprehensive, multidisciplined assessment of the state-level utility of ERTS and Skylab data. Major participating organizations are:

- Department of Economic and Community Development (DECD, Lead Agency)
- Department of Natural Resources (DNR)
- Ohio Environmental Protection Agency (OEPA)
- Department of Transportation (DOT)
- Public Works
- Battelle Columbus Laboratories (BCL)

Figure 1 shows a portion of the Remote Sensing Applications Laboratory at Battelle which is used in concert with state researchers and planners for the routine analysis of incoming ERTS and Skylab/EREP data. Major equipment in this facility as well as that located at state agencies used in the collection and analysis of remotely-sensed data are listed in Table I.

APPLICATION ANALYSES

The usefulness of orbital data, principally ERTS MSS images, in Ohio has been limited thus far to experimental demonstrations of application possibilities. Major satellite data application areas under examination in Ohio are listed in Table II. The table notes the importance of the state need, as well as the potential state operational usefulness. The applications range in scope from a single

TABLE I. DATA ACQUISITION AND DATA ANALYSIS EQUIPMENT CURRENTLY BEING USED ON THE OHIO-ORBITAL SURVEY PROGRAMS

	BATTELLE	
32-Color Viewer	Spatial Data Systems, Inc.	Qualitative & quantitative evaluation of ERTS imagery by converting densities to desired color
Multispectral Viewer Model 20	Spectral Data Corp.	Overlay of up to 4 ERTS images to produce color composites and to enhance specific image features
Multiple Interpretation Module (MIM)	Richards Corp.	Viewing, comparison, magnification and mensuration of ERTS and aircraft imagery
Spectral Radiometer & Recorder	ISCO	Collecting ground-truth radiometric "spectral signatures"
70-mm Multispectral Cameras	Hasselblad	4-camera array used for acquiring aerial multispectral data
K-17 & K-24 Aerial Cameras	Fairchild	Acquire aerial underflight data
	DNR	
K-17 Aerial Camera	Cessna	Acquire aerial underflight data
	OEPA	
Ohio National Guard Helicopter	--	Available upon request to monitor areas of environmental concern
Grant request submitted for purchase & operation of remote sensing aircraft	--	"
	DOT	
Nistri-Analytical Stereoplotter	Nistri-Bendix	Mapping & plotting from ERTS & aircraft photography
K&E Grid Digitizer	K&E	Mapping & plotting from ERTS or aircraft photography
Twin-Engine Plane	Beechcraft	Acquiring aerial photography
6" Zeiss RMK-A	Zeiss	Acquiring aerial photography

B

TABLE II. MAJOR SATELLITE DATA APPLICATION CANDIDATES UNDER EXAMINATION IN OHIO

Application Area	State Need	Potential State Value
Surface mining	> 1/4 million acres affected	Help implement 1972 strip-mine law
Land use	Multiagency priority problem	Provide periodic statewide views of major land-use changes
Air quality	Ohio EPA interest	Test computer model by monitoring smoke plumes
Mapping	Current maps needed at all agency levels	Provide photo base maps
Sanitary land fills	> 1,400 illegal sites estimated	Detect illegal and/or new sites
Floodplains	50% of Ohio cities subject to flood damage	Help define and enforce statewide regulatory law
Outdoor recreation	50 state parks exist--major expansion program underway	Help select new recreation sites
Lake Erie	Pollution and sedimentation studies by OEPA and DNR coastal zone management	Improve state water quality planning and enforcement activities
Mineral estimates	Ohio Geological Survey	Determine remaining coal reserves
Acid mine drainage	To detect surface water seepage into nonactive underground mines in southeastern Ohio	Prevent vegetative and wildlife destruction
Metropolitan areas	Transportation network/ residential densities	Aid in land-use legislation & transportation planning
Soil studies	Soil erosion problems	Enhance water quality, land value, and agricultural productivity
Agriculture & forestry	To inventory crop and timber acreage	Improve agriculture and forestry resources

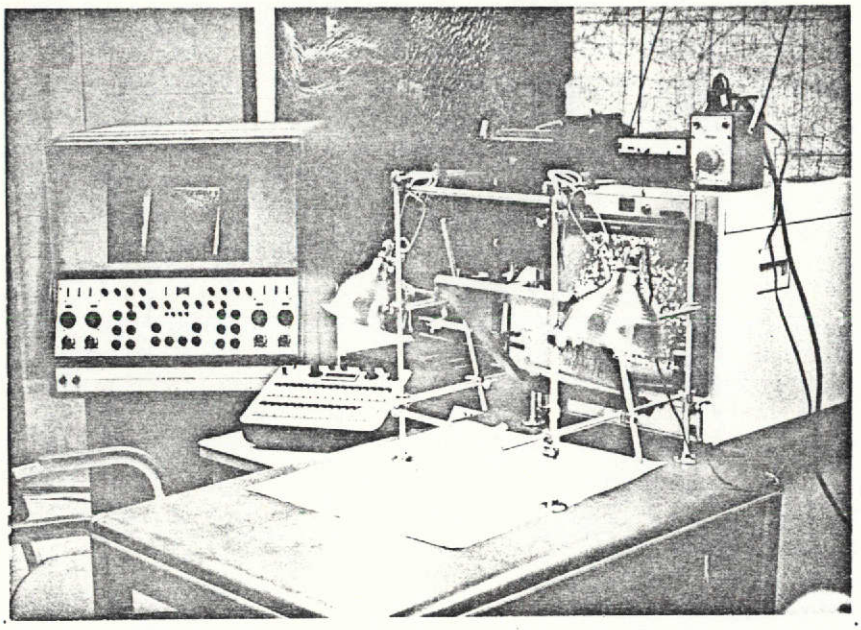


Fig. 1. View of data analysis equipment used by Battelle and State of Ohio personnel to analyze satellite earth resources data on Ohio.

department's interest in soil erosion in a highly localized area to multidepartmental interests in statewide land-use trends. In this presentation, the analytical efforts employed and results obtained in evaluating the usefulness of satellite data to Ohio surface mining and land-use interests will be described in detail. Status of studies of other application candidates and the results of several real-time, problem-solving exercises will be only briefly noted.

Surface Mining

State Need

Surface mining in Ohio is a major industry requiring more and more state attention. Foremost among current state efforts relate to legislative improvements in surface-mining controls. For example, in April, 1972, Ohio enacted a more rigid strip-mine law containing provisions for:

- Determining and holding reclamation bonds
- Establishing and enforcing reclamation requirements
- Monitoring the status of the strip-mining activity and assessing environmental degradation.

To effectively enforce this law the state must have the capability and resources to:

- Inventory past strip-mine activity, both reclaimed and unreclaimed
- Inventory current strip-mine activity
- Determine condition of unreclaimed land and type of reclamation practice required to restore it
- Verify data and reclamation plans contained in strip-mining permit applications.

Thus, the emergence of ERTS was quite timely if data could be used to inventory, monitor, and assess stripping and reclamation activities.

Application Results

Utilizing the equipment at the Battelle Remote Sensing Applications Laboratory we have looked at ERTS MSS imagery, aircraft photos, and on-site radiometric (spectral) signatures of the same strip-mined areas. Conclusions thus far are that ERTS MSS imagery can indeed be utilized to inventory (within the inherent accuracy limitations of scale) the extent of strip mining in Ohio. Assessment of the condition of the stripped terrain is problematical but can be done effectively. Monitoring the actual activity of strip mining can be done provided a sufficient time has elapsed, and appropriate imagery (cloud cover permitting) is obtained. Obviously aircraft aerial photos can provide greater precision of measurement and interpretation, but at a far greater cost in both collection and analyzation of the information.

Figure 2 shows a typical ERTS-1 scene of southeastern Ohio (Band 5) with strip-mined areas clearly discernible even at the 1:1,000,000 scale. Figure 3 compares enlargements of this strip-mine area for Bands 5 (visible) and 7 (near infrared) showing the capacity of Band 7 to detect standing bodies of water.

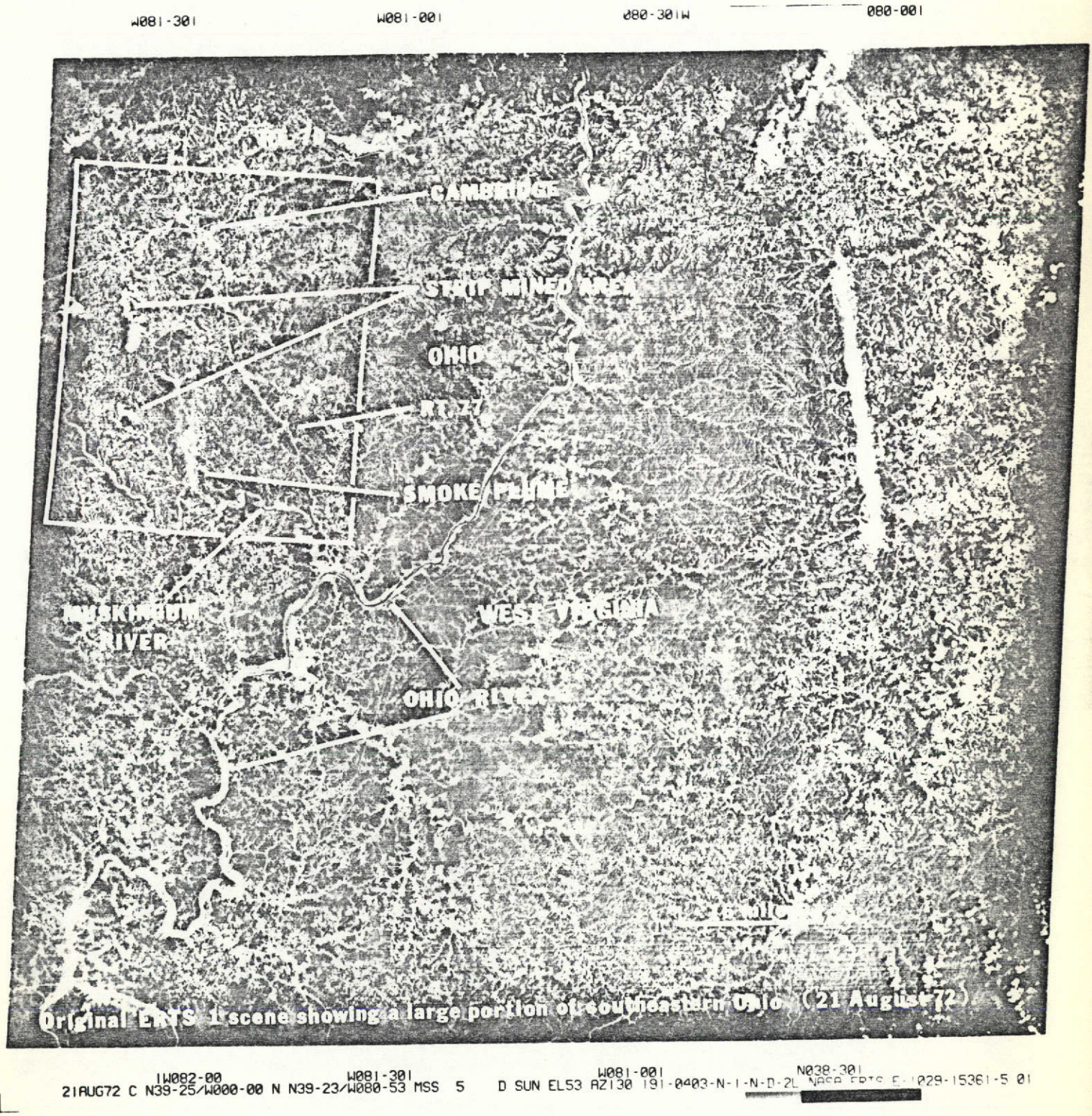


Fig. 2. Typical ERTS-1 (Band 5) scene of southeastern Ohio showing how pronounced strip-mining areas appear.

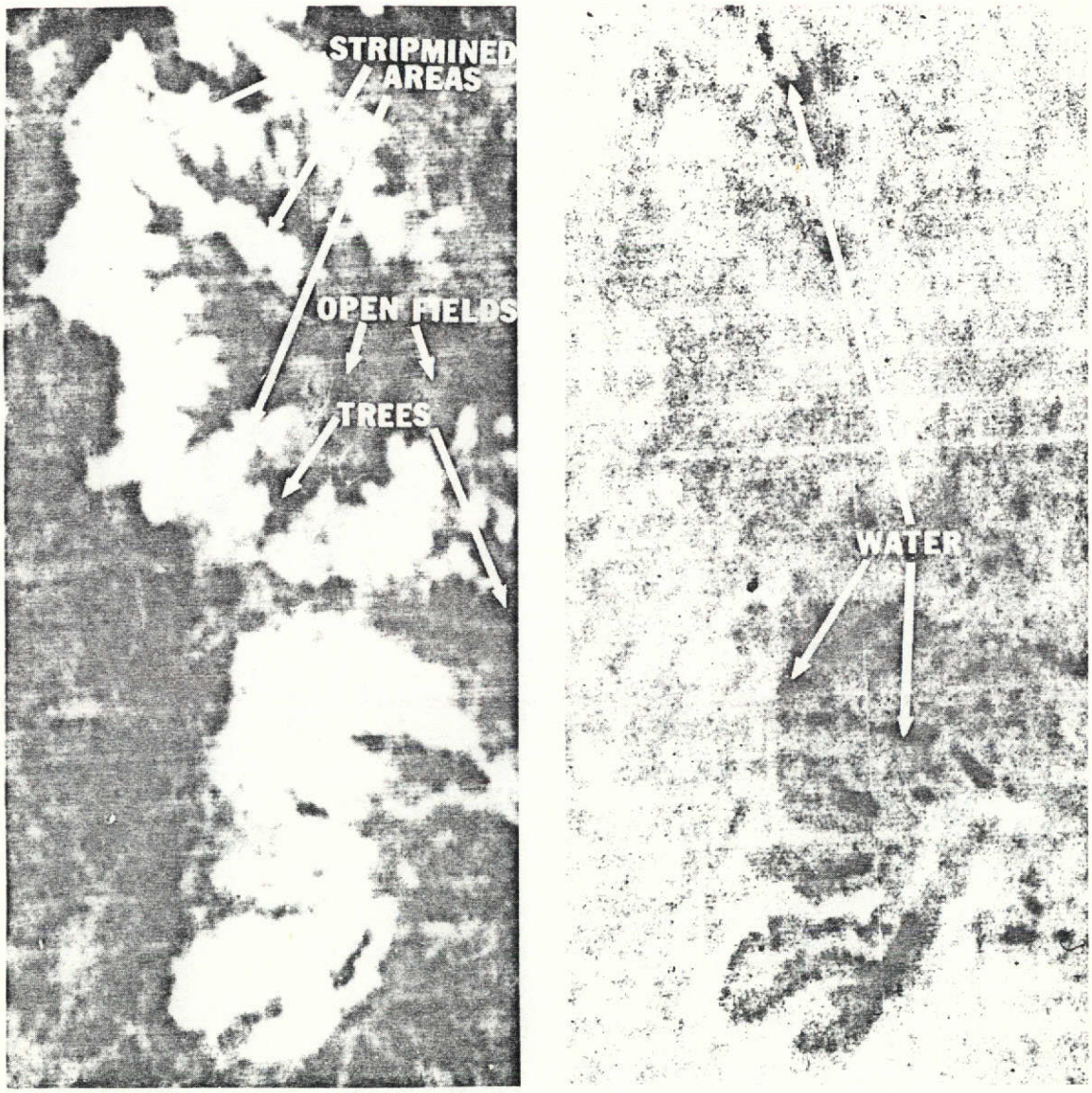


Fig. 3. Comparison of strip-mine areas as seen on ERTS-1 Band 5 (left) and Band 7.

By comparing aerial underflight panchromatic photography of strip-mining areas at a scale of 1:24,000 with ERTS imagery blown up to the same scale it was found that the examination of ERTS Bands 5 and 7 in some instances yields more information than the comparative aircraft photography. This was the case for at least two features: water and residual vegetation in the strip-mine area. The image density slicing viewer can discern 25-30 density differences in a single strip-mine area which may eventually be relatable to spoil bank materials, high walls, and other features appearing in a typical Ohio strip mine (see Figures 4a-c).

Since a strip-mine area is obvious by the removal of the so-called overburden or original vegetation, the restoration of such an area can be monitored by the increased recovering of such base areas. Older strip-mine areas under reclamation are best discerned on ERTS Band 7. They distinguish themselves by a less dense vegetation cover than the surrounding areas covered by original vegetation and by a large number of small ponds and lakes. Strip-mine areas 30 years old and older have been observed. Analyses of areas under reclamation are made by comparing the area under reclamation with newly strip-mined land (0 percent reclamation) and original vegetation (100 percent). Degrees of reclamation are then made as 0-25 percent, 25-50 percent, 50-75 percent, and 75-100 percent.

Using the built-in electronic planimeter capability of the Spatial Data Image Density Slicing Viewer, and standard planimetric techniques, an effort was undertaken to demonstrate that (1) the unreclaimed strip-mine areas could be enhanced to the exclusion of any other terrain feature using ERTS imagery, and (2) that an accurate area calculation was possible in a relatively short period of time. A test survey of areas strip mined and areas reclaimed was made of Harrison County in eastern Ohio using Band 5 of an ERTS-1 image. The resulting area calculation achieved in this survey corresponds quite favorably to Department of Natural Resources data as shown in Table III. Total time to complete this one county survey using ERTS-1 imagery was less than a day.

We are currently looking at the feasibility of extending the demonstrated capability of ERTS to detect and inventory strip mining to other surface-mining operations in Ohio. Figure 5 shows how surface radiometric signatures of typical gravel pits, limestone quarries, and strip mines in Ohio differ from one another. Hopefully, these differences are adequate to permit differentiation of surface-mining type on satellite imagery.

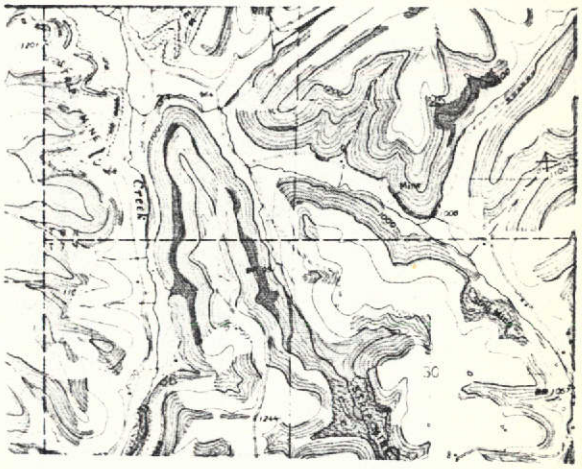


Fig. 4a. 1:24,000 USGS topographic map sheet (reduced by 1/2 original format) showing typical active Ohio strip-mine area.

Fig. 4b. 1:24,000 aircraft photo of the same strip-mine area. Photos such as these were used to demonstrate that ERTS imagery has sufficient image quality and area fidelity to perform strip-mine inventories (photo by NASA Lewis Research Center).

Fig. 4c. Electronically magnified and enhanced ERTS-1 MSS Band 5 image of the same area. Note similarity to aircraft photo above.

TABLE III

COMPARISON OF STRIP-MINE AREA ESTIMATES FOR HARRISON COUNTY, OHIO		
Total Land Area -- 258,000 Acres		
	ODNR	ERTS-1
% of strip-mined land	19.01	18.4
Area affected	49,064 acres	47,472 acres
% of unreclaimed strip-mined land	6.8	6.2
Area unreclaimed	17,603 acres	15,996 acres

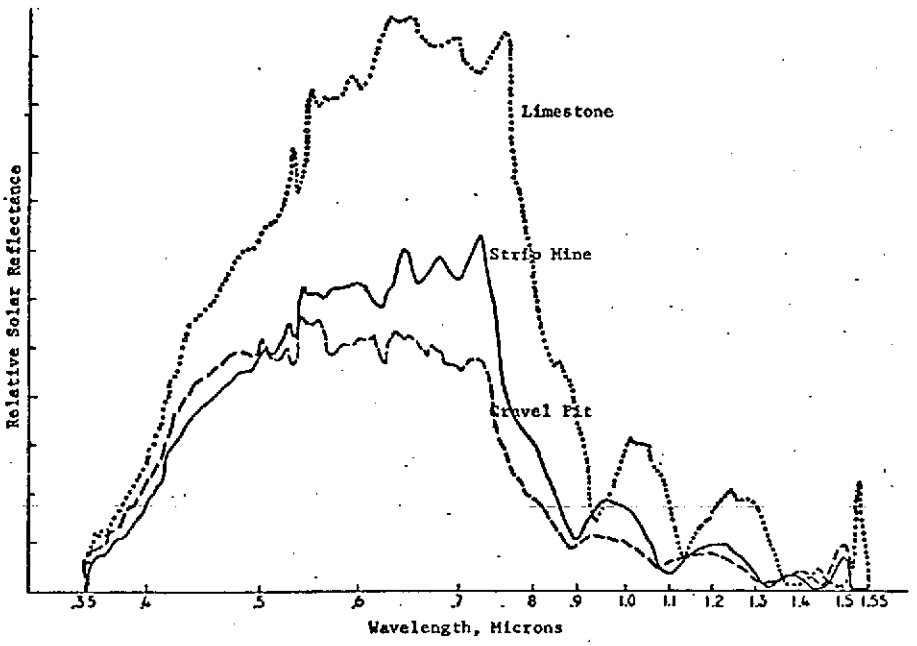


Fig. 5. Comparison of relative reflectance curves of limestone quarry, gravel pit, and strip mine operations in Ohio. These data indicate definite differences in the reflectance characteristics of the visible portion of the electromagnetic spectrum. Such data are necessary for distinguishing types of surface-mine operations in Ohio using ERTS data.

Land Use

State Need

Ohio, like every other state, faces increasing multiagency requirements for the preparation of a relatively inexpensive and periodic revision of a statewide inventory of the land and natural resources for general planning, land-use decision making, and legislative purposes.

Ohio has previously constructed a map at the scale of 1:250,000 for the entire state at a cost of somewhat over $250,000. ERTS photography provides an opportunity to update statewide land-use mapping at a significantly lesser cost and would represent an improvement in terms of the completion time. ERTS photography required to map the entire state has become available in less than a year. In the 1960 land-use study, aerial photography over a period from 1958 to 1964 was generalized. Of course, aerial photography for the entire state could have been flown during a shorter time span but this would have been much more costly than making maximum use of available photography.

This is not to say that there aren't some critical trade-offs involved. For example, the 1960 study was done at a scale of 1:24,000 and then combined and generalized to arrive at the 1:250,000 and 1:500,000 maps. Thus, detailed land-use work sheets were available as back-ups and for use by planners requiring detailed information. Using the ERTS photography this won't be possible except for cases wherein detailed land-use maps were made for selected areas of the state. Also, the possibility exists that future operational survey satellites may have the capability to obtain higher resolution photography for selected "high interest" development areas on a less frequent basis, e.g., once or twice a year coincident with low cloud cover conditions.

Application Results

A preliminary evaluation indicates that available orbital survey data are adequate for mapping State of Ohio land uses at least for scales of 1:250,000 and 1:500,000. These mapping scales will be useful to the state in overall long-range,

land-use planning and in meeting the requirements of the pending National Land-Use Policy Act. These preliminary utility assessments already completed confirm that such mapping projects are feasible and have established the techniques required to prepare the land-use products.

Since it was not the intent of the program to develop a classification scheme, a prominent scheme developed and used by the U. S. Geological Survey was adopted. An outline of this classification scheme is shown in Table IV, and the level to which each major classification has been evaluated thus far for Ohio-ERTS land-use interests is shown on the right side of the table. The feasibility of updating Ohio's 1967 land-use map is demonstrated in the series of enlarged and color enhanced ERTS-1 and Skylab/EREP photographs of the Columbus and Cleveland, Ohio, metropolitan areas shown in Figures 6-11.

Other Activities

In addition to the above major application evaluation activities, several real-time, problem-solving experiences in which ERTS data utility was examined can be cited:

(1) The capability of ERTS to detect areas mined many years ago has been used by the Ohio Geological Survey to determine how much of certain coal seams remain to be mined. In this study, rather than a time-consuming search of old permit records, ERTS photography was used to determine if certain suspected areas had been strip mined many years ago.

(2) Ohio EPA researchers are seriously interested in using satellite photography for Lake Erie water quality management practices. Figures 12 and 13 show the ability of ERTS to provide an overview of Lake Erie pollution and sedimentation plumes heretofore unavailable. From a preliminary analysis of repetitive scenes, OEPA personnel are optimistic that ERTS data may significantly improve understanding of the dynamic characteristics of Lake Erie and make more accurate modeling possible. In addition to a better definition of nearshore and offshore developments, OEPA personnel are interested in evaluating such specific correlations as: littoral drift/lake dispersions, algae masses, temperature phenomena, water level (for coastal zone management, also an interest of the Department of Natural Resources), and wave refraction.

TABLE IV. USGS LAND-USE CLASSIFICATION SYSTEM FOR USE WITH REMOTE SENSOR DATA*

Level I	Level II		ERTS, Analysis Status (Includes Levels 1 & 2)
01. Urban and Built-up Land			
	01.	Residential	TBD**
	02.	Commercial and Services	TBD
	03.	Industrial	TBD
	04.	Extractive	Yes
	05.	Transportation, Communications, and Utilities	Yes
	06.	Institutional	TBD
	07.	Strip and Clustered Settlement	Yes
	08.	Mixed	Yes
	09.	Open and Other	Yes
02. Agricultural Land			
	01.	Cropland and Pasture	Yes
	02.	Orchards, Groves, Bush Fruits, Vineyards, and Horticultural Areas	TBD
	03.	Feeding Operations	TBD
	04.	Other	TBD
03. Rangeland			
	01.	Grass	N/A***
	02.	Savannas (Palmetto Prairies)	N/A
	03.	Chaparral	N/A
	04.	Desert Shrub	N/A
04. Forest Land			
	01.	Deciduous	TBD
	02.	Evergreen (Coniferous and Other)	TBD
	03.	Mixed	Yes
05. Water			
	01.	Streams and Waterways	Yes
	02.	Lakes	Yes
	03.	Reservoirs	Yes
	04.	Bays and Estuaries	Yes
	05.	Other (Ice and Snow)	Yes
06. Nonforested Wetland			
	01.	Vegetated	Yes
	02.	Bare	Yes
07. Barren Land			
	01.	Salt Flats	N/A
	02.	Beaches	TBD
	03.	Sand Other Than Beaches	TBD
	04.	Bare Exposed Rock	TBD
	05.	Other	TBD
08. Tundra			
	01.	Tundra	N/A
09. Permanent Snow and Icefields			
	01.	Permanent Snow and Icefields	N/A

* "A Land-Use Classification System for Use With Remote Sensor Data", J. R. Anderson, E. E. Hardy, & J. T. Roach, Geological Survey Circular, 671, Washington, D. C., 1972.

** TBD = To be determined by future analysis.

*** N/A = Classification not applicable to Ohio.

Fig. 6. Magnified and color enhanced portion of an ERTS-1 MSS Band 5 photograph of 15 October 72 showing recently urbanized areas superimposed on a Franklin County, Ohio, highway map (scale, 1 inch = 2 miles).

Fig. 7. Magnified and color enhanced portion of an ERTS-1 MSS Band 5 photograph of 15 October 72 superimposed on a 1:48,000 aircraft index photo sheet of 17 April 72. This picture highlights the recently urbanized areas of northeastern Columbus, Ohio.

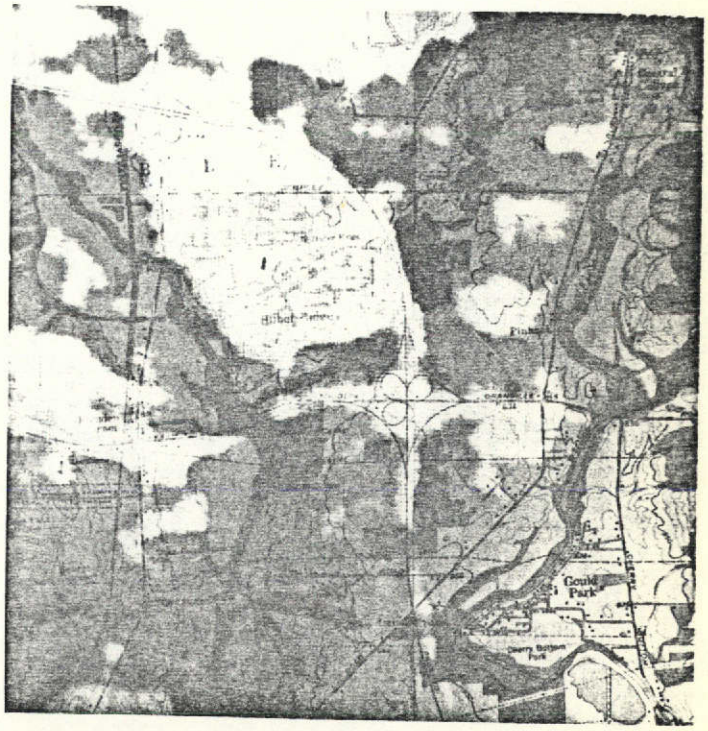


Fig. 8. Magnified and color enhanced portion of an ERTS-1 MSS Band 5 photograph of 15 October 72 superimposed on a 1964 1:24,000 USGS topographic map sheet of northeastern Columbus, Ohio. As in Fig. 7 recently urbanized areas of northeastern Columbus, Ohio, are highlighted.

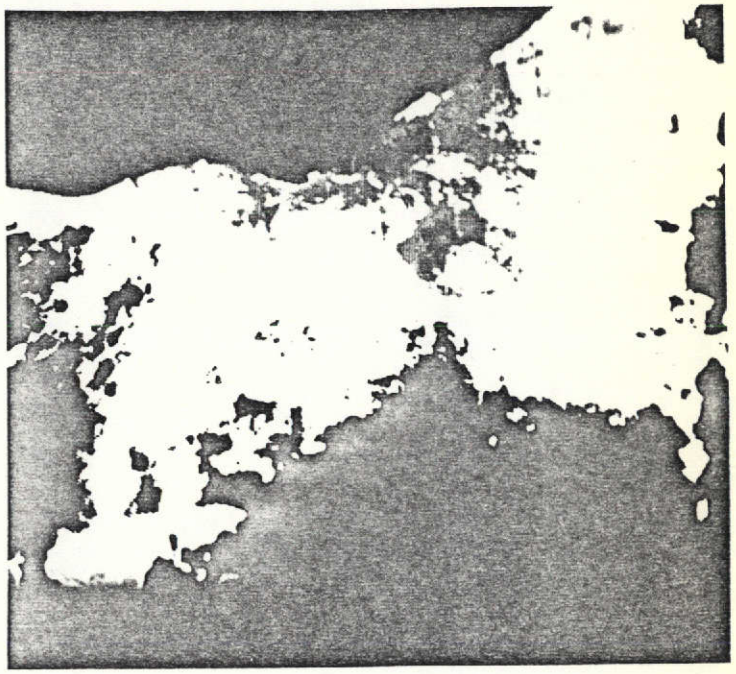


Fig. 9a. Total urbanized areas of the Cleveland, Ohio, area are accentuated in this magnified and color enhanced portion of a Skylab 190A photo taken 12 June 73.

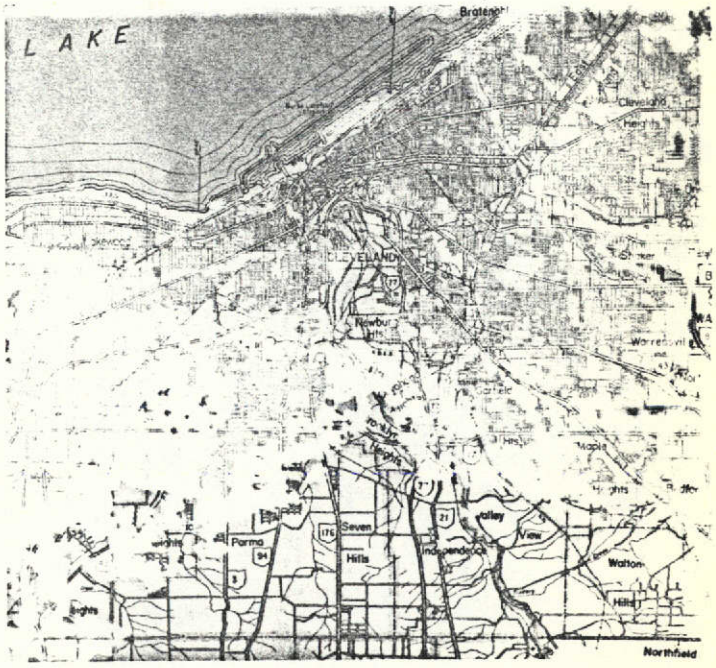
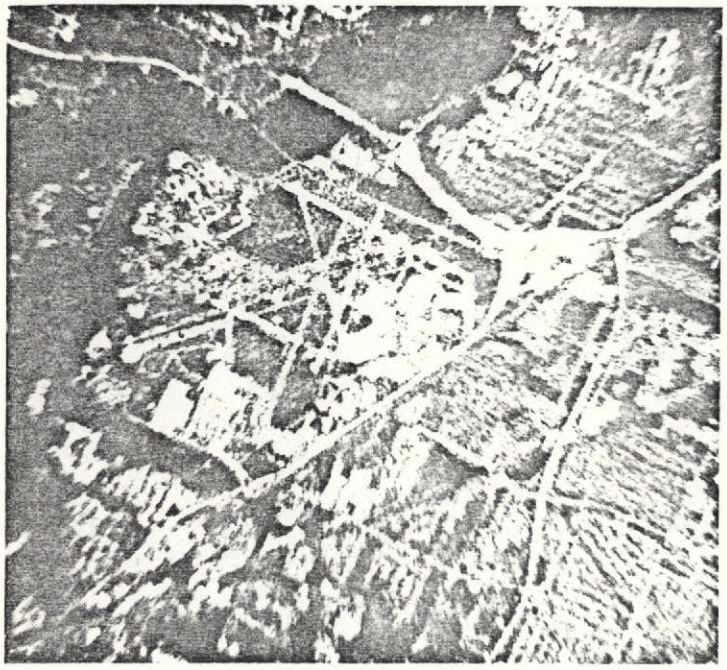
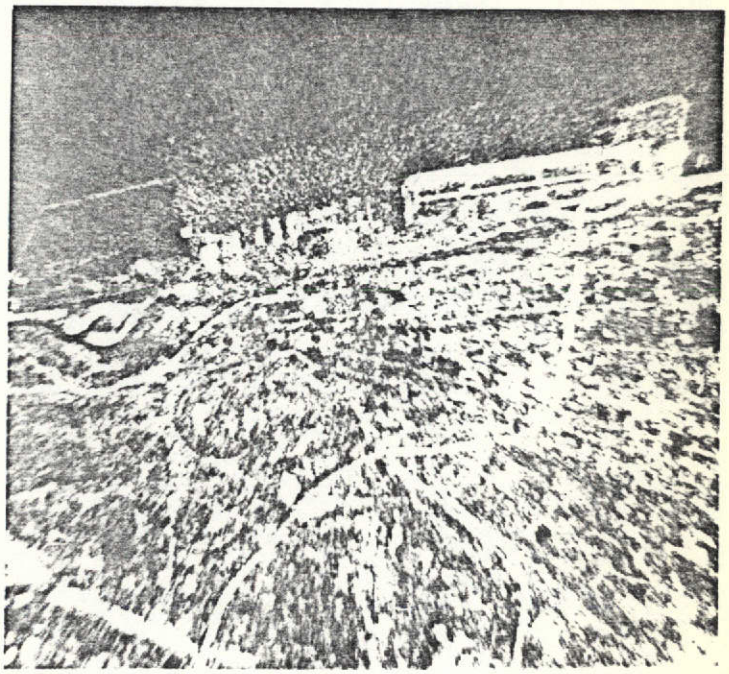


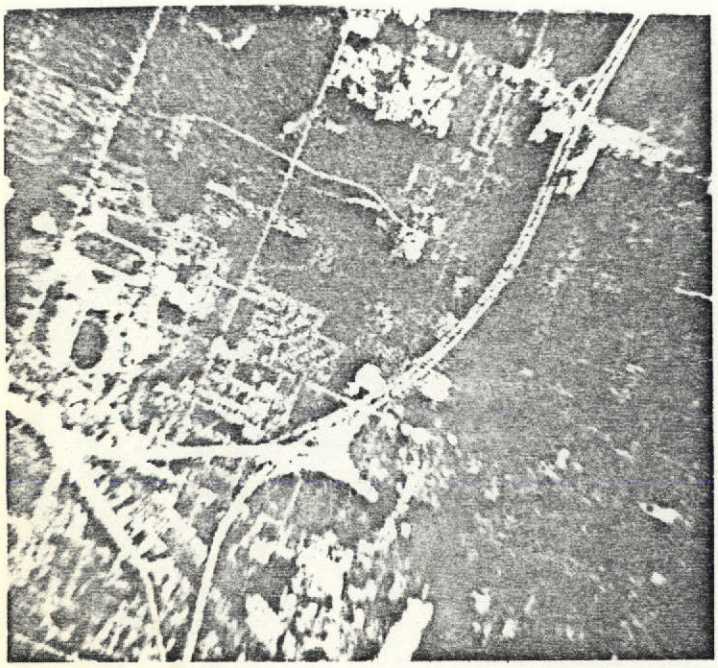
Fig. 9b. The same color enhanced portion of the Skylab image superimposed upon a Cuyahoga County highway map (scale, 1 inch = 2 miles).



Area 1



Area 2



Area 3

Fig. 10. Enlargements of Skylab 190A imagery of Cleveland, Ohio (12 June 73), illustrating the extent that urbanized features are discernible. Note, for example, bridges, airports, and transportation networks as well as the median strip visible between the lanes of I-271.

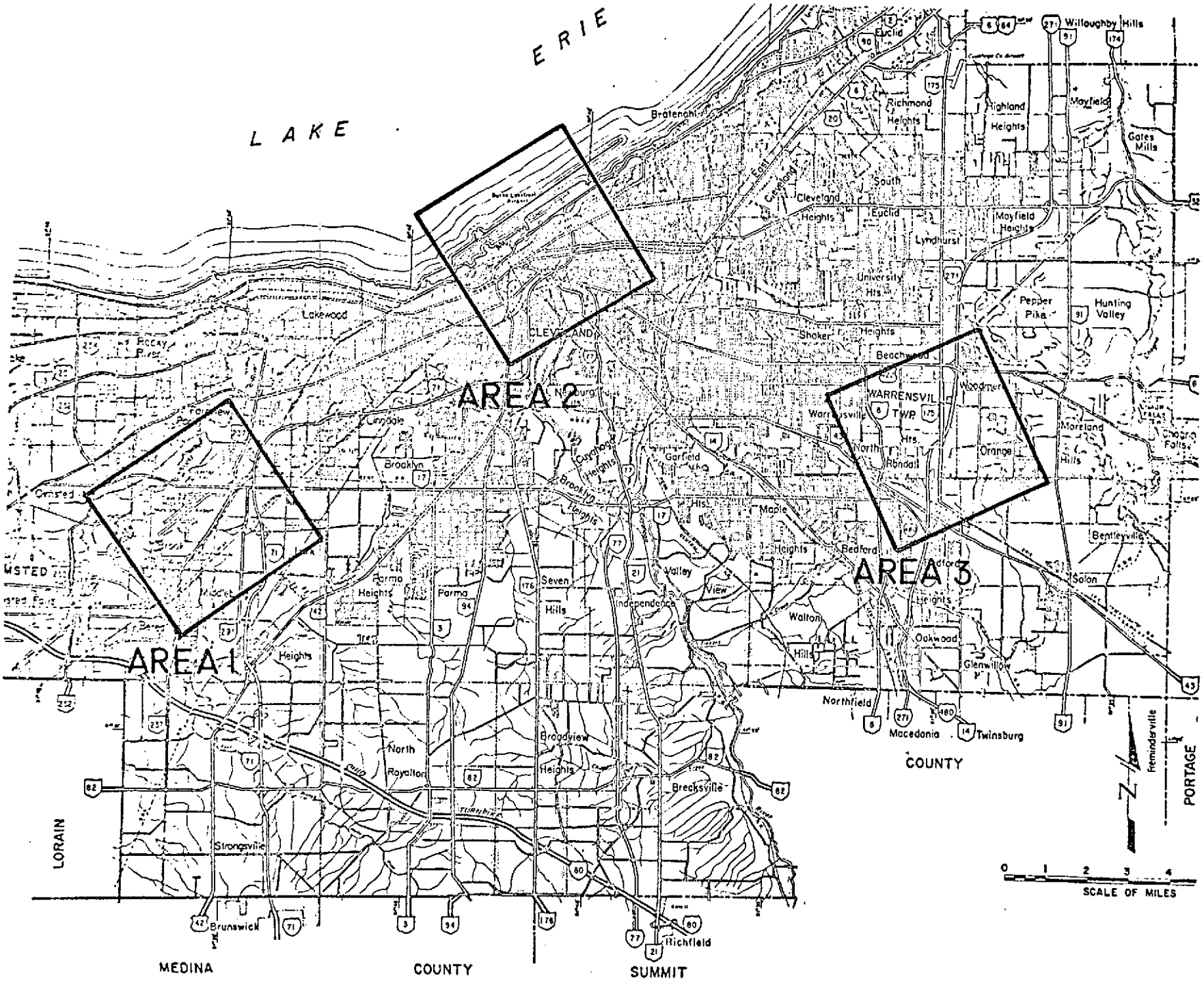


Fig. 11. Corresponding map of areas shown in Fig. 10.

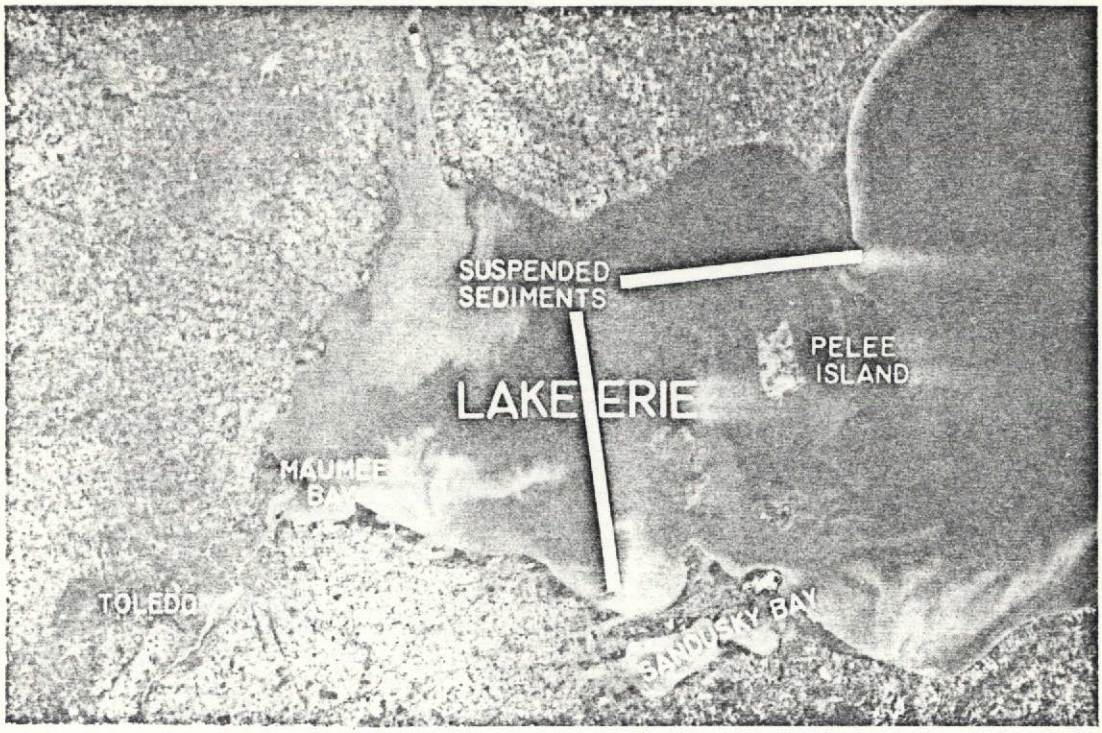


Fig. 12. ERTS-1 photo taken 27 March 73 showing sedimentation patterns in western Lake Erie (Band 5, 6,000-7,000 Å). Note that the Sandusky Bay land areas appear partially inundated (see Fig. 13 for comparison).

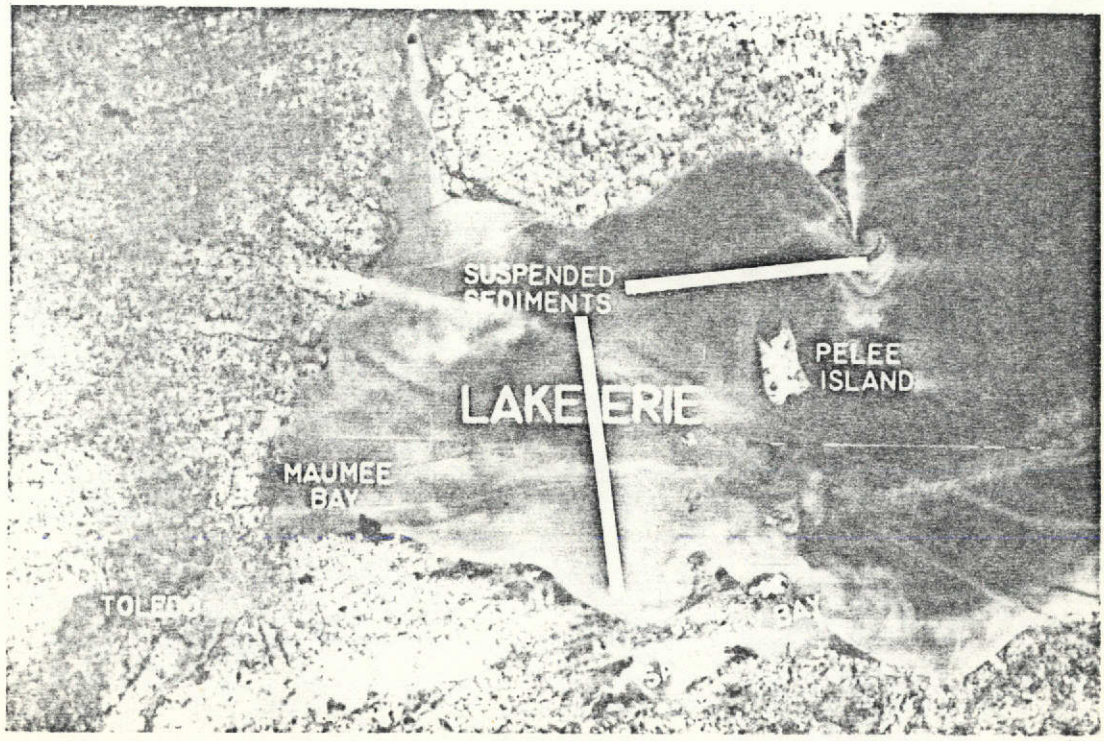


Fig. 13. ERTS-1 photo taken 14 April 73 showing sedimentation patterns in western Lake Erie. Also note that water in Sandusky Bay area has receded (see Fig. 12 for comparison).

Realizing that these areas cannot be treated in great depth under the present ERTS program, the Ohio EPA is working jointly with The Ohio State University and Battelle's Columbus Laboratories to design a program for Federal EPA support for greater data collection and satellite imagery analysis of Lake Erie.

(3) OEPA personnel have made a preliminary assessment of the ability of ERTS imagery to provide an inventory of sanitary land fills (many illegal) throughout the state. The resolution of current ERTS imagery was found inadequate for this application.

(4) Since major smoke plumes are discernible in ERTS imagery, the Ohio EPA plans to use ERTS data on the location, movement, and confluence of smoke plumes to test computer air motion models being developed for use in statewide air pollution control practices.

(5) Enlargements of ERTS data have been made available to the Ohio Biological Survey to support their concentrated study of the Scioto River basin.

(6) Department of Natural Resources has also begun studies on the seepage of surface water into old underground mines in southeastern Ohio and the resulting acid mine water pollution. ERTS imagery has been used to detect possible wet areas in which surface water is prominent by vegetative patterns and vegetation differences which may be due to adverse affects of such pollution.

(7) Department of Natural Resources used ERTS imagery in their study of soil erosion problems in Meigs County, Ohio.

(8) Department of Natural Resources is interested in determining to what extent ERTS data could be used to detect new developments encroaching upon the floodplain and from this the extent to which the repetitive nature of orbital survey data could be used to monitor the floodplains. Results will be important to the ability to enforce statewide floodplain regulations under legislative consideration in Ohio.

(9) The Department of Transportation is looking at satellite data from both transportation planning and support to other agencies from the viewpoint of base maps. The Department has prepared photo mosaics of the entire state at a scale of 1:250,000 for general planning purposes. They hope to eventually use such up-to-date ERTS base maps for general land and soil studies, land development plans, tax information, geological/construction implications, noting the availability of existing surveys, and as an aid to determine updating requirements for USGS topographic map series.

(10) The Ohio State University is cooperating with state government agencies and BCL in pursuing the educational implications of remote sensing applications. Specialized workshops, interdepartmental seminars, and courses in remote sensing have been organized in which satellite/aircraft data on Ohio have or are being analyzed.

SUMMARY

Although progress to date has been significant and swift, the application of remotely-sensed data and particularly satellite data has only just begun in Ohio state government. The development and operational employment of specific techniques and applications for state government is very difficult, time consuming, and most important, quite expensive. Ohio for one simply cannot afford to develop this technology on its own.

These meetings are a great help in exchanging ideas, techniques, and findings. The major problem is user acceptance! Another problem is insertion into the main stream of decision-making activity. State government is doing its job, perhaps not as effectively as we would like, but it is doing the job. Thus, the general philosophy among many state officials is "Why should we bother with this stuff?", or "Can you show how it will help me do my job?", and these are indeed valid questions to which we must effectively respond. The days of ill-defined practices and equipment developed at great expense are giving way to austere but effective management and utilization of data. Collection technology is far ahead of utilization (data reduction) technology as is evidenced by the vast amount of imagery that has never been utilized even superficially.

Accordingly, we must try to arrange for increased budgeting at all levels of government to accelerate the application and utilization of existing and anticipated remote-sensing data. To create a larger, state-user demand for remote-sensing products and services requires that application efforts in the near future be as <u>simple</u> and as <u>specific</u> as possible.