SEMI-ANNUAL PROGRESS REPORT NO. 6

May 1, 1976 - October 30, 1976

APPLICATION OF REMOTE SENSING TO STATE AND REGIONAL PROBLEMS

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Submitted By

W. Frank Miller*
Jerry C. Harris
Bradley D. Carter
David E. Pettry

MISSISSIPPI STATE UNIVERSITY
P. O. Drawer FD
Mississippi State, MS 39762

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*Program Coordinator

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I. INTRODUCTION

Although a tremendous proliferation of research in the area of space imagery applications has occurred since 1972, the full potential of the space program has not as yet been realized. The impetus provided by the Gemini and Apollo missions led to the research and development explosion created by the LANDSAT and SKYLAB missions. Unfortunately, the vast potential user community has not reaped the benefits of this storehouse of information - a vacuum has been created between scientific achievement and operational utilization of the data. The problem of technology transfer has many ramifications, not the least of which is user education in the concepts of sensor resolution, data formats available, and feasible uses. Other facets of the problem include data acquisition and transformation to products acceptable to the users. Optimized institutionalization of data management, product transfer, and education of the user community are also of major concern. With respect to the latter, various structures have been suggested, and NASA has implemented technology transfer through funding of ASTV projects and Remote Sensing Applications Programs.

The problems mentioned above assume even greater significance in view of the plans for launch of LANDSAT 3, and the LANDSAT FOLLOW-ON package.

Mississippi State University was awarded a grant by NASA to effect remote sensing technology transfer in Mississippi and the Mid-South region and to demonstrate the operational uses of remote sensing in providing the basic data and information necessary to solve problems of state and regional nature. Thus, the primary purpose of the Remote Sensing Applications Program at Mississippi State University is for members of the University community to participate in activities that improve effective communication between the scientific community engaged in remote sensing research and development, and the potential users of modern remote sensing technology. The state-of-the-art remote sensing capability is significantly beyond the present-day applications of the potential user group. The program serves to accelerate the operational use of proven remote sensing technology which will help to insure reasonable pay-off from the better usage of space, high altitude, and other remote sensing products evolved by the NASA program.

Outputs of this program are assisting the State of Mississippi in recognizing and solving its environmental, resource planning, and socio-economic sensing systems.

In order to achieve this purpose, the participants in this program and collaborating departments are interacting with State and federal agencies, counties, and citizen groups in the following ways:

1. Identifying and analyzing state and local problems, real needs of major importance, which remote sensing techniques of demonstrated feasibility can help to solve.

2. Assisting potential users to learn how to better use remote sensing where it is appropriate to the solution of specified problems.
3. Conducting remote sensing applications programs to bring remote sensing technology to bear upon the solution of selected high priority problems.
4. Identifying additional research needs to which remote sensing technology may be applied and establishing priorities for meeting these needs.
5. Stimulating, guiding, and aiding the faculty and students at Mississippi State University, and others in the State of Mississippi, to utilize information from the NASA Earth Resources Satellites and the Aircraft Programs in research and public service activities. This program is augmented by cooperation from the EROS Users Assistance Center, National Space Technology Laboratories at Bay St. Louis, MS, and the George C. Marshall Space Flight Center at Huntsville, AL.
6. Provide a center of expertise and an operational laboratory for short-course training of users, and provide assistance to departments and agencies in utilizing appropriate remote sensing technology in solving their problems, and making certain specialized equipment available to users.

Program participants consist of faculty research personnel interested in the multifaceted aspects of the application of remote sensing technology to problems in Mississippi, the region, the nation, and the world.

The program participants are organized so as to help foster the growth and improve the effectiveness of the group, and to strive toward accomplishing the purposes of the program.

Approximately ten months ago, the thrust of the Program was somewhat changed; heretofore, emphasis was placed on manual techniques which were within the financial capabilities of even the poorest government agencies. The basic philosophy was to extract the maximum amount of information with a minimum investment in hardware. Although this type of activity will still occupy a small portion of the total Program effort, major emphasis is now being placed on the utilization of space data and technology to demonstrate operational uses in problem-solving.

W. Frank Miller, Associate Professor of Forestry, is serving as Program Coordinator. Other key personnel in the program include: J. C. Harris, Landscape Architecture; Dr. David E. Pettry, Agronomy (Soils); and Dr. Bradley D. Carter, Associate Professor of Computer Science.

II. PROJECT PROGRESS REPORTS

A. Bark Beetle Project - Copiah County

Objective

The objective of the study is to provide information to the Mississippi Forestry Commission (MFC) which will allow the organization to identify and map high-risk forest stands; that is, those stands which have characteristics that cause them to have a high probability of attack by the Southern pine beetle.

Accomplishments

As indicated in Semi-Annual Progress Report No. 5 (November 1, 1975 - April 30, 1976), efforts were made to contact industrial forestry and U. S. Forest Service personnel in southwestern Mississippi to ascertain interest in a formal presentation of the results of this study.

Replies indicating interest were received from the Georgia-Pacific Corporation, International Paper Company, St. Regis Paper Company, and the Mississippi National Forests. Accordingly, a one-half day workshop was held on June 17, 1976, at the Bude Work Center of the Homochitto National Forest. Eight persons representing the various organizations were in attendance.

Current Status

Also noted in No. 5 were plans to attempt classification of high-risk stands by means of digital LANDSAT tapes and digitized contour data from a U. S. Geological Survey 1:250,000 quadrangle sheet. Progress since the last report has been slight; the digital contour data were only recently received from the National Cartographic Information Center (NCIC) at Reston, Va.

Work has been held in abeyance until all software programs obtained from the George C. Marshall Space Flight Center were operational, and tested on the Sixteenth Section project.

Plans

The digitized contour data will be used in conjunction with the LANDSAT digital tape analyses to attempt delineation of high-risk stands. This classification will be verified by comparison with existing stand locations as obtained from manual interpretation of low-level color infrared imagery, and from ground truth.

B. Water Quality

Objective

The objective of this study was to develop an inexpensive means of monitoring water quality; specifically, total suspended solids.

Current Status

It was felt that this project was reaching the point of diminishing returns, and therefore, it was terminated.

C. The Yazoo-Little Tallahatchie Flood Prevention Project

The objective of this project was to develop an operational technique to identify and locate land areas which needed, planting for erosion control.

Accomplishments

The procedure developed in this project was adopted by the U. S. Forest Service and utilized for site mapping.

Current Status

The project was terminated.

D. Resource Inventory - The Homochitto National Forest

Objective

The objective of this project is to demonstrate the utility of various remote sensing products in supplying information for different levels or intensities of planning in natural resource management: specifically, to supply information necessary to evaluate wildlife and forest habitat quality and recreational potentials.

Accomplishments

This project remained essentially inactive awaiting the testing of the software package from MSFC and digitized contour data from NCIC.

Current Status

This project is inactive.

Plans

Terrain information will be utilized in conjunction with signature analysis of digital LANDSAT data in order to extract the maximum amount of information concerning productive potentials for the various forest resources.

E. Forest Resource Inventory of Sixteenth-Section Lands - Copiah County

Objective

The objective of this project is to determine the most efficient procedure for updating inventories of 16th-section

lands, and to provide a basis for more intensive management of the State's forest resource.

Accomplishments

The procedure given in Progress Report No. 5 is approximately 30% completed. However, the major thrust of the work has been concerned with the software package obtained from MSFC. A progress report was presented at a regional meeting of the American Society of Photogrammetry; the abstract is presented here, and the paper is included in the appendices.

Presented At
The Second Annual Meeting
of the
Mid-South Region of the American Society of Photogrammetry
Chattanooga, Tennessee
November 1976

A COMPARISON OF METHODOLOGIES AND
DATA PRODUCTS COMMONLY USED TO
ANALYZE LAND COVER

ABSTRACT

A comparison of methodologies of classifying land cover employing three data sources is presented in this study. The classification system developed by the U. S. Geological Survey and expanded by the researcher is used to classify land cover utilizing each of the data sources, color infrared imagery 1/24,000 scale, color infrared imagery 1/120,000 scale, and LANDSAT computer compatible tapes (CCT). Land cover is classified manually with the aid of a Zoom 240 stereoscope on both

the 1/24,000 and 1/120,000 scale imagery. Imagery of the same area is processed on a scanning microdensitometer to produce digital data recorded on magnetic tapes for further processing, along with the CCT's, on a UNIVAC 1106 to produce gray tone maps by assigning gray shades to the ditial density data on the CCT's and magnetic tapes. Using the 1/24,000 CIR imagery as a source of registration points and with the aid of a Numonics graphic calculator, signatures for various forest types are developed by digitizing training samples from the CIR imagery and then searching the spectral range of each of the four bands on the CCT to develop a signature on each. Land cover classification on the maps is accomplished by the use of the HINDU clustering algorithm whereby terrain is developed by connecting each histogram cell to all of its higher density neighbors. The end result being a computer assisted classified map. Details of level of information output, accuracy of interpretation, relative costs of both the remote sensing data products and methods of analysis and time required will give the comparison desired. Problems such as obtaining and preparing coverage from each of the three data sources for the same area and time required to convert the computer programs from the IBM system for which they were initially written to the UNIVAC system will be discussed.

Figure 1 presents a pixel-by-pixel analysis of one of the sixteenth-sections on a three-level classification wherein only forest stands of pure pine and pure hardwoods were recognized, and all other land cover classes were placed in the third category.

The scanning microdensitometer at MSFC was utilized to provide another data source. Selected sixteenth-sections were scanned on both high altitude (1:120,000) and low altitude (1:24,000) color infrared imagery.

Manual interpretation of the high and low altitude imagery has been completed.

Current Status

Histograms and statistical analyses of threshold values for other Level I cover categories are being obtained. Also under investigation are signature analyses of sub-categories of the major levels.

Plans

When each type of classification or interpretation has been completed for each type of data (LANDSAT, scanning microdensitometer, manual), a comparison of the level of classification attainable, accuracy, and cost per unit area for each of the data sources will be made.

F. Natchez State Park

Although the procedure has been transferred to the Mississippi Park Commission, and the results utilized in

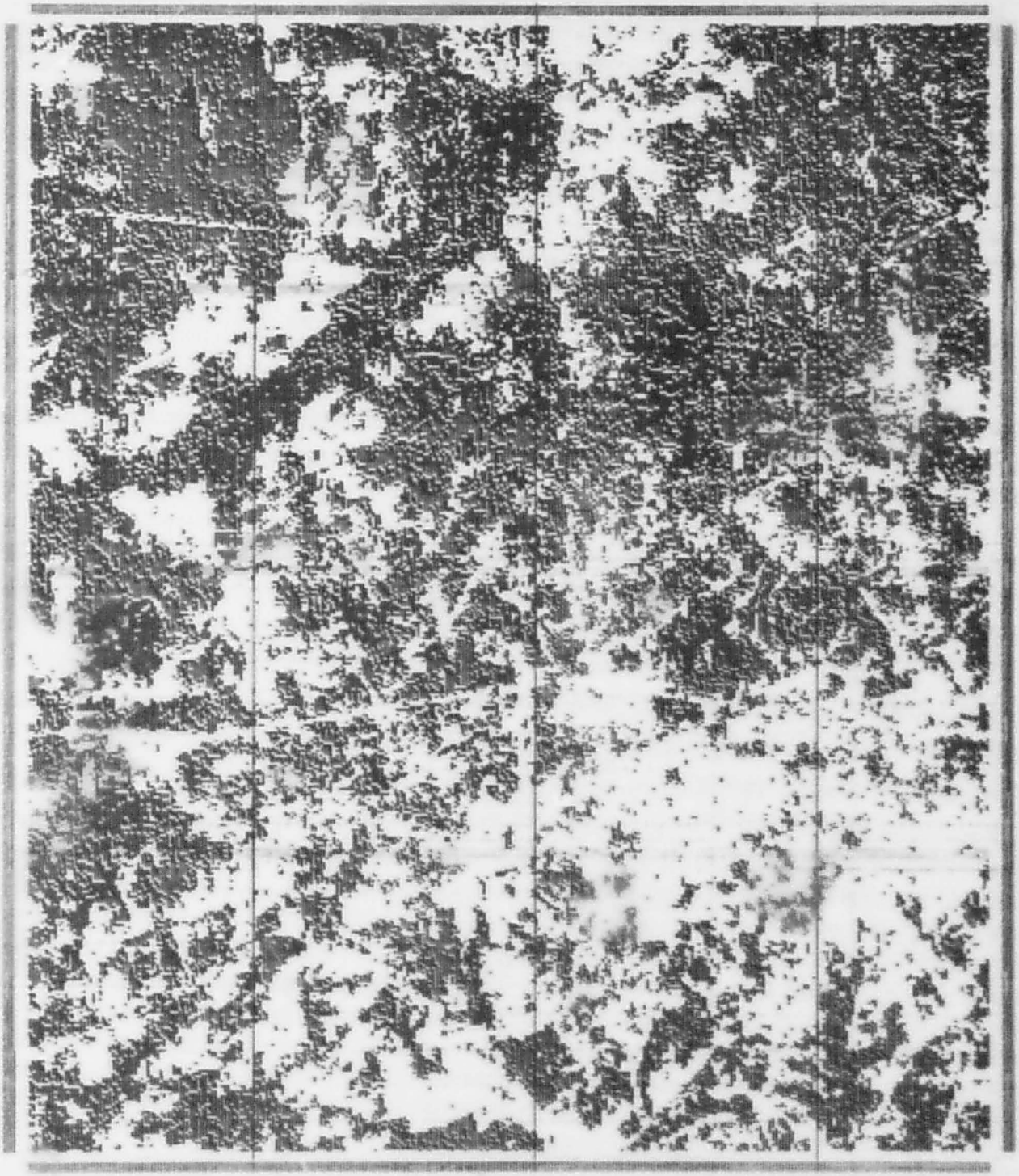

Figure 1. A Computer-Assisted Cover Classification map. Pure pine in green; pure hardwood in brown; all other cover types in white.

preliminary park planning, the concepts developed in this project are still being utilized in other areas.

A paper utilizing the concept of Computer-Assisted Land Use Planning as applied to timber harvesting operations has been prepared for presentation to the Forest Engineering Section of the American Society of Agricultural Engineers at Chicago, IL, in December 1976.

G. Remote Sensing Applications in Land Use Planning

This project is a modification of a project included in the (1975-76) Continuation Proposal. The rationale for the project is the rapidly increasing public awareness of the potential impacts of the Tennessee-Tombigbee Waterway project in northeastern Mississippi. This awareness has stimulated a concern for comprehensive and rational land use planning decisions. Two state agencies have requested assistance with a pilot project to illustrate the time and cost efficiency and utility of data obtained by remote sensing as a basis for decision-making. The Golden Triangle Planning and Development District (GTPDD) and the Mississippi Research and Development Center (R & D Center) are active cooperators on this project.

Objective

The objective of this project is to demonstrate the need for a data management system based largely on remotely sensed data in the land use planning process.

Accomplishments

The pilot study of Lowndes County, Mississippi, is progressing at a steady rate, according to the procedure outlined in the 1975-76 Continuation Proposal. Two conferences have been held with participation from the R & D Center, the GTPDD, and principal investigators from the Applications Program (Landscape Architecture, Computer Science, Agronomy, and Forestry). These preliminary conferences have established general objectives and goals and attendant data needs. Based on the statement of preliminary needs, digitization of variables has proceeded.

The prelimary list of 26 variables selected is given below:

1. centroid evaluation
2. topographical aspect
3. slope
4. land capability classes
5. water - existing and proposed Tombigbee Waterway
6. forest composition
7. forest density
8. forest age
9. agriculture
10. existing land use
11. existing residential

12. existing industry
13. existing public
14. existing recreation
15. aquifer recharge areas
16. vehicular transportation
17. rail transportation
18. air transportation
19. existing utilities
20. existing city limits
21. existing sanitary landfills
22. existing landforms
23. watersheds
24. polluted area
25. mineral and mining
26. population distribution

Based on the land capability analysis technique developed by the Program Coordinator, land classes reflecting inherent use potential have been mapped on high altitude imagery and digitized. A 1:62,500 U. S. Geological Survey quadrangle map is being digitized in order to obtain topographic variables (# 1-3 above).

A recent, cloud-free, LANDSAT pass over the study area has been obtained for current land cover information.

Current Status

Digitization of variables is proceeding, and preparation of a final variable listing is in progress. Preliminary models for vulnerability and attractiveness are in preliminary stages of development.

Plans

Early in January, 1977, another conference will be held at the R & D Center in Jackson in order to finalize variable selection and model development. Variable digitization will continue, and will be completed by the end of February.

H. Application of LANDSAT Data to Strip Mine Inventory and Reclamation Progress

Objective

The objective of this project is to provide the Geological Survey of Alabama with the necessary software and interpretive technique for monitoring strip mine occurrence and reclamation activities on a periodic basis. This information will also be made available to the appropriate state agency in Mississippi when a pending reclamation law is passed.

Accomplishments

Periodic searches have been made in order to determine dates of high-quality, cloud free LANDSAT passes for the 1976 growing season. To date, only the frame covering the northern portion of the proposed study area has been found to be suitable.

Geological Survey personnel have completed ground truth observations of selected strip mines, and have obtained aerial coverage of the major portions of the study area.

Current Status

This project is essentially inactive, and will remain so until suitable LANDSAT data can be obtained.

Plans

A meeting with Survey personnel has been selected for early January, 1977, to reassess the location or extent of the proposed study area.

A search for suitable data will continue.

I. Remote Sensing Data Analysis Support Systems

Objective

It is the objective of this effort to provide the data collection and processing capabilities necessary to support the various demonstration projects and to provide a low-cost operational center so that such projects can have continuing input into the overall objective of the Applications Program, both for present and future use.

Accomplishments

Since the last semi-annual progress report, most of the data processing and data analysis effort has been directed toward improving the techniques used for land cover and land use classification using the LANDSAT computer compatible tapes and toward developing effective output displays of the results. To this end, the following specific items have been accomplished:

1. Translation programs for the LANDSAT tapes have been developed and tested.

2. Image display programs for the plotter and printer have been developed and tested.

3. A geographic referencing program obtained from NASA-MSFC for translating map coordinates to LANDSAT pixel coordinates has been adapted and tested.

4. A digitizer for outlining classification training samples and for augmenting the LANDSAT data with additional geographic data has been purchased.

5. An on-line handler program to receive the output from the digitizer and point coordinates to pixel designations for area, line, and point specification is presently being tested.

6. Two classification algorithms, ELLTAB (a supervised maximum likelihood procedure developed at NASA-JSC-ERL) and HINDU (an unsupervised clustering algorithm), have been obtained and are in the process of being checked out.

In addition, improvements in the Computer Assisted Land Use Planning (CALUP) routines have been made to support the Lowndes County Project (Project G).

Current Status

Improvements in both the efficiency and the effectiveness of the software and the analysis techniques are in process. Specifications for several new pieces of display equipment are being developed and should be released for bids shortly. It is felt that, with the new display equipment, the available data processing capabilities can fully support the other projects of the Applications Program.

Plans

Plans for future efforts involve the development of several analysis algorithms for the use of classified LANDSAT

data in land suitability studies, in forest resource inventory, and various other planning and inventory applications. Associated with these plans is the need for an improved image display capability. Although display programs for the printer and plotter have been developed, neither provides a suitable display capability for most applications. It is essential to the success of future applications that a video display device (either color or grey scale) and an improved hard-copy capability (such as high quality grey-scale plotter) be obtained. With the implementation of the software presently under development and this improved hardware, it is felt that the long range success of this project would be insured.

III. A PROPOSAL FOR LOCATION AND EVALUATION OF POTENTIAL INDUSTRIAL SITES ALONG THE TENNESSEE-TOMBIGBEE WATERWAY CORRIDOR

This proposed project is being presented at the request of the Mississippi Research and Development Center.

Pre-Proposal
Identification, Classification and Evaluation of Potential Industrial Sites Along the Tennessee-Tombigbee Waterway Corridor

Objectives: To 1) survey the land in a 10-mile-wide corridor centered on the Tennessee-Tombigbee Waterway; 2) identify and select parcels suitable for industrial development (including previously identified parcels and all other lands); and 3) classify those suited

parcels as to the most appropriate industrial type and catagory on the basis of specific needs for each major industrial type.

Procedure: LANDSAT satellite remote sensing imagery and high altitude NASA EROS underflight imagery will be selected over the Tennessee-Tombigbee Waterway corridor. The imagery will be statistically and optically processed and enhanced to provide measurements and information for classification of land as to suitability for industrial use and industrial type. Certain statistical data will be gathered to provide further insight into assessment of land for industrial sites.

	Sources		
Factor	Processed* LANDSAT MSS Imagery	High Altitude* Under Flight Imagery	Statistical++ Record Data
Locational Factors	Location of all parcels of land		Maps (township plats) will be used for parcel definition and location
	Proximity to Waterway		
		Accessibility via road, railroad transportation, and utilities	
	Proximity to existing indue-trial sites		Maps will be used to assist in measurement
	Proximity to residential sites for access of labor and activity incompatability assessment		Maps will be used to assist in measurement

Factor	Processed* LANDSAT MSS Imagery	High Altitude* Under Flight Imagery	Statistical++ Record Data
Locational Factors Continued	Proximity to commercial facilities		Maps will be used to assist in measurement
	Proximity to public infra-structure elements-fire stations, hos-pitals, landfills	Certain public infrastructure facilities not available on MSS imagery	
	Size and shape of each parcel		
Physical Factors		Slope of land and length of slope	
		Soil type bearing capacity and water holding capacity	
			Potential flood threat or water damage
		Local relative relief	
	Subsurface features and geology	Geologic features not visible on MSS imagery	Geology and structure maps and reports
		Minor obstructions and impediments	
Economic Factors	Existing land use		
	Existing alternative land uses	Existing alternate land uses not available on MSS imagery	Land cost estimates
Institutional Factors			Land zoning, ownership and tenure
			Government and legal restrictions

Factor	Processed* LANDSAT MSS Imagery	High Altitude* Under Flight Imagery	Statistical++ Record Data
Environmental Factors	Vulnerability of land-erosion		
	Dangers of atmospheric and water pollution and effects on related or adjacent land uses		
	Destruction of irreplaceable natural resources		

*Quality control and accuracy assessment will be evaluated and checked with ground truth procedures.

++Available from published government reports and public records.

This data will be compiled into a list of land attributes for each parcel in the study corridor. These will be evaluated as to their suitability for industrial use. Methodologically, the analysis will begin with a survey and evaluation of the entire Tennessee-Tombigbee corridor to determine on a basis of certain key critical industrial variables -- proximity to Waterway, commercial, and residential land uses, soil bearing capacity, flood danger and related physical considerations -- which lands are suitable for industrial use. The unit of analysis for this initial evaluation will be 10 hectars in size. It is anticipated that a substantial proportion of the corridor will be eliminated from consideration as "not prime industrial land." Those sites selected as appropriate for industrial development will be further analyzed to determine for which of the three main classes of

industry they are best suited. (The locational criterion applied will be from the references listed at the end. The spatial unit of analysis for this individual intensive site analysis will be 1.1 acres in size.

The major alternative classes of industry being 1) raw material processing, 2) fabricating and light manufacture, and 3) complementary, linked, assembly, final product processing and warehousing. Each of these three types of industrial activities have very different characteristics and very different locational and site requirements. The site attributes of each parcel and combination of parcels in the Tennessee-Tombigbee corridor will be evaluated on the basis of the criterion in the abstract references for these three classes of industry. Each parcel will be catagorized as to the industrial type for which it is best suited.

Products: The products of this study will be 1) a tabulated and classified presentation listing all the industrially appropriate parcels of land in the Tennessee-Tombigbee corridor, 2) a listing and table of the attributes of each parcel, 3) a map of these parcels that are suitable for industrial development, 4) maps of the values of each attribute that determine industrial suitability, and 5) maps of those parcels which are by virtue of their remotely sensed characteristics better suited to each of the sub classes of industry -- raw material processing, complementary and light manufacturing, and final processing

and warehousing. The information and findings on suitability of land for industry and by industry type is needed for planning and decision making for optimum land use by the Mississippi Research and Development Center which is charged with the analysis and evaluation of potential industrial sites along the Tennessee-Tombigbee canal. Additionally, this study will provide them with the "consistant analytical procedure they are seeking to accurately and realistically set priorities for industrial site acquisitions." The Mississippi Research and Development Center will cooperate in this project to the extent of furnishing lists of preliminary sights, characteristics, and studies completed on the area, providing data, documentation, space and equipment where appropriate, as well as man power involvement in terms of guidance and assistance.

REFERENCES

International Cooperation Administration, Plant Requirement for Manufacture of Lead Pencils

Creenhut, M. L.; Plant Location in Theory and Practices, University of North Carolina

ESTIMATED BUDGET
FOR TENNESSEE-TOMBIGBEE
POTENTIAL INDUSTRIAL SITING STUDY

Project Director (5% of time) 9-month period	$ 630.00
Graduate Students (3), $2500 each, 9-month period	7,500.00
(1) Primarily in laboratory work (1) Primarily in computer and analysis work (1) Primarily in field work	
Supplies and Expendable Material	700.00
Field Trip for Ground Truth Calibration or for Data Collection Verification or Consultation	700.00
Presentation of Finding at Professional Meeting	300.00
Final Report Preparation and Material	120.00
	$9,950.00

IV. LIST OF SPECIAL ASSISTANCE OFFERED

Assistance in the form of data products, resource materials, and interpretive assistance was provided to both students and faculty from various departments of the University such as Geology and Geography, Archeology, Wildlife and Fisheries, Forestry, and Agronomy. Assistance was also provided to Stanley Associates of Muscatine, Iowa, and Harland Bartholomew & Associates of Atlanta, Georgia.

Interpretation assistance and mapping was provided for the Golden Triangle Regional Airport to provide information for the FAA.

Utilizing the techniques developed in the Bark Beetle Project (Project A), beetle infestations in the Piedmont of Georgia were evaluated for the Division of State and Private Forests of the U. S. Forest Service. Also, resource materials and information were supplied to EPA on beetle infestation.

Another outgrowth of the Program was a request from the U. S. Forest Service to train personnel of the Delta National Forest to stand map the forest on color infrared imagery.

Information or publications from the Program were supplied to the following people or agencies:

Land Use Division
Natal Provincial Administration
Natalia

Mr. David Smith
White River (AR) National Wildlife Refuge
U. S. Department of Interior

Mr. Paul Howell
Union Camp Corporation
Montgomery, Alabama

Geo Abstracts Ltd
University of East Anglia
Norwich, England

Gordon E. Howard
E.P.A.
Vint Hills Form
Warrenton, Virginia

Woodlands Division
International Paper Company
Natchez, Mississippi

The Nature Conservancy
Washington, D. C.

The Mississippi Natural Heritage Program
2304 Riverside Drive
Jackson, Mississippi

Program personnel worked closely with the Governor's Office of Science and Technology (OST) on a special assistance project.

OST was responsible for providing basic data to the Mississippi Natural Heritage Program (MNHP) concerning a 33,000 acre tract in the Pascagoula River bottom. The MNHP was in turn responsible for advising the Mississippi Legislature as to the advisability of the State's purchasing this tract. Personnel of the Applications Program using 1/24,000 color infrared imagery, type-mapped the entire tract to provide data which was used in the decision-making process. Eight forest species or species groups (associations) were recognized together with 3 size classes and 3 density classes; thus, 72 forest habit mapping units could be mapped.

The Mississippi Legislature subsequently approved a bond issue to purchase the area.

V. SHORT COURSES AND WORKSHOPS

As mentioned in Project A, a workshop was held for industrial and federal foresters to aquaint them with the risk-rating system for the Southern pine beetle.

Short course materials and interpretive equipment were supplied to Union Camp Corporation for a workshop on remote sensing applications in forestry.

Although funded by the George C. Marshall Space Flight Center, Applications Program personnel and display materials were utilized in a remote sensing application display at the annual meeting of the East Mississippi Council, and at a workshop, "The Status of Remote Sensing in Mississippi." A copy of the Proceedings is included in Appendix II.

APPENDIX I

A COMPARISON OF METHODOLOGIES AND DATA PRODUCTS COMMONLY USED TO ANALYZE LAND COVER

Presented by

Robert Maggio

The objectives of this study are to develop a rapid low cost method of obtaining information for forest resource inventory and to elevate the level of information output, accuracy of interpretation, and relative costs of both the remote sensing data products and methods of analysis. At present, numerous classification systems based on remotely sensed data are being utilized for classification of land cover and use. Most of the data analysis systems are developed to be used with a single data source; consequently, there has been little work done in the area of systems comparisions.

Classification systems range in sophistication from manual interpretation of low level aircraft imagery to supervised computer recognition programs, and in accuracy from 95 to 100% correct identification to 50 or 60% correct recognition. Thus far, systems which have been developed are not sufficiently flexible to produce information concerning the variety of parameters required for sound planning in natural resources.

Previous work in forest land cover classification includes work done by the U. S. Forest Service (1972) in which a scanning microdensitometer was used on 1:120,000 scale photos and then, using a clustering algorithm to group picture elements, type maps were produced from computer print outs. DeSteigner (1974) used LANDSAT, Skylab and high altitude data sources to generate type maps and found that Skylab required the least time for delineation and interpretation. Including resource type classification, interpretation time was estimated to be seven times greater on high altitude than on LANDSAT.

These studies deal with comparisons of classification systems or with results obtained from different data sources. Comparative figures of cost, accuracy, detail, and time are sketchy. The multislage study of my on going research proposes to deal with these factors to produce comparative figures.

The study area is Copiah County, Miss. which is located in the SW portion of the state. Topographic features vary from rolling plains to rugged hills, with elevations varying from 300 to 550 feet above sea level. The rolling hills are products of erosion of the upland areas and are underlain by Miocene strata and some alluvial terrace materials. The county lies in the Long Leaf Pine Hills and hardwood species consist of the oak hickory group.

The soils of the county are developed from clastic sediments, being composed of clay, silt, sand and gravel; these materials were deposited in deltaic, fluvial and aeolian enviornments.

Ground truth data will be used that was collected for an application project dealing with inventory of 16th section lands in Copiah Co., and supplemented with data from the Miss. Forestry Commission. Additional ground truth data will be collected where necessary for an unsupervised computer analysis.

Low altitude aircraft CIR imagery, 1:24,000 scale, high altitude aircraft CIR imagery 1:120,000 scale and LANDSAT digital tapes are being used to classify forest land cover and will be compared to the ground truth data.

Manual interpretation was performed on the low and high altitude imagery and natural resource infromation was classified by preparing acetate overlays. This interpretation was done with the aid of a Bausch & Lomb Zoom 240 steroscope mounted on a Richards light table. Parameters

necessary for the comparative study of level of information output, accuracy of interpretation, relative costs, and detail will be noted from the manual interpretations.

Using a rotating drum scanning microdensitometer, transparencies of the low and high altitude CIR imagery were scanned. Scan lines were taken at 50 microns for the low altitude and 25 microns for the high altitude and the resulting 256 shades of gray were recorded digitally on magnetic tapes. The tapes are to be processed on a UNIVAC 1108 computer, the 256 graey shades will be condensed to 64 and with the aid of a clustering algorithm to group picture elements maps suitable for resource inventory analyses will be produced. Again here, as in the manual interpretation, the same parameters will be noted so as to make the cost-benefit comparison. A problem we encountered here was that the number of digitally recorded points from the SMD was so great that it would be beyond our compatibilities to utilize all of them. We hope to either drop every other column and every fourth row or to cluster a number of the points and use the resulting mean gray shade to reduce the number of data points to a level that can be utilized. Since the digital tapes have not been processed as yet, further results are not available at this time.

Landsat computer compatable tapes were used for the third stage of this multistage inventory system. The CCT's were processed on the computer line printer and a pixil by pixil map of the entire county was produced. Ten levels of gray represented on the map by the overprinting of from one to four symbols from the line printer were used to produce the strips of the map.

In this stage of the inventory system, we are using both a supervised and an unsupervised inventory with the CCT. First the supervised inventory.

Using the low altitude CIR imagery, representative stands of pure pine were located and then transferred to the high altitude CIR imagery. In order to locate these stands on the CCTS, registration points were located both on the computer generated map and the transparencies. Using a Numonics graphics calculator, a digitizer, these registration points from the map and the photo were built into a file so as to allow the location of the stands of pure pine on the CCT's. Each stand was then digitized and built into the same file.

The gray shade range of the spectral signature of the digitized training samples of pure pine was checked and the frequency of accurrance distribution was recorded in each of the 64 gray shades present on the computer compatable tapes in each of the four bands. Ninety per cent of the gray shades representing the training samples fall within the outer limits and seventy per cent fall within the inner limits. Those gray shades that fall within the inner limits denote the gray shade levels that have the highest probability of being pure pine. Those pixils whose representative gray shade was within the inner limits of the gray tone frequency distribution would have the greatest probability of being pure pine in its spectral band. This procedure was repeated for each of the four bands represented on the CCTs. If a pixils representative gray shade was within the inner limits of the gray shade frequency distribution on each of the four bands, then that pixil was coded as pure pine. If a pixil's gray shade fell within the inner limits on three of the four bands, it was coded as a high level of "maybe." If it fell within the inner limits in less than 3 of the four bands it was coded as a low level of "maybe." Anything falling outside of the outer limits was not considered for pine coding.

Once the pixils were assigned a code, another pixil by pixil map was generated that had only the pure pine and the two levels of "maybe."

Verification of accuracy of this map was accomplished by checking it back to the low altitude CIR transparencies on a pixil by pixil basis. With the aid of the computer, a listing of those map pixil coordinates and the corresponding digitizer settings were made of all those pixils coded to pure pine. By locating the pixils on the low altitude CIR transparency, visual interpretation will reveal the accuracy of the pixil classification. The map of pure pine generated in this manner has proven to be 88.5% accurate on a pixil by pixil basis.

A portion of the 11.5% misclassification is attirbutable to long shadows cast by the edge of tall pine stands bordering on open areas, pastured fields or any such adjoining feature where a long shadow may fall unobstructed. Such shadows tend to take on a spectral signature similar enough to that of pure pine to be classified as such. Some of the other notable features that have caused misclassification are large crowned elm trees and a recurring, but unidentified pasture cover.

Maps of stands of pure hardwood are in the process of being produced in the same manner as those of pure pine. Again here, as with pure pine, the digitizer is being used to verify the accuracy of the maps.

A problem encountered here that causes only a minor inconvenience in verrification is that there is eleven months difference between the time that the high altitude aircraft imagery was taken and the time that the LANDSAT tapes were recorded.

The unsupervised computer classification is being done with the aid of the HINDU clustering algorithm package. The terrain is developed by connecting each histogram cell to all of its higher density neighbors. This process leads to amalgamation of all the cells belonging to each of the clusters.

Thus far our work with the unsupervised classification system has not been extensive enough to form any firm results, but we have been

able to produce a pixil by pixil map that has clustered pine and hardwood into one cluster, agriculture fields and pastures into another and everything else into a third. Efforts to break pine and hardwood into spearate classification levels have not been successful. It was hoped that by increasing the number of possible levels of classification to seven or twelve, pine and hardwood would separate but this only resulted in more variability in the clustering of agriculture fields and pastures.

This data tends to reveal that, when using winter satellite tapes, the degree of variability between pines and hardwoods is considerably less than the degree of variability which can be discerned among agricultural fields and pastures. In future studies, therefore, it might be desirable to use summer recorded satellite tapes.

In the course of our study, we have utilized methods of applying remotely sensed data ranging from manual interpretation, to interpretation involving the use of a scanning microdensitometer and finally computer-assisted classifications for the purpose of developing a rapid-low cost method of obtaining information for forest resource inventory and the evaluation of those parameters necessary to make a comparison of the remote sensing data products and methods of analysis.

APPENDIX II

PROCEEDINGS

THE STATUS OF REMOTE SENSING IN MISSISSIPPI

A WORKSHOP

Sponsored by: The Department of Forestry, Mississippi State University
The Mississippi Office of Science and Technology
The Research and Development Center

In Cooperation With

The George C. Marshall Space Flight Center

August 24, 1976

Research and Development Center
Jackson, Mississippi

DATA SOURCES AND USER ASSISTANCE AVAILABILITY

EROS Applications Assistance Facility

The EROS Applications Assistance Facility at the National Space Technology Laboratories is primarily concerned with the application of remotely sensed data to land resource and environmental problems. As one of the EROS Program's regional assistance centers for the transfer of remote-sensing technology to industry, government, educational institutions, and the general public, the facility is equipped to:

- Provide professional assistance in obtaining and using remotely sensed data.
- Act as a regional support center to the Department of the Interior's Geological Survey EROS Data Center at Sioux Falls, South Dakota, and provide for distribution of information, products, data, and services of the EROS Program.
- Provide a computerized interrogation and ordering capability for all available photographic products for the EROS Data Center.
- Operate a 16-mm microfilm Data Reference File for viewing and evaluating LANDSAT, Skylab, NASA aircraft, and U.S. Geological Survey aircraft photography.
- Maintain a special remote-sensing lending library and conduct special literature searches.
- Offer assistance by trained remote-sensing specialists and make available specialized photo interpretation and image enhancement equipment for personal use.
- Assist officials and users in the Southern States in the establishment and execution of demonstration projects, or experiments, which employ remotely sensed data from satellites and aircraft.
- Offer bimonthly remote-sensing workshops to provide training in the interpretation and use of aircraft and spacecraft data and derived information.

ADDRESS: Building 1100
National Space Technology Laboratories
Bay St. Louis, Mississippi 39520
(601) 688-3541

Marshall Space Flight Center

At MSFC, programs oriented toward providing information and assistance to users in the public domain are primarily conducted under sponsorship of the NASA Office of Applications. There are three significant programs in which MSFC participates directly interface with users:

1. Data and Information Management

2. Earth Resources and Environmental Applications

3. Space Applications Transfer Activities

Other areas in which there is indirect and some direct user involvement are Technology Utilization, Space Processing, Solar Energy Research, Space Shuttle/Spacelab, and University Affairs. Activities in the first three significant areas are outlined in the following paragraphs.

In the Data and Information Management Program MSFC two years ago was assigned the role of Discipline Center for NASA with a charter to lead direct research and applications in three primary functional areas, Systems Engineering and Analysis, Technology Assessments and Technology Development. The Systems Engineering and Analysis role includes end-to-end data systems research to predict and help correct trouble areas and bottlenecks in the NASA Space Program data systems. For example, we are working closely with such programs as LANDSAT to assure that the most efficient and economical data flow from sensor to User is provided for LANDSAT follow-on. In performing the system engineering a major first step (and continuing requirement) is Technology Assessment; that is we must examine all the system parts and components available or in state-of-the-art development that are going to make it possible to meet future increasing data requirements - both hardware and sotfware. One example of this work is a total assessment of Data Processing Algorithms in being and proposed in this country. Finally, Technology Development has to be undertaken in critical areas where there are obvious needs and deficiencies. We are involved in such areas as improved software systems using advanced mini-computer developments for Data Base Management Systems; advanced design of optical data processing systems using laser technology; and development of a Data Simulation System that enables us to perform advanced investigations of end-to-end data flows which are planned for future satellite systems such as LANDSAT follow-on. This way we learn on the ground what to expect and can correct the design in time for the first actual mission flight.

In the Earth Resources and Environmental Applications Program, MSFC conducts research in the application of remote sensing to problems of environmental disciplines, land use, water quality, agriculture, forestry, geology, urban environment, and natural resources management; and in techniques for handling, processing, and using the remote sensing data to meet user needs. We have particularly investigated automatic computerized data interpretation storage and retrieval. In this program MSFC conducts cooperative demonstration projects with users in state and local governments. MSFC funds a number of small contracts with universities and in some cases commercial companies to study and work with a user agency to find ways in which remote sensing can help the user meet a specific need. For example we currently have

joint projects in the disciplines indicated above as detailed in the attached lists (attachment 1). MSFC also maintains a User Workroom at the Center in Huntsville with a LANDSAT and EREP browse file, limited satellite and aircraft multispectral photography, maps, color additive viewers, and limited other equipment to assist users with their manual interpretation of satellite and aircraft data. NASA has recently initiated a Space Applications Transfer Program through which the user demonstration projects will be much the same as those previously conducted but with greater emphasis on users who will cost share and plan to implement follow-up systems which will apply the results of the project. To provide better communications and information flow and more effective and useful project activity each NASA center is appointing a Space Applications Transfer Officer to carry out these responsibilities. At MSFC the Space Transfer Officer is James L. Daniels, Jr., mail code EF01, Marshall Space Flight Center, Alabama, 35812; Phone (205) 453-3724. He is available as a primary contact to assist users in getting information regarding possible space technology applications. Attachment 2 is a list of all the MSFC contacts for information and assistance in the various functional areas and disciplines.

National Aeronautics and Space Administration
Johnson Space Center
Earth Resources Laboratory

The Earth Resources Laboratory like other NASA organizations is a Research and Development Organization and does not and cannot provide goods or services in the sense that service organizations can. However, the Laboratory is chartered to develop remote sensing techniques and applications that address problems local to Mississippi and the Gulf area, and is available to help agencies with technique and applications development and to participate in programs to transfer technology to user organizations.

Many techniques and applications have been developed and are ready to be transferred to user organizations, and others are under development. Agencies are invited to discuss their needs with Laboratory personnel to determine if there is existing technology that could be applied to meet those needs, or to explore the possibility of developing a new technique to solve a special problem.

ORGANIZATION:	MARSHALL SPACE FLIGHT CENTER	NAME:
DATA SYSTEMS LABORATORY	EARTH RESOURCES AND ENVIRONMENTAL APPLICATIONS DEMONSTRATION PROJECTS	J. L. DANIELS
		DATE: AUGUST 1976

ACTIVITY	USER PARTNERS AND CONTRACTORS	DISCIPLINE
REMOTE SENSING APPLICATION TO LAND-USE CHANGE MONITORING AND PREDICTION	ENVIRONMENTAL AND REGIONAL RESEARCH ASSOC., EAST TENN. COUNCIL OF GOVERNMENTS	LAND-USE PLANNING
LANDSAT DATA ANALYSIS (COTTON ACREAGE DETERMINATION, GEOLOGICAL FEATURES, AND GENERAL LAND-USE IN NORTH ALABAMA)	GEORGIA INSTITUTE OF TECHNOLOGY, COTTON INC., USDA, TARCOG	LAND-USE PLANNING, AGRICULTURE/ FORESTRY, GEOLOGY
USGS/NASA LAND-USE CLASSIFICATION SYSTEM APPLICATION TO URBAN AREA	GEORGIA INSTITUTE OF TECHNOLOGY, USGS, CITY OF ATLANTA	LAND-USE PLANNING, URBAN ENVIRONMENT
MISSOURI LAND-USE PLANNING AND NATURAL RESOURCES MANAGEMENT	UNIVERSITY OF MISSOURI AT ROLLA, STATE DEPT. OF NATURAL RESOURCES, MISSOURI GEO. SURVEY	LAND-USE PLANNING, NATURAL RESOURCES MANAGEMENT
REMOTE SENSING OF EFFECTS OF LAND-USE PRACTICES ON WATER QUALITY	UNIVERSITY OF KENTUCKY, KENTUCKY STATE AGENCIES	LAND-USE PLANNING, WATER QUALITY
DETECTION OF SOIL ACIDITY AND NEMATODE STRESS IN COTTON, PEANUTS AND TOMATOES THROUGH THE USE OF MULTISPECTRAL AERIAL PHOTOGRAPHY	AUBURN UNIVERSITY, USDA COOPERATIVE EXTENSION SERVICE	AGRICULTURE/ FORESTRY
CORRELATION STUDIES OF REMOTE SENSING DETECTION AND MONITORING PINE BEETLE INFESTATION	NORTH GEORGIA COLLEGE, GEORGIA STATE FORESTRY DEPT.	AGRICULTURE/ FORESTRY

27-1-7-5

Attachment 1

FILE NO.

ORGANIZATION:	MARSHALL SPACE FLIGHT CENTER	NAME:
DATA SYSTEMS LABORATORY	EARTH RESOURCES AND ENVIRONMENTAL APPLICATIONS DEMONSTRATION PROJECTS	J. L. DANIELS
		DATE: AUGUST 1976

ACTIVITY (CON'T)	USER PARTNERS AND CONTRACTORS	DISCIPLINE
REMOTE SENSING APPLICATION TO STUDY OF PEACH SHORT LIFE IN GEORGIA	GEORGIA INSTITUTE OF TECHNOLOGY, USDA, SE FRUIT AND NUT EXPERIMENT STATION	AGRICULTURE/ FORESTRY
WEST TENNESSEE WETLANDS BASELINE	UNIVERSITY OF TENN./UTSI, TENNESSEE STATE PLANNING OFFICE	AGRICULTURE/ FORESTRY - NATURAL RESOURCES MANAGEMENT
GEOLOGICAL-VEGETATIVE RELATIONSHIPS	GEORGIA SOUTHWESTERN COLLEGE, GEORGIA FORESTRY DEP'T., STATE GEOLOGICAL SURVEY	GEOLOGY
PRACTICALITY OF REMOTE SENSING TECHNIQUE FOR A STUDY OF THE EFFECTS OF STRIP MINING OF ALABAMA	UNIVERSITY OF ALABAMA (TUSCALOOSA), ALABAMA GEOLOGICAL SURVEY	GEOLOGY
STUDY TO DEFINE POINTS OF ENTRY FOR POTENTIAL CONTAMINANTS IN LIMESTONE AQUIFERS	UNIV. OF ALABAMA IN HUNTSVILLE, ALABAMA GEOLOGICAL SURVEY	GEOLOGY - WATER QUALITY
USE OF REMOTE SENSING TECHNIQUES FOR GEOLOGICAL HAZARD SURVEYS IN VEGETATED AND URBAN REGIONS	UNIV. OF ALABAMA (TUSCALOOSA), ALA. GEOLOGICAL SURVEY	GEOLOGY - URBAN ENVIRONMENT
ENVIRONMENTAL PARAMETERS OF THE TENNESSEE RIVER	UNIV. OF ALABAMA IN HUNTSVILLE, TVA	WATER QUALITY
ANALYSIS AND MONITORING MOBILE BAY WATER PARAMETERS	MARINE ENVIRONMENTAL SCIENCES CONSORTIUM, CORP. OF ENGINEERS	WATER QUALITY

27-A-7-6

Attachment 1 Continued

ORGANIZATION:	MARSHALL SPACE FLIGHT CENTER	NAME:
DATA SYSTEMS LABORATORY	EARTH RESOURCES AND ENVIRONMENTAL APPLICATIONS DEMONSTRATION PROJECTS	J. L. DANIELS
		DATE: AUGUST 1976

ACTIVITY (CON'T)	USER PARTNERS AND CONTRACTORS	DISCIPLINE
APPLICATION OF SATELLITE/DCP SYSTEMS TO AUTOMATED WATER QUALITY STATIONS	MISS. AIR AND WATER POLLUTION CONTROL BOARD, PEARL RIVER BASIN DEVELOPMENT DISTRICT	WATER QUALITY
APPLICATION OF REMOTE SENSING TO THE DEVELOPMENT AND FORMULATION OF HYDROLOGIC PLANNING (RUN OFF PREDICTION FOR UNINSTRUMENTED WATERSHEDS)	ECOSYSTEMS INTERNATIONAL, INC., GOVT. OF FLORENCE, ITALY, GOVT. OF BRAZIL, ET. AL. UNITED NATIONS	WATER QUALITY - NATURAL RESOURCES MANAGEMENT
DEVELOPMENT OF AN ALABAMA RESOURCES INFORMATION MANAGEMENT SYSTEM	AUBURN UNIVERSITY, ALABAMA DEVELOPMENT OFFICE	NATURAL RESOURCES MANAGEMENT
DATA BASE MANAGEMENT ON SMALL COMPUTERS	COMPUTER SCIENCES CORP. HUNTSVILLE, TENNESSEE STATE PLANNING OFFICE	NATURAL RESOURCES MANAGEMENT - DATA TECHNIQUES
ADAPTIVE PATTERN CLASSIFIERS FOR REMOTELY-SENSED DATA	UNIVERSITY OF TENNESSEE, TENNESSEE STATE PLANNING OFFICE	DATA TECHNIQUES
SEDIMENT TRANSPORT MODEL FOR MOBILE BAY (USING DCP'S)	UNIVERSITY OF ALABAMA (TUSCALOOSA), MARINE ENVIRONMENTAL SCIENCES CONSORTIUM	DATA TECHNIQUES

21-A-7-7

Attachment 1 Continued

ORGANIZATION:	MARSHALL SPACE FLIGHT CENTER	NAME:
DATA SYSTEMS LABORATORY	APPLICATIONS TRANSFER ACTIVITIES MSFC CONTACTS	J. L. DANIELS
		DATE: AUGUST 1976

PRIMARY CONTACT	MR. JAMES L. DANIELS 205-453-3724 SPACE APPLICATIONS TRANSFER OFFICER
EARTH RESOURCES, REMOTE SENSING, AND LAND-USE APPLICATIONS	DR. TED PALUDAN 205-453-0992 DATA SYSTEMS LABORATORY
AGRICULTURE/FORESTRY APPLICATION	MR. SANFORD DOWNS 205-453-0991 DATA SYSTEMS LABORATORY
GEOLOGIC APPLICATIONS	MR. JOHN BENSKO 205-453-0991 DATA SYSTEMS LABORATORY
WATER QUALITY APPLICATIONS	MR. REX MORTON 205-453-0991 DATA SYSTEMS LABORATORY
URBAN APPLICATIONS	DR. GEORGE MCDONOUGH 205-453-3723 DATA SYSTEMS LABORATORY
DATA AND INFORMATION AUTOMATIC PROCESSING TECHNIQUES	DR. BOB JAYROE 205-453-3706 DATA SYSTEMS LABORATORY
DATA AND INFORMATION SYSTEMS	DR. G. R. WALLACE 205-453-0995 DATA SYSTEMS LABORATORY
	MR. TED CAREY 205-453-3424 PROGRAM DEVELOPMENT DIRECTORATE
DATA BASE MANAGEMENT	DR. BOB SEITZ 205-453-3714 DATA SYSTEMS LABORATORY
UNIVERSITY AFFAIRS	MR. MARION KENT 205-453-5671 CENTRAL PLANS OFFICE
GENERAL TECHNOLOGY UTILIZATION AND APPLICATIONS	MR. AUBREY SMITH 205-453-2224 TECHNOLOGY UTILIZATION OFFICE

27-A-7-8

Attachment 2

THE CURRENT STATUS OF REMOTE SENSING APPLICATIONS IN MISSISSIPPI

THE MISSISSIPPI RESEARCH AND DEVELOPMENT CENTER

Mississippi Land Resources Inventory
A State Land Use Mapping Project

In June, 1972, the State of Mississippi began plans for a statewide land resources mapping program. The objectives of this statewide program were as follows:

1. Generate a detailed statewide inventory of land uses and natural resources.
2. Establish a base mapping system for the State.
3. Establish a land use classification and mapping standards for the state.
4. Establish a system to computerize natural resource data in reference to a stable base.
5. Establish a system that can be integrated with the nation's land use policy.

The initial phase of the land resource inventory mapping program was to use high altitude photography and closely follow the pilot study conducted by the NASA Earth Resources Laboratory (ERL) at the National Space Technology Laboratories. In order to implement this phase of the program, a joint request was made by the State of Mississippi, the Earth Resources Observation Systems Office (EROS), and NASA Earth Resources Laboratory to NASA Aircraft Program Office (APO) to fly a photographic mapping mission covering the State of Mississippi. This request was granted and the State was photographed from 60,000 feet. Three separate missions were required to cover the entire State with cloud-free photography. The first mission was flown on December 16 and 18, 1972, and covered the areas immediately north of Jackson to the Tennessee line. The second mission, flown on January 16, 1973, was scheduled to complete coverage of the remainder of the State, but a 40-mile-wide area in the central part including Vicksburg, Jackson, and Meridian was covered with clouds. This area was later photographed by a special mission flown on February 7, 1975.

On August 24, 1973, a meeting was held at the Mississippi Research and Development Center for representatives from interested State agencies to consider and adopt a land use classification system. After minor changes to the draft under consideration, a system was adopted to use on the State mapping project.

The Statewide land resource inventory mapping plan was implemented, and work began in September, 1973, with an R&D Center staff of three. This inventory plan was so designed that the ten planning and development districts were to do the basic land resource identifications within their districts and the R&D Center provided the enlarged photo map bases with section lines, supplied copies of the classification system, and provided quality control over the final product. This final product is a 20-inch by 24-inch photo map of a township with numbered sections. All land resources are identified according to the adopted classification system and major physical/cultural features are identified and labeled. Also included in this

final product is the county name in which this township is found, the township/range, a county index map, and a legend listing the classification system and each category identification symbol.

In order for these maps to be more useful, the reliability of the land use had to be established. Forty townships selected over the State were checked for accuracy in order to establish some numerical value of reliability. Approximately 25,000 points were inspected by ground truth, and the reliability values are as follows:

Level 1 - 97%
Level 2 - 95%
Level 3 - 87%

See the enclosed Classification System.

Upon completion of this phase of the Mississippi Land Resources Inventory, there will be approximately 1,400 photo maps made. To date, over 800 townships have been completed, exclusive of the townships in Pearl River, Hancock, Harrison, Jackson, Hinds, and Rankin Counties, that were completed by NASA in the pilot study. These maps have proven quite valuable and may be used in such areas as:

1. Industrial site location;
2. Transportation route location;
3. Identification of flood-prone areas;
4. Location of recreational sites;
5. Addition of untaxed property to tax rolls;
6. County planning and development programs;
7. School bus routing plans;
8. Forest patrolling, fire fighting, and fire containment plans;
9. Population distribution studies for locating water and sewer systems;
10. Identification of growth areas for locating potential housing sites;
11. Identification of sanitary landfill sites for solid waste disposal;
12. Land use information required for water resources studies;
13. Location of surface water supply sites;
14. Location of soil erosion problem areas; and
15. Inventory of forests.

These are just a few of the many uses of these maps. As one becomes more familiar with the maps, additional uses will be discovered.

The second phase of the land resource inventory is already in motion. This phase consists of a computerized system of automatically updating these land resource inventory maps. This system incorporates satellite (LANDSAT 2) data obtained every 18 days to detect changes taking place on the Mississippi landscape.

Completion of the initial phase of the mapping program plus the update capability will give Mississippi a land resource inventory program that will be envied by many of her sister states.

A great deal of the work shown above utilizes the concept of land capability classification - a means of identifying and mapping land areas having similar productive and use capacities.

Also, the earlier work was accomplished with manual procedures - the Zoom 240 Richards Light Table, and the Zoom Transfer Scope. Now we are working with digital satellite tapes, and thus have begun to use a line-following digitizer, a computer terminal, and the computer readout for analyses.

At this point, I would like, as I always do, to say that some of the interpretation may seem mysterious - But it cannot be accomplished without First obtaining ground truth information.

In closing, I would like to have your help in identifying problems where we might have an opportunity to assist you in problem-solving. We are open for new projects where a need can be demonstrated.

THE GOVERNOR'S OFFICE OF SCIENCE AND TECHNOLOGY

The Status of Remote Sensing Applications in Mississippi

As an outgrowth of previous cooperative efforts between NASA and the State of Mississippi, a major joint project was initiated in April 1975 to transfer significant NASA-developed remote sensing capabilities to the State. The objective of this project is to test and demonstrate a computer-assisted natural resources inventory and information system based on remotely sensed data, oriented to State or regional use, and directed at specific applications. This project includes joint activities with the NASA/JSC Earth Resources Laboratory at Slidell, Louisiana, and with a number of key State agencies. The Office of Science & Technology (Office of the Governor) provides overall project management and coordinates the multi-agency participation.

Most previous remote sensing projects have been directed at demonstrating a single application, or developing a one-time problem solution. This project differs from previous efforts, in that the objective is to demonstrate and establish a system to support a range of applications and users. The project involves three major task areas: (1) conversion of NASA-developed computer software for use on State computers, to enable classification of LANDSAT multispectral scanner data and subsequent data base handling; (2) demonstration of specific system applications in agriculture, forestry, wildlife management, water resources, and planning and development, by NASA/ERL working in conjunction with appropriate State agencies; and (3) evaluation of system applications and implementation by the State.

At present, major task areas (1) and (2) are nearing completion. The PATREC (Pattern Recognition) and GEOREF (Geographic Referencing) software packages have been converted to run on the State Computer Center's IBM 370/155 system. To test the system, an initial Statewide classification from newly acquired LANDSAT-2 data (October 1975) has been undertaken by Office of Science and Technology computer specialists utilizing "ground truth" collected by county agents, county foresters, game biologists, and other State employees. This classification is presently 80% complete. Documenta-

tion of PATREC and GEOREF programs and conversion of the DATA BASE software are expected to be completed by early 1977. Demonstration applications by NASA/ERL in crop survey, wildlife carrying capacity, reforestation needs inventory, and land use statistics have been performed, and initial demonstration products (maps, printouts, etc.) are being transmitted to participating State agencies for their evaluation. Additional applications will be completed within the coming year.

Our experience to date promotes serious consideration of this system as an operational resource inventory and information tool to serve many users on a state wide basis.

MAJOR RESOURCE MANAGEMENT INITIATIVES

STATE BOARD OF WATER COMMISSIONERS

Level B Planning--Statewide Comprehensive Water Management Plan

Numerous planning programs are underway, or have been completed in Mississippi. Most are for the sole purpose of qualifying for Federal construction funds for a particular project, with no attempt to coordinate the planning with any other program.

The Corps of Engineers, through its five separate Districts in Mississippi, has actively engaged in water management planning and has accumulated vast quantities of valuable data. Unfortunately, coordination has been very limited--even between the adjacent Corps Districts--so maximum effectiveness has been sacrificed.

Better Statewide coordination has been achieved under River Basin Planning Programs of the Department of Agriculture. Under the sponsorship of the Board of Water Commissioners, the USDA will up-date all of its river basin plans into a single Statewide study. Even though this is a step in the right direction, the study will lack comprehensiveness, since funds will be available for only Department of Agriculture agencies.

Until rather recently, there has been only limited Water Quality Planning in Mississippi. Another speaker will tell about Section 208 of Public Law 92-500, the program now receiving the most attention--because it has funds available.

Today, I want to explain the purposes of another portion of P.L. 92-500--Section 209. The responsibility for this activity is assigned to the Water Resources Council, and not to the Environmental Protection Agency that administers the rest of the Act. Less is known about it, and until this year, no funds have been requested to implement its provisions.

Section 209--and not Section 208--is intended to be the comprehensive planning authority. The Water Resources Council is the Federal agency created to coordinate all Federal water planning, and will work with the appropriate State and Federal agencies to develop a Water Management Plan for both quality and quantity. Any plan that does not consider both cannot be effectively implemented.

The Water Recources Council will receive funds for six Level B (Comprehensive River Basin Plans) studies for the current fiscal year. Working through the Mississippi River Commission (Lower Mississippi River Division of the Corps of Engineers). The Board of Water Commissioners has submitted "A Proposal to Study" for a Statewide Level B Plan.

Funds will be appropriated only to Federal agencies to carry out the responsibilities assigned to them by the Plan of Study. Assurance has been received from most of the concerned agencies that they are willing to contract with their State counterpart for this work.

We are very enthusiastic about the results that can be expected from this program. It is the best possible vehicle to put together the many specialized plans that have been developed over the past years--and put them into a truly coordinated, comprehensive, Management Plan.

If we work together at all levels of Government, we can provide a Development Plan that will be beneficial to each of us.

Indications appear favorable for an initial appropriation to be made during the Federal fiscal year that begins in October.

TRIANGLE J COUNCIL OF GOVERNMENT
TRIANGLE PARK, NORTH CAROLINA

Applications of LANDSAT Imagery in Resource Planning

The Federal Water Pollution Control Act Amendments of 1972 initiated a coordinative approach to the problem of water pollution. Areawide water quality management planning, termed 208 by the section designation, for the first time enabled sub-State regional agencies to plan for improved water quality while concurrently addressing the land use, environmental, and organizational aspects which are directly related to solving the problem. Such a planning process deals with point sources of pollution and, perhaps more importantly, with non-point pollution caused by stormwater runoff.

The Triangle J Council of Governments, located in the Research Triangle Park, North Carolina, was the first regional planning agency to be granted EPA funds to conduct a water quality management program. Of primary importance in the work plan was the interrelationship of resource inventory information with the generation and evaluation of alternatives. In particular, data concerning land resources and use, pollution analysis of non-point sources, and environmental resources were approached on common grounds - a uniform base map of existing resources and a data base which could be related to existing and future land uses, stormwater quality problems, and environmental impacts. Computer assisted analysis of LANDSAT satellite imagery provided an efficient, cost-effective, and multi-purpose method for addressing these interrelationships.

Planning at the regional level is often difficult due to the lack of uniform and consistent data concerning resources. Accompanying this difficulty, in water quality planning, is the challenge to show interrelationships of existing and projected land resource utilization to water quality. Time, manpower, and money each contribute to the problem.

It was determined that the 208 inventory of resources would have to include various land use and forest categories, as well as maps and associated statistical data. Such an inventory would be utilized in describing existing land use and environmental conditions, and as input in non-point source water pollution analysis. This data would also have to be flexible for aggregation to a variety of planning units such as counties, census tracts, and watersheds.

The needed inventory was obtained by Triangle J for its 1,750 square mile 208 study area through the analysis of LANDSAT remotely-sensed imagery for October 25, 1973. Utilizing computer processing techniques for computer compatible tapes (CCT's), ten land cover categories were interpreted for the study area at a detail of 0.44 hectares (1.1 acres). These included 3 "developed" categories, 4 forest types, agricultural-managed lands, bare soil, and water. The resulting products included color-coded overlays for each of the ten categories at a 1:96,000 ration (1 inch = 8,000 feet), color composite maps of the same categories and scale, and a computer tape containing data for 54 USGS quadrangles (7.5 minute) where each 50 meter grid cell was coded as to the ten land cover types. All ground truthing and category analysis was done by Triangle J 208 staff, and computer processing was provided under contract by Bendix Corporation, Aerospace Systems Division in Ann Arbor, Michigan.

Triangle J delineated sub-basing drainage areas based upon LANDSAT generated land-cover overlays, and topographic and stream maps of the region. Pollution coefficients for runoff from a particular land cover (i.e. high, medium, and low density developed; agricultural; bare soil) were used with other data to estimate the amount and quality of stormwater runoff. Base maps and data generated from LANDSAT imagery provided information for analyzing existing land use and developing alternative land development patterns. Vegetational communities and wildlife habitat were delineated by the four forest types, and maps and data were used to describe existing resources and environmental impacts of plan alternatives.

By using the LANDSAT data as a base mapping and statistical tool, the entire 208 planning area was inventoried and scale corrected map overlays and a computer data tape were generated in less than four months. Overall classification accuracy of the categories was judged to be around 90% and the cost of processing the LANDSAT scene and generating the products was approximately $4.00 per square mile.

MISSISSIPPI RESEARCH AND DEVELOPMENT CENTER

Regional Planning

The R&D Center has been working with the Tombigbee River Valley Water Management District and the Appalachian Regional Commission on a study of the 15-county region of the Tennessee-Tombigbee Waterway within northeast Mississippi. The study required analysis of the existing planning documents in the 15-county region, a public information program, development of a capital improvement schedule, and development of land and resource management recommendations. In the course of this study it was discovered there was a lack of a comprehensive data base in graphic form for the region so the R&D Center secured through the Tennessee-Tombigbee Authority a HUD grant for the preparation of a transparent overlay system. The overlay system is now complete. It depicts factors affecting development within the region. It is produced at a scale of one inch equals one mile. The overlay system is divided into three sections basically along the Planning and Development District boundaries. Factors presented in the overlay include such things as soil associations, flood hazard areas, historic and recreational sites, unique wildlife habitat areas, and topography and transportation facilities.

The R&D Center is looking into the use of LANDSAT data for future land use planning within the State to help in meeting HUD 701 planning requirements for the coming years. We plan to use LANDSAT data for this and possibly in conjunction with the Coastal Zone Management program and EPA Section 208 and 201 which includes control of nonpoint pollution. The R&D Center sees the value of remotely sensed data in these areas and will be looking into their future use.

MISSISSIPPI MARINE RESOURCES COUNCIL COASTAL ZONE MANAGEMENT

(Abstract)

The Mississippi Marine Resources Council is the State Agency required by Law to coordinate planning for the State's Coastal Zone Management Program in accordance with the federal CZM Act of 1972. The Council is presently completing the second year of a four-year planning program. This program will utilize environmental and socio-economic information in order to establish a coordinated management system "to preserve, protect, develop, and where possible, to restore or enhance the resources" of the coastal area of the State of Mississippi.

An integral part of this system will be the Coastal Wetlands Protection Act, currently administered by the Council. The use of high altitude aircraft imagery and satellite remote sensing data in this program has aided in the broad general resolution of wetlands boundaries and has indicated those areas which need to be investigated further.

WORKSHOP

The Status of Remote Sensing Applications In Mississippi Workshop

Agriculture Section Report:

The agricultural section combined with the water resources section in a joint 2 hour workshop session. Some 17 members participated in the session. Two presentations were made on current water resources efforts and two were made on agricultural applications of remote sensing technology. There was considerable commonality between the two disciplines in using remote sensing techniques. There was insufficient time for detailed discussions. There was considerable interest and open discussion in the time allocated.

Session Concensus:

The presentations appeared to be at a level considerably beyond the background of the participants. Many technical terms had little meaning to the group. A need was expressed for an in-depth training session where basic points, terminologies, and applications could be addressed.

Benefits:

Areas in agriculture where possible realistic benefits might be accomplished via using remote sensing technology included the following:

1. Improved base maps for soil surveys.
2. Crop inventories and temporal coverage to estimate potential yields.
3. Crop disease and severe insect infestation detection.
4. Base-line data acquisition of soil and landscape information in rugged inaccessible areas.
5. Data acquisition of environmental data including soil temperature, soil moisture and related atmospheric conditions.
6. Detection and monitoring of severe erosion and sedimentation routing.
7. Mapping of changing land use patterns in the agricultural section.

Problems:

Resolution of imagery; response time in obtaining data; interpretation of data; lack of facilities throughout the state where the agricultural production is located; severe limitations of observing only the thin soil surface and lack of forest penetration; expense.

The general concensus of the group relevant to usage of remote sensing technology condensed to:

a. What does it take to get it, where, how?
b. What form is it?
c. How to use it?
d. How much does it cost?
e. Who will help interpret it?
f. What will the State of Mississippi do to help me?

Group - Forestry, Wildlife and Recreation:

Dr. Armand Joyce (NASA - JSC - ERI) presented detailed information on several projects involving the use of LANDSAT tapes:

1. Pascagoula Heritage Area - Wildlife Habitat
2. Agricultural crop yield predictions
3. Reforestation needs of Yazoo Little Tallahatchie Flood Prevention Project

He also mentioned a study in progress which involves the use of "3-P" sampling for forest inventory. Mr. John Gwaltney of Forestry Suppliers indicated that the ground truth instrument being utilized (Barr & Stroud Dendrometer) is no longer in production, but that other suitable instruments were available.

Professor Miller (MSU - Dept. of Forestry) presented the concept of land capability classification using manual interpretation of satellite, high altitude and low altitude imagery. This concept can be used to evaluate productive capacity and use capacity for agriculture, wildlife, forestry and recreation.

Mr. Miller and Mr. Jack Mallory (U.S. Army-Corps of Engineers) presented a very brief look at the Tennessee-Tombigbee Waterway project.

Discussion Summary:

The major concern expressed was the lack of uniform resource information system. Each available system of data management appears to be designed for a rather limited objective, and therefore, none seem to have general applications (MIADS, LUDI).

The need for a State-wide resource inventory was also expressed. It was felt that various Federal and State agencies would purchase information if such a service was available.

THE FUTURE OF REMOTE SENSING APPLICATIONS IN MISSISSIPPI

The continuing availability of remotely sensed data appears to be excellent. In the case of aircraft-acquired data (color infrared or multispectral scanner), commercial sources are expected to provide more of the technical capabilities which NASA's aircraft fleet has been providing in a research mode. For satellite data, LANDSAT-1 and -2 together continue to provide 9-day coverage. The third in this generation of satellites, LANDSAT-C, is scheduled for launch in September 1977. LANDSAT-C will have the same capabilities as LANDSAT-1 and -2, plus the addition of a thermal infrared channel to the multispectral scanner (MSS). A new generation of satellites is presently being proposed by NASA for launch in 1980. Called the LANDSAT's Follow-on System, these satellites will differ from present LANDSATs in several important ways: (1) They will be part of an operational system, rather than a research project; (2) There will be two satellites in orbit, plus a spare on the ground, to assure 9-day cycle of coverage; (3) They will carry the present MSS, plus an additional MSS which will have increased spectral resolution (6 bands) and improved spatial resolution (30 meters); (4) The data delivery system will be set up to provide digital data within three to four days after a pass. If approved, the LANDSAT Follow-on System will greatly enhance the utilization of satellite multispectral data. In summary, the availability of data for future remote sensing applications looks very promising.

In regard to future applications and uses in Mississippi, we are approaching an important turning point. Past and present applications have been experimental, or for prototype development and demonstration purposes. If remote sensing applications are to become an operational source of information for resource managers and decision-makers, then there must be an operational organization to focus remote sensing and related data management capabilities in Mississippi. Efforts are now underway to determine the organizational arrangements and resources necessary for an operation to: (1) provide certain baseline inventory/information products on a regular periodic schedule; (2) provide consultation and planning for specific applications; (3) provide a range of remote sensing applications services, from photo-interpretation to computer-assisted classification; and (4) develop and provide a center of expertise for geographically referenced data-base systems and applications. By coordinating our requirements and pooling our resources, we can make the most cost-effective use of our remote sensing capabilities. The support and cooperation of all interested organizations in the State will be necessary for the success of this effort.

THE STATUS OF REMOTE SENSING APPLICATIONS IN MISSISSIPPI
A WORKSHOP

Speakers and Workshop Chairmen

MOONEYHAN, Wayne, Director, Earth Resources Laboratory
JOYCE, Armond, Chief, Land Applications Group
GRIFFIN, R. H., Agronomist
ZETKA, E. F., Chief, Coastal Applications Group
NASA-JSC, Earth Resources Laboratory, Slidell Computer Complex, 1010 Gause Blvd., Slidell, LA 70458
DANIELS, James L., Space Applications Transfer Officer, Data Systems Laboratory, EF01, George C. Marshall Space Flight Center, Marshall Space Flight Center, AL
SCHECTER, Roger, Senior Environmental Specialist, Triangle J Council of Governments, Box 12276, Research Triangle Park, North Carolina 27700
BARNES, Richard, Special Assistant to the Director, Governor's Office of Science and Technology, 416 North State Street, Jackson, MS 39201
BALEY, E. Robert, Manager, Communications and Area Planning Division, Mississippi R & D Center, 3825 Ridgewood Road, Jackson, MS
PEPPER, Jack W., State Water Engineer, Board of Water Commissioners of the State of Mississippi, 416 North State Street, Jackson, MS 39201
DOWNING, Paul Edward, A.S.L.A., Manager, Regional Planning Board, Community/Area Planning Division, Mississippi R & D Center, 3825 Ridgewood Road, Jackson, MS
MINOR, Sylvia, Resource Analyst, Mississippi Marine Resources Council, Box 497, Long Beach, MS 39560
CONGDON, Barney, Exhibits and Information Specialist, U.S.G.S.-EROS, Building 1100, National Space Technology Laboratories, Bay St. Louis, MS 39520
WILLIAMSON, A. N., U. S. Army Corps of Engineers, Waterways Experiment Station, P. O. Box 631, Vicksburg, MS 39180
PETTRY, David, Professor, Department of Agronomy, Mississippi State University, P. O. Box 5248, Mississippi State, MS 39762
MILLER, W. Frank, Program Coordinator, Remote Sensing Applications, Department of Forestry, Mississippi State University, P. O. Drawer FD, Mississippi State, MS 39762
HARRIS, Jerry C., Assistant Professor, Department of Landscape Architecture, Mississippi State University, P. O. Drawer MQ, Mississippi State, MS 39762
CISSNA, Volney J., Jr., Special Projects Officer, Southern Mississippi Planning & Development District, 1020 32nd Avenue, Gulfport, MS 39501
MALLORY, Jack, Biologist, U. S. Army Corps of Engineers, Mobile District, P. O. Box 2288, Mobile, AL 36601
LADNER, Cornell, Mississippi Marine Resources Council, Box 497, Long Beach, MS 39560

Participants

BOGRAD, Michael, Mississippi Geological Survey, P. O. Box 4915, Jackson, MS 39202
CARTER, Bradley D., Associate Director & Associate Professor, Computer Science and Statistics Department, Mississippi State University, P. O. Drawer CC, Mississippi State, MS 39762
CARTER, James Thomas, Northeast Mississippi Junior College, Booneville, MS 38829
CHAPIN, Bob T., Coordinator, Land Use Center, Mississippi State University, P. O. Box 5405, Mississippi State, MS 39762
COLLINS, Richard J., Mississippi Forestry Commission, 908 Robert E. Lee Bldg., Jackson, MS 39201
COOK, Caye, Land Use Center, Mississippi State University, P. O. Box 5405, Mississippi State, MS 39762
CRISMAN, Hank, Jackson County Planning Commission, 600 Conuent Avenue, Pascagoula, MS 39567
FERGUSON, Russell W., Central Data Processing Authority, 508 Robert E. Lee Bldg., Jackson, MS 39202
GORDON, Kenneth L., Mississippi Natural Heritage Program, 2304 Riverside Dr., Jackson, MS 39202
GUYNN, David C., Assistant Professor, Department of Wildlife & Fisheries, Mississippi State University, P. O. Drawer LW, Mississippi State, MS 39762
GWALTNEY, John, Forestry Suppliers, P. O. Box 8397, Jackson, MS 39204
HICKS, Marilyn, U. S. Fish & Wildlife Service, 409 Merchants National Bank Bldg., Vicksburg, MS 39180
HIGGS, Gary, Department of Geology and Geography, Mississippi State University, P. O. Drawer GG, Mississippi State, MS 39762
HILL, Chuck, Department of Wildlife & Fisheries, Mississippi State University, P. O. Drawer LW, Mississippi State, MS 39762
HORTON, Gene, Southwest Mississippi Planning and Development District, Inc., P. O. Box 636, Meadville, MS 39653
JACOB, Joe, Mississippi Natural Heritage Program, 2304 Riverside Drive, Jackson, MS 39202
JACOBSON, Harry, Department of Wildlife & Fisheries, Mississippi State University, P. O. Drawer LW, Mississippi State, MS 39762
JEPSEN, Chuck, District Conservationist, Soil Conservation Service, Box 345, Brandon, MS 39042
JEW, Herman, Jackson City Planning Board, 218 S. President, Jackson, MS 39201
JOHNSON, Joe, Mississippi Natural Heritage Program, 2304 Riverside Drive, Jackson, MS 39202
KETCHAM, Sonny, Graduate Student, University of Southern Mississippi, 2010 Hardy Street, Apt. #8, Hattiesburg, MS 39401
KOELN, Greg, Department of Wildlife & Fisheries, Mississippi State University, P. O. Drawer LW, Mississippi State, MS 39762
KOOS, W. M., Soil Conservation Service, 3106 Ponderosa Drive, Jackson, MS 39212
LANGLOIS, Terry, Mississippi Park Commission, 717 Robert E. Lee Bldg., Jackson, MS 39201

Participants - Continued

LASWELL, Troy J., Professor and Head, Department of Geology and Geography, P. O. Drawer GG, Mississippi State, MS 39762
LYONS, Russell H., U. S. Army, Corps of Engineers, Waterways Experiment Station, P. O. Box 631, Vicksburg, MS 39180
MARBLE, John C., Mississippi Geological Survey, P. O. Box 4915, Jackson, MS 39202
MARTIN, Gale, Mississippi Soil & Water Conservation Commission, 754 N. President, Jackson, MS 39202
MATTHEWS, Gary, Jackson County Planning Commission, 600 Conuent Avenue, Pascagoula, MS 39567
MAXEY, Greg, North Delta Planning and Development District, Inc., P. O. Box 1244, Clarksdale, MS 38614
McDADE, John E., Central Data Processing Authority, 508 Robert E. Lee Bldg., Jackson, MS 39202
MORGAN, Cliff, Mississippi Forestry Commission, 908 Robert E. Lee Bldg., Jackson, MS 39201
PEACOCK, Willie, Southwest Mississippi Planning and Development District, Inc., P. O. Box 636, Meadville, MS 39653
STANLEY, Glenn, U. S. Fish & Wildlife Service, 409 Merchants National Bank Bldg., Vicksburg, MS 39180
THORNHILL, Tom, U. S. Fish & Wildlife Service, 409 Merchants National Bank Bldg., Vicksburg, MS 39180
WAGGONER, Joe, Pearl River Planning and Development District, Inc., P. O. Box 5332, Jackson, MS 39216
WESLEY, David, Department of Wildlife & Fisheries, Mississippi State University, P. O. Drawer LW, Mississippi State, MS 39762
WETZEL, Thomas A., Mississippi Park Commission, 717 Robert E. Lee Bldg., Jackson, MS 39201
MASON, John, Mississippi State Highway Department, P. O. Box 1850, Jackson, MS 39205
BANKS, Jerry, Air and Water Pollution Control Commission, 600 Robert E. Lee Bldg., Jackson, MS
FORSYTHE, Stephen, U. S. Fish & Wildlife Service, 409 Merchants National Bank Bldg., Vicksburg, MS 39180
INMON, Lloyd E., U. S. Fish & Wildlife Service, 409 Merchants National Bank Bldg., Vicksburg, MS 39180
HARRIS, Patrick, Vicksburg District, Corps of Engineers, Vicksburg, MS 39180
SPIRES, Charles, U. S. Geological Survey, 2525 North West Street, Jackson, MS
BARDWELL, Lee, U. S. Forest Service, Box 1291, Jackson, MS
LaFAYETTE, Russell, U. S. Forest Service, Box 1291, Jackson, MS
ROUTH, Duane, U. S. Forest Service, Box 1291, Jackson, MS
WHITE, Robert, Department of Housing & Urban Development, 300 Woodrow Wilson Avenue, West, Jackson Mall, Jackson, MS 39213
ARANT, W. H., Lockheed-Houston, affiliated with Mississippi R & D Center, 3825 Ridgewood Road, Jackson, MS
MILLER, Ron, Vicksburg District, Corps of Engineers, Vicksburg, MS 39180

Participants - Cont ued

HOLLOWAY, Elton, Transportation and Planning Division, Mississippi State Highway Department, P. O. Box 1850, Jackson, MS 39205
MASON, Ralph, Mississippi Office of Science & Technology, 416 North State Street, Jackson, MS 39201
NORTON, Ken, Mississippi Office of Science & Technology, 416 North State Street, Jackson, MS 39201
DEATON, John, Mississippi R & D Center, 3825 Ridgewood Road, Jackson, MS
BAILEY, Bob, Vicksburg District, Corps of Engineers, Vicksburg, MS 39180
DAVIS, Paul, Mississippi R & D Center, 3825 Ridgewood Road, Jackson, MS
HEIDEL, Ray, Department of Housing & Urban Development, 300 Woodrow Wilson Avenue, West, Jackson Mall, Jackson, MS 39213
DUNAWAY, Alton, Mississippi Game and Fish Commission, P. O. Box 451, Jackson, MS
HESSELL, Bill, East Central Mississippi Planning and Development District, 410 Decatur Street, Newton, MS 39345
JEMISON, Don, East Central Mississippi Planning and Development District, 410 Decatur Street, Newton, MS 39345
FINCHER, Murray, Mississippi Bureau of Outdoor Recreation, Natural Heritage Program, 2304 Riverside Drive, Jackson, MS 39202
REUSS, John, Bureau of Mines, Mississippi Liaison, Jackson, MS
JONES, Owen, Bureau of Mines, Mississippi Liaison, Jackson, MS
WALLS, Mike, Planning Office, Mississippi Bank of Choctaw Indians, Philadelphia, MS
WELLS, Roger, Rahenkamp, Sachs & Wells & Assoc., Inc., Stetson House, 1717 Green Garden Street, Philadelphia, PA 19130
HEAD, Jim, Gulf Regional Planning Commission, P. O. Box 4206, Gulfport, MS 39501
LANGSTON, John, Soil Conservation Service, Staff Leader, River Basin Survey Staff, P. O. Box 3319, Jackson, MS 39207

REMOTE SENSING SEMINAR
August 24, 1976

Planning and Land Use Workshop

Michael Bogard	Mississippi Geological Survey
Hank Crisman	Jackson County Planning Commission
Duane Routh	U. S. Forest Service, Jackson
Murray Fincher	Miss. Bureau of Outdoor Recreation/ Miss. Natural Heritage Program
W. H. Arant	Lockheed/R & D Center
Paul E. Downing	R & D Center
Bob T. Chapin	MCES Land Use Center
Gary Higgs	Dept. of Geography/Miss. State University
Paul S. Davis	R & D Center
Herman Jew	Jackson City Planning Board
Sonny Ketcman	University of Southern Mississippi
Michael D. Wells	Planning Office, Miss. Band of Choctaw Indians
Robert E. White	DHUD
Gene Horton	Southwest Mississippi PDD
Bradley D. Carter	MSU (Computer Science)
Elton Holloway	Transportation Planning Div., Miss. Highway Department
Wayne Mooneyhan	NASA/Earth Resources Laboratory
Jim Daniels	NASA/Marshall Space Flight Center
Fred Wise	R & D Center

27-A-7-23

WORKSHOP PROGRAM

ETV Auditorium

August 24, 1976

8:00 AM - 8:30 AM Registration

8:30 AM Introduction to Workshop - Purpose; Announcements

8:40 AM - 9:25 AM Data Sources and User Assistance Availability

EROS Users Assistance Facility - Mr. Barney Congdon, Exhibits and Information Specialist

NASA - Marshall Space Flight Center - Mr. James L. Daniels, Space Applications Transfer Officer, Data Systems Laboratory

NASA - Johnson Spacecraft Center - Mr. Wayne Mooneyhan, Director, Earth Resources Laboratory, Slidell, Louisiana

9:25 AM - 10:05 AM The Current Status of Remote Sensing Applications in Mississippi

Research and Development Center - Mr. E. Robert Daley, Manager, Communications and Area Planning Division

Mississippi State University - Mr. W. Frank Miller, Program Coordinator, Remote Sensing Applications

Mississippi Office of Science and Technology - Mr. Dick Barnes, Special Assistant to the Director, Governor's Office of Science and Technology

10:05 AM - 10:30 AM Coffee

10:30 AM - 12:00 Major Resource Management Initiatives

State-Wide Comprehensive Water Management Plan - Level B - Mr. Jack Pepper, State Water Engineer, Mississippi Board of Water Commissioners

EPA 208 - Mr. Roger Schecter, Senior Environmental Specialist, Triangle J Council of Governments, North Carolina

Regional Planning - Mr. Paul Edward Downing, A.S.L.A., Manager, Regional Planning Board, Community/Area Planning Division

Coastal Zone Management - Ms Sylvia Minor, Resource Analyst, Mississippi Marine Resources Council

27-A-7-24

1:30 PM - 3:30 PM Workshop Sessions

A. Agriculture - Room 130

Dr. David Pettry, Professor, Department of Agronomy, Mississippi State University

Dr. R. H. Griffin, NASA-JSC-ERL, Agronomist

B. Forestry, Wildlife, Outdoor Recreation - Room 140

W. Frank Miller, Department of Forestry, Mississippi State University

Dr. Armond Joyce, Chief, Land Applications Group, NASA-JSC-ERL

Mr. Jack Mallory, Biologist, Corps of Engineers, Mobile District

C. Water and Related Resources - Room 142

Mr. Roger Schecter

Mr. Al Williamson, U. S. Army Corps of Engineers, Waterways Experiment Station

D. Coastal Resources - Room 136

Dr. Cornell Ladner and Ms Sylvia Minor, Mississippi Marine Resources Council

Mr. E. F. Zetka, Chief, Coastal Applications Group, NASA-JSC-ERL

E. Planning and Land Use - Room 137

Mr. E. Robert Dacey

Mr. Volney J. Cissna, Jr., Special Projects Officer, Southern Mississippi Planning & Development District

Mr. Jerry Harris, Department of Landscape Architecture, Mississippi State University

3:30 PM - 4:30 PM Auditorium

Panel Reports

The Future for Remote Sensing Applications in Mississippi - Mr. Dick Barnes