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Introductory Workshops on Remote Sensing as Related to Geological Problems in Georgia

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INTRODUCTORY WORKSHOPS ON REMOTE SENSING

AS RELATED TO GEOLOGICAL PROBLEMS IN GEORGIA

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Introduction

Most professionals in the natural science disciplines are aware of the tremendous impact that remote sensing, particularly satellite imagery, is making on field research. However, in some areas of the country the practical application of these techniques, even on a rudimentary level, is lagging far behind the professional innovation. In Georgia this is frequently the situation in the field of regional planning.

Sponsored by a NASA contract, it was our objective to introduce planners to the possible practical applications of remote sensing, particularly in the solution of geological problems. This was to be accomplished through a series of workshops directed largely at regional planners, especially those working in Georgia's eighteen Area Planning and Development Commissions (APDC's). This group constitutes a very diversified audience. The southern portion of Georgia is largely agrarian and timber producing, and the planning agencies are relatively small (15-25 persons for an 8-10 county area). Sophisticated technical instrumentation is not generally available and remote sensing data is virtually unused except for occasional conventional aerial photographs. The educational backgrounds of the planners also vary and some have had little exposure to advanced mathematical and physical concepts, while others may have recently completed college work in these areas.

In contrast, the far northern Planning Commissions in Georgia are larger and more sophisticated (150 persons for an 8-10 county area). LANDSAT data is in day-to-day use at at least one APDC and is becoming commonplace at several others. The Atlanta Regional Commission was not included in our goal since their advanced program required no introduction to remote sensing. In fact, we later discussed some of their remote sensing experiences in our own presentations.

Our workshops, then, were principally designed to expose uninitiated planners, possibly with a limited technical background, to remote sensing and how they might use it in areas related to geology.

The 1977 Statewide Workshop

During the spring of 1977, in cooperation with the Georgia Department of Natural Resources, we presented a two-day program on remote sensing. We invited knowledgeable speakers from various governmental agencies to discuss their own practical experiences, particularly as they related to Georgia. The response from the speakers was excellent and almost all of those contacted agreed to help. As a result, our program contained a good balance of nationally-known remote sensing experts and knowledgeable Georgia practitioners, most from the Department of Natural Resources, who could speak on local problems (see speakers list, Table 1).

For practical reasons, we began the program at noon on Wednesday, May 24, and adjourned after a closing luncheon on Thursday, allowing a half-day on both ends for driving time. The workshop was held at Georgia Southwestern College in Americus. No registration fee was necessary,

TABLE 1

SPEAKERS AT THE WORKSHOP ON REMOTE SENSING, MAY 24 AND 25, 1977

Sponsored by Georgia Southwestern College and the Georgia Department of Natural Resources

Funded by a grant from the National Aeronautics and Space Administration

Speaker	Agency	Topic
Dr. James Anderson	Chief Geographer, U.S. Geological Survey.	Introduction to Land Information Analysis.
William Clark	Head, Cartographic Section, Geologic and Water Resources Division, Georgia Department of Natural Resources.	The Georgia LANDSAT Atlas.
Dr. James Anderson	As above.	Workshop on Land Information Analysis.
Bruce Rado	Office of Planning and Research, Georgia Department of Natural Resources.	The Georgia Land Information Program.
James Fisher	Director, Office of Planning and Research, Georgia Department of Natural Resources.	Applications of Remote Sensing in Documenting Federal Projects.
Sam Pickering	State Geologist, Georgia Department of Natural Resources.	Remote Sensing in Pollution Monitoring.
W. E. Grabau	U.S. Army Engineers, Waterways Experiment Station.	Inventorying Small Water Bodies and Mapping the Distribution of Suspended Material in Water from LANDSAT Data.
Gene Coker	U.S. Environmental Protection Agency.	Use of Remote Sensing in Monitoring Mined Land Reclamation.

TABLE 1 (Continued)

Speaker	Agency	Topic
Dr. Linn Pollard	U.S. Geological Survey, Water Resources Division.	Inventorying Irrigation by LANDSAT Imagery.
Arnold Zisa	Geologic and Water Resources Division, Georgia Department of Natural Resources.	Coastal Changes and Remote Sensing.
Douglas Wilson	Head, South Georgia Section, Geologic and Water Resources Division, Georgia Department of Natural Resources.	Workshop on Sinkholes: Origin, Location, and Prediction.
Gene Coker	U.S. Environmental Protection Agency.	Workshop on Sinkholes: Origin, Location, and Prediction.
Dr. Daniel Arden	Chairman, Earth Science Department, Georgia Southwestern College.	Ditto.
Dr. Gayther Plummer	Botany Department, University of Georgia.	Vegetation Mapping in Georgia Using Remotely-Sensed Data.
Gary North	Deputy Chief, National Cartographic Information Center, the U.S. Geological Survey.	Availability of Remote Sensing Materials.
G. William Spann	Vice President, Metrics, Inc.	The Future of LANDSAT and Related Programs.

since NASA contract funds covered the expenses. We charged participants $2.50 for the closing luncheon and made rooms available at the College Continuing Education Center for $4.50 per night.

The workshop was publicized by flyers to all the APDC's, all related university departments, and finally to the entire membership list of the Georgia Planning Association. Participants included representatives from several planning districts, college staff, students, and several representatives of large industries in our area. Total registered attendance was approximately forty, augmented by a number of students who were present only for individual sessions.

The Georgia Southwestern College Traveling Remote Sensing Show

In retrospect, we analyzed our initial workshop to ascertain how we could reach even more planners. After telephone conversations with several APDC directors we finally concluded that many of the staff planners simply did not have two full days to devote to such meetings in addition to other commitments. As one director said, "If I send four planners for two days that's eight man-days, and I just can't spare that much time." Based on this, we decided that there was one obvious way to improve our attendance: to take the workshop to the APDC's and to limit it to one day. Since we could not afford eighteen days* on the road away from our campus teaching duties, we compromised and organized

*There are eighteen APDC's in Georgia.

our traveling show for groups of two or three APDC's, selected geographically so that no one would have to drive much more than one hour.

Obviously, we could not obtain our original speakers again, and certainly not for six separate dates. Even our DNR co-workers could not spare six separate days. A completely revised program was necessary. We decided to approach the subject from a different viewpoint. Most introductory texts and lectures, like our first workshop, emphasize what can be done with remote sensing, with heavy emphasis on visual images. This approach has one failing: After showing a neophyte what can be done, he still has no idea how to do it, and he is still intimidated by the technical knowledge he thinks is required. We decided to give our audience a solid background in the basics of remote sensing, at least as solid as you can provide in one day, and to only dwell briefly, at the end, on practical applications. Further, we would use only Georgia applications. We felt that South Georgia planners really did not need to know whether you could see the San Andreas Fault on LANDSAT images or not! We decided it would be most useful for them to understand how remote sensing works and on what basis the images or photographs are interpreted. This required an entirely new organization of the program.

Basic Subject Material

What topics should be included in a one-day introduction to the principles of remote sensing, and in how much detail? For a non-technical audience it is first necessary to introduce the basic physics of the electromagnetic spectrum. How are the various bands of visible light related? How does infrared relate to the visible and what differences exist within the infrared? How does radar relate to light? What are the sources of electromagnetic radiation and how is it affected when it is reflected off the earth's surface? How does this enable us to detect differences in the earth's surface features from a distance? We decided that the basic physics of the electromagnetic spectrum must be introduced early in the program, perhaps immediately after a brief introduction.

Following this basic framework we elected to discuss the individual remote sensing techniques and how they work. Certainly aerial photography must be discussed, particularly multi-band, color, and false-color infrared. How are photographs restricted to one band of light obtained? How are they useful? What is false-color infrared? How does it relate to the real view? It is easy to see that vegetation appears red, but why does it appear red? What causes the red tone to vary and what can we learn from this? What color will other normal items appear on false-color photos? How are infrared photos taken and how can they be obtained?

However, the new impetus in remote sensing is LANDSAT data, and these images are not photographs. They are visually reconstructed images from optical-mechanical scanner data: a continuous measurement of the intensity of electromagnetic radiation, in various wavelength bands, as it is reflected from the earth's surface features. "You mean these aren't photographs? They sure look like photographs." For a non-technical audience this may be a completely new concept. What is an optical-mechanical scanner and how does it work? What advantages does it have over a conventional camera? How do we get false-color composites from scanner data? How much detail can a satellite mounted scanner see?

How is this electronic data interpreted? Does it require computers? This is a subject with many new concepts to introduce.

There were other subjects we would have liked to include, but considering the practical applications our audience would be interested in, we thought that these would suffice, and would probably tax our participants' attention span. For the remainder of the workshop we wished to demonstrate some applications of these concepts within our state.

Source Materials on Basic Remote Sensing

Various source materials are available for the preparation of a seminar on the basics of remote sensing: texts, movies, and prepared slide programs. From our examination of various introductory books on remote sensing, it appears that they generally fall into one of two categories : technical or "gee whiz". Technical books, like "Remote Sensing, Techniques for Environmental Analysis," by Estes and Senger (1974), are excellent background material, but must be simplified and summarized for the beginning audience. An overabundance of technical detail will frustrate and overwhelm the audience and cause them to lose interest in the presentation and in possible applications of remote sensing. The technical books may be general texts or they may be professional treatises aimed at more specific problem areas. "Remote Sensing in Geomorphology," by H. T. Verstappen (1977), is a good example of the latter.

The vast majority of the general remote sensing texts, however, are of the "gee whiz" variety. They present hundreds of beautiful color pictures with short captions. Background information is relatively brief and most books of this orientation do not explain any details. "Mission to Earth: LANDSAT Views the World," a NASA publication (Short and others, 1976), is of this type. While it may be highly useful in other ways, it has little application as background material for preparing a workshop.

Fortunately, much of the source material on remote sensing has been evaluated and summarized recently (Fisher, 1977). Movies and prepared slide shows are covered, as well as texts. In this summary report we will only supplement this extensive treatment with a review of more recent additions.

An introductory text which provides a good summary of basic physical principles is "Remote Sensing: A Better View," by Robert D. Rudd (1974). This book explains the electromagnetic spectrum, multi-band photography, near and thermal infrared, optical mechanical scanners, side-looking radar and microwave radiometry. Unfortunately, beyond this introductory material Rudd steps into the "gee whiz" realm and gives hundreds of examples of remote sensing applications accompanied by only brief explanations. However, the book is good introductory reading for a person who is unfamiliar with remote sensing. As background material, it offers some good ideas on how to present the basic physical principles and what should be included.

A more technical book which has some interesting background material is "Remote Sensing -- Techniques for Environmental Analysis," edited by John Estes and Leslie Senger (1974). This is a series of papers which were originally delivered as a one-day short course on remote sensing for professional geographers. The material presented by Kirk Stone on the history of remote sensing is an excellent summary. Another chapter, written by John Estes, attempts to summarize the physical principles underlying remote sensing. Unfortunately Estes presupposes a relatively technical background. This chapter is good to use in preparing a lecture, but the material must be simplified for those without a technical education, and would not be good reading for the participants. Statements such as "The term 'electromagnetic spectrum' is applied to all radiant energy that moves with the constant velocity of light in a harmonic wave pattern" will probably intimidate many non-technical readers. Estes covers the electromagnetic spectrum, radiation source characteristics, atmospheric effects, target characteristics, and various data collection systems. He discusses those data collection systems designed for UV, visible and reflected infrared, thermal infrared, passive microwave, and radar, including both photographic and scanning detectors. He also discusses image processing and some principles of interpretation. The discussion is thorough and probably encompasses most of the material which should be presented in one day for non-technical personnel. The next chapter, on Quantitative Data Analysis, by David Simonett, is extremely useful. Quantitative data is the tremendous advantage provided by LANDSAT digital images. However, this area is just beyond what we felt should be included for novices. If a second day or follow-up seminar were planned, this would be excellent background material. The remainder of the chapters in this volume cover various areas of application including land use, vegetation mapping, crop inventory, and urban uses. However, the coverage is technical and detailed and not for introductory presentations.

Possibly the best introductory text on remote sensing available is "Introduction to Environmental Remote Sensing," by E. C. Barrett and L. F. Curtis (1976). This was written as a textbook and the authors tried to make it "basic, explanatory and broad" (preface, Barrett and Curtis, 1976). It is explanatory and broad, but unfortunately it presupposes some technical background and it is not quite basic enough for those with none. The electromagnetic spectrum is first explained with detailed physical equations. The characteristics of solar and earth radiation are examined in detail. Photographic sensors and films are discussed thoroughly and the advantages and disadvantages of various films are weighed. Various scanners are discussed, including LIDAR (laser radar) which is a relatively new development. Sensor platforms and packages are diagrammed, including details on the LANDSAT systems. The need for ground truth data is emphasized and methods of properly obtaining it are outlined. Manual and numerical data processing techniques are covered from photo interpretation through preprocessing to automatic classification techniques. The remainder of this text discusses various applications. It must be stressed, however, that both this text and the previous one present their applications material in a useful, informative, detailed treatment, not in a cursory fashion. As background material for an introductory lecture, this text is extremely useful. However, for a non-technical audience, additional simplification will still be necessary in the introductory stages.

While texts are useful as background for preparing lecture material, they can not be utilized during a one-day course. Participants will not be interested in reading extensive selections, nor will there be time available. Audio-visual stimulation and activity are the key to holding audience attention. Therefore, we evaluated various audio-visual aids which were commercially available and might be integrated into our presentation. A wide variety of illustrative slide sets are available from the LANDSAT and Skylab satellites and from conventional aerial photography. Fisher (1977) catalogs most of these. The slide sets, however, are generally similar to the pictorial books. They reproduce interesting scenes and illustrate important applications without explaining why the feature in question is visible. Most of these, then, would not meet our requirements for introducing the basic principles of remote sensing.

NASA has produced a series of six 16mm sound films on remote sensing for educational use at the high school level. Most of these are also oriented toward applications. The "Big Picture from Outer Space" is a general discussion of LANDSAT applications, while "Pollution Solution" deals more specifically with pollution monitoring: strip mine reclamation, air pollution, and monitoring the paths of industrial wastes. "The Wet Look" deals with water resources, particularly snow pack measurements as they relate to both water supply and flooding. The assessment of agricultural resources is discussed in "Growing Concerns." "The Fractured Look" examines LANDSAT's applications to geology, both in mineral exploration and in the identification of environmental hazards. Finally, "Land for People, Land for Bears" looks at land use mapping and discusses how spectral reflectance signatures are used to differentiate various land use categories. At an elementary level this would be useful in a program such as we propose. However, because these were produced for a pre-college audience, we did not actually preview these movies, and they might well be more useful than the brief summary from EROS indicates. The EROS Data Center has these for loan on a "one film at a time" basis, at no charge. Contact: USGS/EROS Data Center, Attention William Redmond, Applications Branch, Sioux Falls, South Dakota, 57198.

There are several general introductions available, either as films or as slide-tape programs, with which you can open your session. An EROS prepared slide set is "ERTS-1 A New Window on Our Planet." The previously mentioned EROS film "Big Picture from Outer Space" can also fill this role. A more thorough and technically oriented introduction is provided by "Remote Sensing: Tool for Managing Earth's Resources." This is a product of the Technology Application Center, the University of New Mexico (address -- The Audio-Visual Institute, 6839 Guadalupe Trail NW, Albuquerque, New Mexico, 87107). It effectively introduces the background physics, very briefly, then mentions several different remote sensing techniques, and then innumerates some varied practical examples. Many of the examples explain how the interpretation was made. This is a useful introduction for the type of program presently under discussion.

However, the Laboratory for the Applications of Remote Sensing (LARS) of Purdue University has prepared a series of nineteen slide-tape "minicourses" with workbooks which are nearly ideal for this purpose.

Not only is the program audio and visual, but the participant is actually involved in doing sample problems in the workbook. Obviously, all nineteen of these sets are not to be shown in one day; the audience would become catatonic. Each topic requires from a half-hour to forty-five minutes to complete. The first two sets are prerequisites for all the others, so they must be included. "Remote Sensing: What Is It?" is a technical introduction. It primarily introduces the concepts of remote sensing and why and how it works. The participants learn, for instance, that remote sensing is made possible by variations in field strength. Little time is spent on examples and the few which are included are explained in detail. "The Physical Basis of Remote Sensing" is the second prerequisite. This is the most technical of any of the slide shows we have reviewed and it illicited total frustrated confusions from some participants. However, it is very logically arranged and does not require a detailed technical background to follow. Most participants were able to profitably absorb the material. Most important, however, this slide-tape program covers exactly the physical background we wished to treat: the electromagnetic spectrum; the infrared and visible bands; radar; the sources of electromagnetic radiation and atmospheric effects; reflectance characteristics; and even an introduction to black body theory.

The remainder of the LARS minicourse series is divided into different groups, some being prerequisites for others. One group discusses the spectral basis of remote sensing, with one slide set on reflectance characteristics of vegetation and another on reflectance characteristics of earth surface features. Another group describes the organization of remote sensing programs. One set on this topic discusses mission planning, another LANDSAT, and the third Skylab. Yet another group treats applications, with slide sets on forestry, geology, crop surveys, and temperature mapping of water. Since we were confined to a limited time schedule, we elected not to utilize any of these groups.

Instead, after the two prerequisite minicourses, we used portions of a group on sensor systems. Since the vast majority of remote sensing, particularly in areas where technical facilities and expertise are limited, is simple aerial photography, this topic is of interest and practical importance to most participants. The LARS minicourse on "Photographic Sensors" describes various camera systems and how film-filter combinations make multi-band photography possible. It also describes the composition of both color film and false-color infrared film, and it explains basically why the colors on false-color infrared film must be shifted and how this affects the final photograph. For each minicourse in the Sensor Systems group, there is a parallel course in another group on Image Interpretation. "Interpretation of Color Infrared Photography" describes in detail the precise color shifts seen on color infrared film. The distinctive colors of clear vs. turbid water or of different soil types are explained. The advantages and disadvantages of color infrared film are then compared, with particular emphasis on detecting differences in plant types or vegetation health. The ability to distinguish between deciduous and coniferous trees is a well-documented advantage of false-color infrared film, and this has particular importance in Georgia where coniferous pulpwood is a major crop.

Beyond conventional aerial photography, the main emphasis of remote sensing is obviously LANDSAT. Since LANDSAT images are obtained by multi-spectral scanners and not by cameras, we decided that an explanation of the operation of a multi-spectral scanner should be included in the program. T e LARS minicourse on "Multi-Spectral Scanners", from the Sensor Systems group, covered most of the topics we deemed important. It explains the optical, mechanical, and electronic operation of a multi-spectral scanner and how the data is registered and displayed as electronic images. It explains how the instantaneous viewing area varies with altitude and view angle, and provides an exercise calculating the instantaneous viewing area of LANDSAT, Skylab, and the Environmental Research Institute of Michigan scanners. This is particularly useful in helping your audience to appreciate the limits of resolution of the satellite images. The minicourse continues with an extended discussion of image quality based on a long, cumbersome equation. Although we used this section along with the rest of the minicourse, in retrospect we decided that the audience would have absorbed more of the other, more useful material, if this portion were omitted.

The companion minicourse on the "Interpretation of Multispectral Scanner Images" is perhaps the best of the series for audience involvement. It describes the interpretation process in terms of spatial, spectral, and temporal variations and provides exercises using each one of these types of data for actual interpretation of multi-band images. These six minicourses were selected as pertinent to our goal and utilized as a part of our program. The LARS series also includes "Side-Looking Airborne Radar" and "Interpretation of Radar Imagery," as well as two sets on numerical analysis: "Pattern Recognition in Remote Sensing" and

"Typical Steps in Numerical Analysis." Inquiries on the entire LARS minicourse series, collectively titled Fundamentals of Remote Sensing, may be obtained from Continuing Education Administration, 116 Stewart Center, Purdue University, West Lafayette, Indiana, 47907.

The EROS Data Center also has available several slide programs with taped narratives on various aspects of remote sensing. "Evolution of the LANDSAT Color Composite" (SCTM-1) is a detailed explanation of the procedure used to prepare a color composite from the four channels of spectral data received by the multi-spectral scanner. It is interesting and gives one an appreciation of what a color composite actually is and the complexity of the preparation, but it does not treat any of the useful theoretical material which is necessary to understand this data. "Guide to Your First Use of the Image 100" (SCTM-2) also explains a technique, rather than theory. However, in this case it could have great impact. Many planners from rural areas in Georgia were not familiar with computer analysis of LANDSAT tapes and are somewhat intimidated by the supposed complexity. This slide set is well prepared to explain the logical operation of image analysis systems, based on multi-spectral data. It also explains several image enhancement techniques such as contrast stretching or calculating channel ratios. After a thorough introduction to the basics of the electromagnetic spectrum and the utility of multi-channel spectral data, this slide-tape set can demonstrate to your audience that image analysis is simply a logical extension of these basic principles using a computer as a tool. If this program precedes your presentation on applications your audience will have a much greater understanding of how and why these applications work.

An excellent example of the application of remote sensing data is described in "Monitoring Irrigated Land Acreage Using LANDSAT Imagery" (SCTM-3), another of the EROS slide-tape modules. This study documents a step-by-step manual interpretation technique actually used by the Oregon Water Resource Department over an area of 5,700 square miles. The cost of the LANDSAT survey was $1,500.00 compared to an estimated $20,000.00 for a conventional field survey. The Oregon Water Resource Department concluded that the technique was a "useful, economical, and quick method of accomplishing a reasonable estimate of the number of acres irrigated." The detailed documentation provided by this slide set provides a useful practical example from which the audience can not only learn what was done, but how it was accomplished. The subject of irrigation and groundwater is of great topical importance in Georgia since the disastrous drought of the summer of 1977. Although we did not think that we had time to utilize this presentation, it would most probably have been very well received by the participants.

Another useful EROS program is "Determining LANDSAT Image Availability at the EROS Data Center" (SCTM-5). This is an excellent program to use to conclude a session. It explains, line by line, how to locate and order the LANDSAT images which best fulfill your requirements. You should preview this slide-tape program carefully and provide your audience with the mentioned order blanks so that they may personally take notes on how to complete them.

In order to emphasize the applicability of remote sensing data in our local area we prepared two short slide presentations on remote sensing in Georgia. At our 1977 workshop, both Bruce Rado and Arnold Zisa, from the Georgia Department of Natural Resources, had presented interesting talks on applications of remote sensing in Georgia. Mr. Rado had spoken on the Georgia Land Information Program, an attempt at land information analysis from LANDSAT data on a statewide basis. Mr. Zisa had discussed the use of remote sensing data in monitoring coastal changes. Both speakers helped us duplicate their presentations and prepare notes for our delivery of their material.

Finally, we felt that some information on Georgia's new regional office of the Cartographic Information Center was pertinent. This cataloging center for all cartographic data will be operated by the Department of Natural Resources, Geologic and Water Resources Division. William Clark, head of the Cartographic Section, described the operation in detail and we prepared notes and some slides of the microfilm viewers and a few of the older maps in the file. Eventually, this office will have a list of all maps and aerial photographs ever made of Georgia or the surrounding states. For some maps, it will not only have a list, but it will have a microfilm copy of the original. A user will be able to order a paper copy of any map or photo in the film from the main office of the Cartographic Information Center. This service should be most important to planners, particularly in uncovering older maps from which they can measure changing trends in land use. As we expected, this portion of our presentation was of particular interest.

Our Program and Suggested Improvements

Our resultant program was as follows:

"Remote Sensing: What Is It?" (LARS).

"The Physical Basis of Remote Sensing" (LARS).

Break.

"Photographic Sensors" (LARS).

"Interpretation of Color Infrared Photography" (LARS).

Lunch (one hour).

"Multispectral Scanners" (LARS).

"Interpretation of Multispectral Scanner Images" (LARS).

Break.

Use of Remote Sensing in Monitoring Coastal Changes in Georgia (Courtesy of Arnold Zisa of the Georgia Department of Natural Resources).

The Georgia Land Information Program (Courtesy of Bruce Rado of the Georgia Department of Natural Resources).

The Georgia Office of the Cartographic Information Center (Prepared with the assistance of William Clark, the Georgia Department of Natural Resources).

We normally started shortly after nine o'clock a.m., broke one hour for lunch, and were done by roughly three-thirty p.m. By the end of the day it was obvious that the attention span of our audience was being taxed. Overall we reached a total of approximately 75 participants from 17 APDC's in six different workshops.

Based on our experience, we can suggest some untried improvements. Begin with a different, lighter introduction, then move into the LARS series. We found the six minicourses we used well received and we would recommend their continuance with the exclusion of the short section on multi-spectral scanner data quality. However, between the minicourses, where there is no break scheduled, plan five to ten minutes of explanatory lecture and local applications. This will serve to break the monotony and keep participants alert. Use large prints and maps which can be passed around with the lights on. Avoid using more slides. It would be desirable to also use the EROS programs on the Image 100, Irrigation Monitoring, and Image Ordering. These would preclude the organized presentations on local applications, but the latter would be replaced by the short demonstrations between the slide modules which would help vary the day. Based on our experience we find that a program such as is suggested below should be easy to prepare, educational, practically-oriented, and well-received.

Suggested One-Day Workshop on Remote Sensing for Planners

1. Introduction -- "Remote Sensing: Tool for Managing Earth's Resources" (Technology Application Center, the University of New Mexico).
2. "Remote Sensing: What Is It?" (Laboratory for the Applications of Remote Sensing, Purdue University).
3. Ten minutes of explanatory comments and pertinent local examples.
4. "The Physical Basis of Remote Sensing" (LARS, Purdue University).
5. Break (15 minutes).
6. "Photographic Sensors" (LARS, Purdue University).
7. Ten minutes on local aerial photography and its applications.
8. "Interpretation of Color Infrared Photography" (LARS, Purdue University).
9. Lunch (one hour).
10. "Multispectral Scanners" (LARS, Purdue University). Omit the portion on data quality.

11. Ten minutes on explanatory comments and local applications; possibly twenty minutes in this area.

12. "Interpretation of Multispectral Scanner Images" (LARS, Purdue University).

13. Break (15 minutes).

14. "Guide to Your First Use of the Image 100" (EROS Data Center).

15. Ten minutes of computer examples and maps.

16. "Monitoring Irrigated Land Acreage Using LANDSAT Imagery" (EROS Data Center).

17. Ten minutes of discussion of available data of different types with addresses for sources.

18. "Determining LANDSAT Image Availability at the EROS Data Center" (EROS Data Center); with order blanks for participants to refer to.

REFERENCES

Barrett, E.C., and Curtis, L.F., 1976, Introduction to Environmental Remote Sensing: London, Chapman and Hall, 336 p.

Estes, J.E., and Senger, L.W., 1974, Remote Sensing: Techniques for Environmental Analysis: Santa Barbara, California, Hamilton Publishing Company, 340 p.

Fisher, J.J., 1977, Teaching Geologic/Earth Science Remote Sensing at the Collegiate and the Secondary School Level: J. of Geologic Ed., v. 25, p. 2-13.

Rudd, R.D., 1974, Remote Sensing: A Better View: North Scituate, Massachusetts, Duxbury Press, 135 p.

Short, N.M., Lowman, P.D., Jr., Freden, S.C., and Finch, W.A., Jr., 1976, Mission to Earth: LANDSAT Views the World: Washington, D.C., N.A.S.A., 459 p.

Verstappen, H. Th., 1977, Remote Sensing in Geomorphology: Amsterdam, The Netherlands, Elsevier Scientific Publishing Company, 214 p.