
The Earth Resources Observation Systems Data Center's Training, Technical Assistance, and Applications Research Activities

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1981

Open File Report No. 81-1247

**United States
Department of Interior
Geological Survey**

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INTRODUCTION

The Earth Resources Observation Systems (EROS) Data Center (EDC), administered by the U.S. Geological Survey, U.S. Department of the Interior, provides remotely sensed data to the user community and offers a variety of professional services to further the understanding and use of remote sensing technology. EDC reproduces and sells photographic and electronic copies of satellite images of areas throughout the world. Other products include aerial photographs collected by 16 organizations, including the U.S. Geological Survey and the National Aeronautics and Space Administration. Primary users of the remotely sensed data are Federal, State, and municipal government agencies, universities, foreign nations, and private industries. The

professional services available at EDC are primarily directed at integrating satellite and aircraft remote sensing technology into the programs of the Department of the Interior and its cooperators. This is accomplished through formal training workshops, user assistance, cooperative demonstration projects, and access to equipment and capabilities in an advanced data analysis laboratory. In addition, other Federal agencies, State and local governments, universities, and the general public can get assistance from the EDC Staff.

Since 1973, EDC has contributed to the accelerating growth in development and operational use of remotely sensed data for land resource problems through its role as educator and by conducting basic and applied

remote sensing applications research. As remote sensing technology continues to evolve, EDC will continue to respond to the increasing demand for timely information on remote sensing applications. Questions most often asked about EDC's research and training programs include: Who may attend an EDC remote sensing training course? Specifically, what is taught? Who may cooperate with EDC on remote sensing projects? Are interpretation services provided on a service basis? This report attempts to define the goals and objectives of and policies on the following EDC services:

1. Training Program.
2. User Assistance.
3. Data Analysis Laboratory.
4. Cooperative Demonstration Projects.
5. Research Projects.

TRAINING

EDC is a primary source for training in the applications of remotely sensed data to the inventorying, monitoring, and management of the Earth's resources. From 1974 to 1980, over 160 remote sensing training courses have been presented by the staff of EDC to over 3,500 resource scientists and engineers. While EDC's main training responsibility is to the Department of the Interior agencies, most courses are open to other personnel from Federal, State, and local governments, universities, and private agencies. In addition, two courses are offered annually specifically to foreign scientists.

The Center's remote sensing training courses vary in scope and content. Some are initiated at the request of user agencies, and others are developed independently by EDC; some courses emphasize manual interpretation techniques, and others deal with digital data analysis. They range in length from 2 days to 4 weeks, although the majority of domestic, discipline-related courses are 1 week in duration. Enrollment per course varies from 5 to 50.

The demand for remote sensing training has evolved from courses on fundamentals to courses on more advanced topics. Currently, introductory photograph- or image-interpretation courses, unrelated to a discipline, are seldom offered by EDC staff. Almost all courses are discipline-related, such as the "Water Resources Remote Sensing Workshop" or the "Advanced Course

in Geological Remote Sensing Techniques." Courses for foreign scientists emphasize broad discipline applications, such as vegetation/land use or geology/hydrology.

Many courses are offered on an annual basis, but it is not feasible to carry over a rigid schedule from year to year. Because of user agency needs and EDC staff commitments, it is difficult to schedule courses more than 6 to 8 months in advance. Persons interested in EDC remote sensing training should consult the EDC newsletter, "Landsat Data User's Notes," in which the training schedule is updated in each bimonthly issue. Those interested in receiving this newsletter should send their name and address to User Services, EROS Data Center, Sioux Falls, SD 57198.

Courses are held in a classroom that can accommodate up to 35 students. The room has large work tables and multimedia teaching aids, including video and sound links between the classroom and EDC's Data Analysis Laboratory (DAL). Workshops are also conducted away from EDC, however, either as part of a scientific symposium, in cooperation with other training facilities, or on-site for some agencies.

Typically, the cost of training for an individual is \$400 to \$500 per week, including course materials. Lodging in local motels ranges from \$10 to \$35 per night. Transportation to EDC from Sioux Falls is usually provided at no extra cost.

Aside from conducting formal training courses, EDC has promoted education in remote sensing at universities. Grants have been extended to several universities for the development of curricula and materials to be used in training courses in remote sensing applications for professionals. Grant recipients are universities that were previously providing remote sensing applications courses but needed support for training professionals through extension services. EDC has also participated in courses offered by Harvard University, the South Dakota School of Mines and Technology, the University of Michigan, the University of California, and Humboldt State University. Postdoctoral research associateships in remote sensing are also available through the U.S. Geological Survey in association with the National Research Council. For more information on these associateships, contact:

Chairman
Postdoctoral Research Associateship
Committee
U.S. Geological Survey
Reston, VA 22092

It is expected that EDC training courses will continue to become more specialized, emphasizing advanced topics such as statistical sampling techniques, digital data base management, and digital image processing. Department of the Interior agencies and other Federal agencies interested in remote sensing training not listed in the EDC newsletter can contact the Chief, Training and Assistance Section, EDC, to discuss the possibility of special courses.

USER ASSISTANCE

EDC provides, on a day-to-day basis, technical information on the applications of remotely sensed data. Each year, the EDC staff receives several hundred visitors from all over the world, handles approximately 600 requests for scientific information, and disseminates a multitude of reprints, bibliographies, and remote sensing training aids. The EDC's Don Lee Kulow Memorial Library houses nearly 25,000 items relating to remote sensing applications.

Meeting the needs of scientific visitors is an important part of EDC's user assistance program. Agencies or individuals are welcome to visit and tour the EDC facility, discuss remote sensing projects with staff scientists, or conduct library research. Many individuals and groups have visited EDC, including geology students from the University of Cincinnati; a member of the United Nations Economic Commission for Africa; consulting geologists; South Dakota farmers and ranchers; and a professor from Grantham College of Education, Hong Kong, to name only a few. Parties interested in visiting EDC should contact the Coordinator, Scientific Visits. Advanced notice should be given so that a complete agenda of activities related to the visitor's interests can be arranged.

In response to inquiries, an attempt is made to answer each question with a personal, specific reply by letter or by telephone. Questions most asked pertain to remote sensing applications to dozens of resource problems including, for example, land use identification and delineation, vegetation cover mapping, and mineral exploration. An information data base is

maintained containing current reprints of articles summarizing remote sensing research, discipline-related bibliographies, and training materials so that answers to inquiries can be supplemented with pertinent material. A continual attempt is made to keep the data base on remote sensing research and training in the United States and other nations up to date.

Because EDC is primarily a Department of the Interior support facility, any interpretive or analytical work done by EDC staff on a service basis is normally in support of Department of the Interior agencies or cooperative projects. Private agencies or individuals seeking interpretive services are usually given a list of commercial firms offering data interpretation services.

Several articles and documents commonly distributed by EDC staff have proven to be of wide appeal to users. Of particular interest is the "EROS Data Center List of Workshop Exercises," which documents all imagery, written material, and costs of the workshop exercises initially generated for use in EDC remote sensing training courses. These exercises (currently numbered at 71) are intended to provide "hands-on" instruction on the fundamentals of remote sensing and its applications. Although the exercises were designed to accompany course lectures, they may be self-administered.

Other materials commonly distributed at no cost include:

1. "The Landat System," facts and figures on Landsats 1, 2, and 3, their orbits, and data.
2. "Publications of the Applications Branch, EROS Data Center," a bibliography of publications authored by the applications staff of EDC. Copies of each article listed are available from EDC.
3. "Audio-Visual Aids of the EROS Data Center" is a list of available video-cassettes, slide-cassettes, and 16 mm films.
4. Bibliographies of remote sensing works related to 13 natural resource applications.

The EDC's Don Lee Kulow Memorial Library contains a collection of books, papers, and journals pertaining to remote sensing technology and applications. Approximately 25,000 items and 70 journals are accessible to EDC staff, visiting scientists, and the general public. A bibliography of all books and articles in the library, and many journal articles, has been entered in EDC's main computer, and the entries are cross-referenced by title, subject, and author. A keyword computer search system allows the user to quickly obtain a listing of articles relating to his/her area of interest. Library holdings may be obtained through interlibrary loan. The library is open daily during working hours. For more information, direct inquiries to the Librarian, EDC.

Under certain circumstances, a visiting individual or group may be escorted to the Data Analysis Laboratory to receive a firsthand demonstration of the usefulness of digital image processing for the enhancement and interpretation of remotely sensed data. However, because of the heavy use of the laboratory by staff scientists, these demonstrations must be scheduled well in advance of a visit. Requests for demonstrations should be submitted several weeks in advance to the Coordinator, Scientific Visits.

DATA ANALYSIS LABORATORY

The Data Analysis Laboratory (DAL) of EDC is a unique facility for the analysis of remotely sensed data and was specifically designed to support the Data Center's mission of technology transfer. The laboratory is used by EDC staff to demonstrate state-of-the-art capabilities in the analysis of remotely sensed data by providing for Department of the Interior research and development and the operational use of these capabilities. This is accomplished by satisfying three objectives:

1. To develop new capabilities in digital image analysis and processing technology.
2. To acquire, develop, modify, and implement state-of-the-art hardware and software capabilities.
3. To support EDC's training and cooperative project activities.

Although the laboratory's computer specialists frequently develop and improve image analysis systems, the laboratory's primary function is to transfer the technology of using the equipment to the users of remotely sensed data. Thus, for example, opportunities for training in machine-processing techniques are available to attendees of some of the EROS-sponsored training courses.

The following image analysis hardware/software systems are available in the Data Analysis Laboratory:

1. Interactive multispectral digital image analysis system (General Electric Image 100)¹.
2. Software-driven digital image manipulation system (Interactive Digital Image Manipulation System [IDIMS] by Electromagnetic Systems Laboratory)¹.

Digital image enhancement and classification functions, statistical analyses, and geographic data analysis techniques are performed on the equipment in the laboratory.

These functions include, but are not limited to: (1) digital image preprocessing, such as radiometric transformations and image enhancement (which enhance visual image interpretability) and geometric transformations; (2) digital image classification algorithms, such as parallelepiped, maximum likelihood, and minimum distance; (3) statistical functions for quantifying remotely sensed data; and (4) geographic data analysis techniques used to digitize mapped data and merge digital data sets. Some examples of applications research performed in the DAL are land use and vegetation cover mapping, mining activity change detection, mineral exploration, and water quality assessment.

Use of the equipment in the laboratory by non-EDC personnel is limited. Top priority, of course, is given to those directly involved with EROS-sponsored training courses, applications demonstrations, and

Department of the Interior application demonstration projects. Second priority goes to Department of the Interior operational users, such as, for example, Bureau of Land Management scientists. Third priority is given to other Federal agencies, and lastly, to State and local governments. Private agencies and individuals seeking image interpretation or enhancement services, or simply experience in image processing using their own data set, are referred to a list of commercial firms in the business of providing image processing support.

Costs for the use of the equipment in the laboratory will be charged in some situations. The Data Center will charge for image analysis support of applications demonstration projects and operational projects conducted by the Department of the Interior and other cooperating agencies. User charges will not be levied for demonstrations in the laboratory; however, training-course tuition charges will reflect the cost of laboratory support. Requests to perform tasks in the laboratory must be submitted in writing to Chief, Applications Branch.

The Data Analysis Laboratory assists in meeting EDC's mission of technology transfer by updating equipment and increasing capabilities. Improvements in hardware and software for the existing image analysis systems will continue. Future capabilities will emphasize the development of a prototype remote image processing station, the improvement of EDC's capability of digitizing mapped data, and the improvement of geographic data analysis capabilities.

¹Trade names are used to exemplify equipment and does not constitute endorsement.

COOPERATIVE DEMONSTRATION PROJECTS

Cooperative demonstration projects are a vital part of the technology transfer process at EDC and a logical continuation of EDC's research and training program. Joint efforts between EDC and other agencies provide an opportunity for those agencies to test the practical utility of proven remote sensing techniques within the administrative and managerial bounds of their own organization. Also, they allow trainees in EDC's courses to apply the remote sensing techniques learned in the classroom to their own operational mission and informational needs.

To ensure transfer of technology to the user agency and to provide a training experience for the project participants, cooperators are required to participate in all phases of the project, including planning, data analysis, field data collection, and reduction and synthesis of results. Short-term residency and training sessions for cooperators are often necessary elements in the cooperative projects. Ideally, cooperator personnel acquire all necessary data and perform all the work themselves, while EDC makes available specialized analysis equipment and provides multidisciplinary council and advice.

Some cooperative projects of national significance include:

1. The Department of the Interior/Office of Surface Mining project on surface-mine detection, inventory, and monitoring problems, in response to the National Strip Mine Monitoring and Reclamation Act of 1977.
2. The Bureau of Land Management project on the Alaska, Arizona, and Idaho regional vegetation and terrain inventory project, in response to the Federal Land Policy and Management Act of 1976.
3. The National Park Service project on developing base-line inventories for park areas, in response to the United Nations' Man in the Biosphere Program.

Examples of past cooperative projects include:

1. Urban and regional land use change detection (Atlanta Regional Commission)
2. Assessment of flood damage in the Red River Valley (U.S. Geological Survey's Water Resources Division and the States of North Dakota and Minnesota)
3. Gypsy moth defoliation study in Pennsylvania (U.S. Department of Agriculture, Animal Plant Health Inspection Service)
4. Determination of irrigable land in the Columbia River Valley (U.S. Army Corps of Engineers)
5. Landsat classification for updating a geobased information system (Minnesota State Planning Bureau)

In recent years, the demand for cooperative projects with EDC has increased significantly, especially among other Department of the Interior agencies such as the Bureau of Land Management, U.S. Fish and Wildlife Service, U.S. Geological Survey's Water Resources Division, and the National Park Service. Other agencies which have recently shown an increasing interest in projects include the U.S. Army Corps of Engineers, the U.S. Geological Survey's National Mapping Division, the U.S. Forest Service, and the City of Sioux Falls, S. Dak. Other trends indicate that the demand is for more complex projects with larger study areas. More projects will be undertaken which involve statistical sampling, geobased information systems, and multidisciplinary information requirements.

Department of the Interior agencies have priority for cooperative demonstration remote sensing projects with EDC. The remaining cooperators, in order of priority, are other Federal agencies, and State, regional, and local governments. Agencies interested in conducting a cooperative demonstration project with EDC should contact in writing, Chief, Applications Branch.

RESEARCH AND DEVELOPMENT

EDC is engaged in research and development of (1) basic and applied remote sensing applications, and (2) data analysis technique and capability.

Basic and applied remote sensing applications research is conducted at EDC to strengthen the scientific and technical foundation of the Data Center's technology transfer program. The objectives of this activity are:

1. To identify gaps in current investigative remote sensing programs at existing research facilities.
2. To solicit assistance in solving remote sensing research problems.
3. To focus the efforts of the EDC staff on specific basic and applied research problems for which EDC has unique capabilities (equipment and facilities).
4. To document and disseminate research results.
5. To integrate research results into the EDC technology transfer program through cooperative demonstration projects and training courses.

To keep up to date with new advancements in digital image processing technology, EDC's Data Analysis Laboratory personnel specialize in equipment and software development. The acquisition, implementation, development, and modification of hardware and software in the laboratory are needed to support training and assistance with state-of-the-art capabilities.

Several past research and development projects include:

1. Targeting nickel laterites in Indonesia with Landsat data.
2. Digital topographic slope and aspect display and analysis.
3. Return beam vidicon Landsat data merging with multispectral scanner Landsat data.
4. Correlation of Landsat data with geophysical data.
5. Classification techniques with Bureau of Reclamation aircraft scanner data.
6. Effect of resampling on Landsat classification accuracy.

Gaps in remote sensing research conducted at other research facilities, needs of cooperating agencies, and EDC information requirements have prompted EDC to address several specific research directions. Three specific needs have been identified:

1. To map, inventory, and monitor natural resources better through remote sensing technology.
2. To incorporate natural resource data into automated data bases to facilitate updating and merging.
3. To use remotely sensed data in predictive or managerial stimulation models.

Specific topics to be addressed include mapping wetland, monitoring irrigated lands, developing geobased information system techniques, and developing low-cost remote (portable) image analysis systems.

SUMMARY

In addition to the reproduction and distribution of remotely sensed data for areas throughout the world, EDC provides professional services for the Department of the Interior, its cooperators, and others. The services are directed toward transferring remote sensing applications technology to (in order of priority) Department of the Interior agencies, other Federal agencies, State and local governments, universities, and private agencies. The Data Center is one of the world's primary sources for training in remote sensing applications. It maintains a data base of remote sensing information that is made available to the public. Proven

remote sensing techniques are demonstrated in practical projects, and remote sensing research is conducted. All these activities are supported by a sophisticated image analysis laboratory. The EROS Data Center thus works to introduce the use of remotely sensed data in natural resource problem solving, planning, and management.

The EROS Data Center will continue to bridge the gap between the users of natural resource data and spacecraft and computer technology. These efforts have and will continue to grow. For example, the USGS/EROS Field Office in Anchorage, Alaska, established in February, 1980, is an extension of the EROS Data Center.

Their mission of technology transfer is directed specifically to government agencies and universities in Alaska. This is effected by: (a) conducting training courses; (b) providing technical information; (c) participating in cooperative demonstration projects; and (d) making manual and digital analysis equipment available for training and operational use. For more information about the Field Office, contact:

USGS/EROS Alaska Field Office
218 E Street
Anchorage, AK 99501
(907) 271-4065