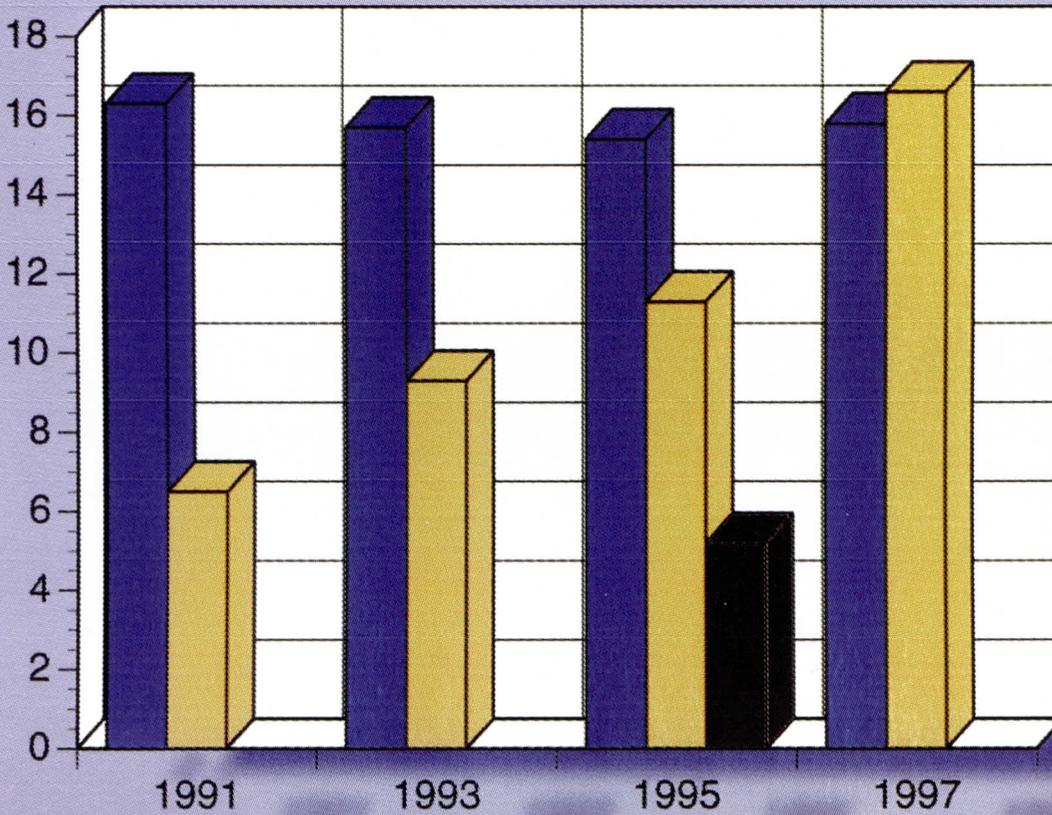


**EROS DATA CENTER
ANNUAL REPORT**

FISCAL YEAR 1997



**U.S. GEOLOGICAL SURVEY
NATIONAL MAPPING DIVISION**

1

The U.S. Geological Survey
A Tradition of Public Service
1879-1997

The U.S. Geological Survey (the USGS), established by Congress in the Organic Act on March 3, 1879, provides geologic, topographic, and hydrologic information to the Nation. This information comprises maps, data bases, and reports containing analyses and interpretations of water, energy and mineral resources, land surfaces, geologic structures, natural hazards, and the dynamic processes of the Earth.

Key actions conducted by the USGS in fulfilling its mission are:

- Collect and analyze data on the quantity and quality of surface and ground water, on water use, and on the quality of precipitation. Assess the impact of human activities and natural phenomena on water resources.*
- Assess energy and mineral resources, develop techniques for their discovery, and evaluate the impact of their extraction.*
- Describe the onshore and offshore geologic framework of the Nation and develop an understanding of the formation and evolution of that framework.*
- Evaluate hazards associated with earthquakes, volcanoes, floods, droughts, landslides, and toxic materials. Develop methods for the prediction and mitigation of such hazards.*
- Produce and update geographic, cartographic, and remotely sensed information in both graphic and digital form.*

The USGS cooperates with and coordinates its efforts with nearly 2,000 agencies at Federal, State, county, and municipal levels, and with other nations and international organizations. The headquarters of the USGS is located in Reston, Virginia. Three regional centers are located in Denver, Colorado; Menlo Park, California; and Reston, Virginia. Field offices, such as the EROS Data Center, are located throughout the 50 states, the Commonwealth of Puerto Rico, and the Trust Territories of the Pacific.

U.S. Geological Survey

Vision

“The U.S. Geological Survey is an earth science organization that is recognized worldwide as scientifically credible, objective, and demonstrably relevant to society’s needs.”

The Mission

As the Nation’s largest water, earth, and biological science and civilian mapping agency, the U.S. Geological Survey works in cooperation with more than 2,000 organizations across the country to provide reliable, impartial, scientific information to resource managers, planners, and development of the nation’s natural resources, and enhance the quality of life by monitoring water, biological, energy, and mineral resources.

Mission of the National Mapping Division

The mission of the U.S. Geological Survey's National Mapping Division is to meet the Nation's need for basic geospatial data, ensuring access to and advancing the application of these data and other related earth science information for users worldwide. In support of this mission, we:

- Ensure the production and availability of basic cartographic and geographic spatial data of the country.*
- Coordinate national geospatial data policy and standards.*
- Provide leadership for the management of earth science data and for information management.*
- Acquire, process, archive, manage, and disseminate the land remote sensing data of the Earth.*
- Improve the understanding and application of geospatial data and technology.*

EROS Data Center

Vision

"We are stewards of land remote sensing and associated data, advancing the availability and applicability of these data for scientific and land management users worldwide."

Mission

The fundamental mission of the U.S. Geological Survey's EROS Data Center is to contribute to meeting the Nation's needs for basic geographic, cartographic, and other types of earth-science information by acquiring, managing, and distributing land remote sensing and associated spatial data. In support of this mission we:

- Provide data products and services to scientific and land management users worldwide.*
- Develop, implement, and operate advanced data storage, information management, data processing, product generation, and product delivery systems.*
- Define and document user requirements, conduct research, and develop data and related technology applications.*

Foreword

The USGS/EROS Data Center's FY 1997 accomplishments were outstanding. There was an increasing demand for our products and services, and we met that demand with high quality and timeliness.

Partnerships with NASA, NOAA, EPA, AID, DOD and others continued to grow in terms of both breadth and depth of work. The National Satellite Land Remote Sensing Data Archive is being recognized not only as a unique national treasure, but also as an extraordinary data management challenge. We met our data production goals for making diapositives in support of the Digital Orthophoto Quadrangle Program and for mapping the land cover in major parts of the eastern U.S. using Landsat thematic mapper and ancillary sources of data.

The amount of data delivered to our customers reached new highs through network transmission, softcopy media and hardcopy photographic products. Total product sales for the fiscal year exceeded \$10.6 million.

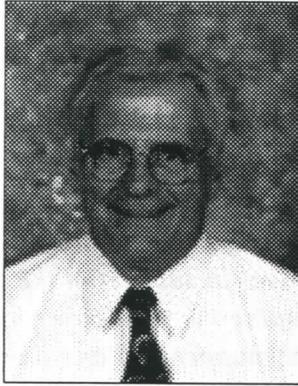
Major milestones were reached in support of NASA's Mission to Planet Earth Program through the installation of new equipment and the start-up of testing and integration of systems needed for the planned 1998 launches of Landsat 7 and EOS AM-1.

In the areas of geographic research and applications, great progress was made on the MRLC database, change detection methodologies, ecological monitoring, decision support systems (FEWS, Mojave), Arctic studies, the InterAmerican Geospatial Data Network, DLG-F activities, DORRAN re-engineering, and state-of-the-art network technologies.

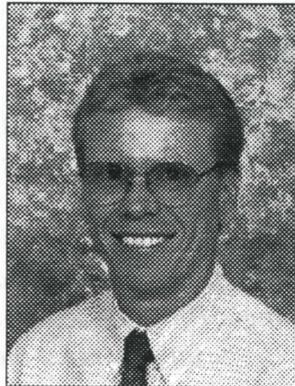
I present the EROS Data Center's Annual Report for fiscal year 1997 with confidence that the Center's staff will continue to enhance the USGS's reputation for providing science for a changing world.

*Donald T. Lauer
Chief, EROS Data Center*

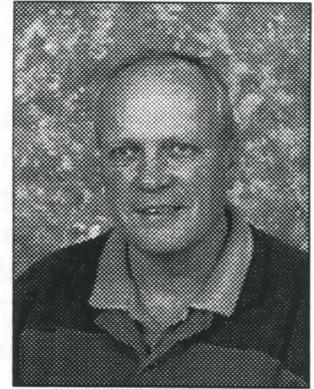
Executive Leadership Chart



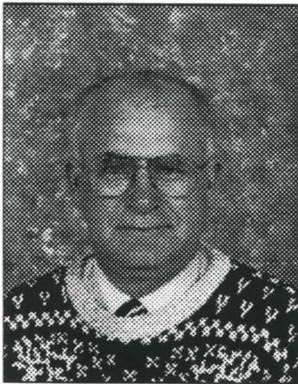
Donald T. Lauer
Chief



James A. Sturdevant
Assistant Chief,
Operations



Wayne G. Rohde
Assistant Chief,
Programs



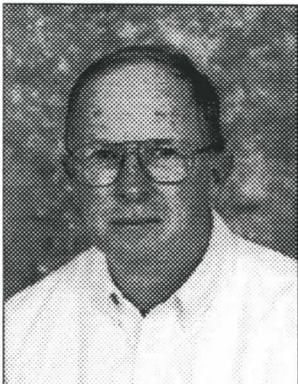
Ralph J. Thompson
Chief, Satellite
Systems Branch



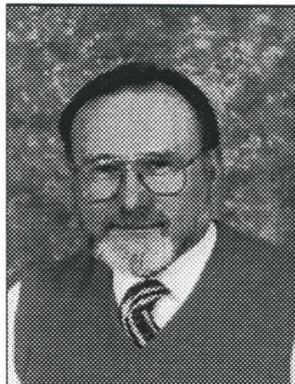
Ronald A. Parsons
Chief, Computer
Services Branch



June M. Thormodsgard
Chief, Science and
Applications Branch



William C. Draeger
Chief, Data Services
Branch



Eugene Napier
Chief, Programs Budget
and Admin. Office

COVER

In October 1991, at the 17th annual EROS Data Center program review meeting held near Lake Okoboji, Iowa, the Center's executive management team developed a strategy to increase partnerships with other Federal agencies and opportunities for additional reimbursable project work. The Center was facing level funding, at best, through direct Congressional appropriations. There was even a likelihood for reduced support from the Congress—driven mostly by the burgeoning problem of huge annual Federal deficits and the growing Federal debt. At that off-site meeting, a decision was made to leverage to the fullest extent possible the Center's appropriated funds with funds that could be provided by cooperators in support of programs and projects of mutual interest to the U.S. Geological Survey and the respective cooperating agency.

As the bar chart shows, the Center was successful in implementing the planned strategy. Funds appropriated by the Congress to the Center in fiscal years 1991, 1993, 1995, and 1997 are shown (\$ million) in dark blue. Funds retained by the Center from the sale of products and services and from cooperative projects with the National Aeronautics and Space Administration, the National Oceanic and Atmospheric Administration, U.S. Agency for International Development, U.S. Environmental Protection Agency, Department of Defense and many other agencies are shown in beige. The black bar in fiscal year 1995 shows funding for the building addition, which was funded in both 1994 (not shown) and 1995.

During this 6-year period of extremely tight budgets in the Federal community, the Center was able to not only increase its cooperation with organizations across the country, but also its overall funding by more than 40 percent—from \$22.8 million in 1991 to \$32.4 million in 1997.

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EROS Data Center Overview

The Earth Resources Observation Systems (EROS) Data Center (EDC) is a field center for many programs and activities of the U.S. Geological Survey's National Mapping Division (NMD). Located near Sioux Falls, South Dakota, staff at the EROS Data Center manage earth-science data bases, develop computer systems, and share technical expertise with users from around the world. The United States Department of the Interior established the Center in 1971 to receive, process, and distribute data from Landsat satellites - a series of experimental platforms launched by the National Aeronautics and Space Administration (NASA). Two decades later, Congress mandated the EDC to become the National Satellite Land Remote Sensing Data Archive. This legislative mandate directs EROS to maintain a high-quality data base of images of the Earth acquired from space suitable to study global environmental change. As a result, EDC holds one of the largest collection of images of the Earth acquired by civilian spacecraft and aircraft. These holdings include over 11 million frames of photographic data and over 200,000 digital tapes. The EROS Data Center also is a major information source for the holdings of foreign Landsat ground reception stations and data acquired by other nations' Earth observing satellites. In addition to these data holdings, EDC receives and processes image data from the Advanced Very High Resolution Radiometer (AVHRR) aboard National Oceanic and Atmospheric Administration (NOAA) weather satellites.

The Data Center's mission centers around activities associated with managing many types and large volumes of global Earth observations data. Its mission includes, but is not limited to, developing and operating advanced computer systems to receive, process, and distribute earth-science data. These and other map and geographic data support many types of scientific studies, resource management programs, and environmental monitoring activities worldwide. At the Center, Earth scientists from many disciplines combine expertise with engineers, technicians, and professionals in systems development, telecommunications, and computer science to conduct research and develop applications that support the mission of the U.S. Geological Survey, the Department of the Interior, other federal agencies, and international organizations.

Another key part of the Center's mission is its involvement in NASA's "Mission to Planet Earth" program. Because of its tie to NASA, EDC will process and archive land data acquired by sensors aboard the Earth Observing System (EOS) satellites, the first of which will be launched next year. The Center continues to assume a major role in managing and distributing remotely sensed land data used by global environmental change researchers. This role is strengthened by EDC's capacity as the Earth Observing System Data and Information System (EOSDIS) Land Processes Distributive Active Archive Center (LPDAAC).

Under another joint partnership with NASA, the Data Center also serves as the home and primary source for data for the United Nations Environmental Programme/Global Resource Information Database (UNEP/GRID) North America Node office. This office is one of several worldwide forming a network to distributed data and research techniques for timely environmental studies by member nations.

In addition to in-house facilities, the Data Center operates field offices or assigns scientists to sites in Anchorage, Alaska; Greenbelt, Maryland; Reston, Virginia; Mountain View, California; and Harare, Zimbabwe, to support resource and environmental studies in those locations.

A Highlight Report - Recovery from Hail Storm

A severe thunderstorm moved through Minnehaha County in southeastern South Dakota during the late afternoon hours on July 13, 1997. The storm caused extensive damage to the EROS Data Center and to the surrounding area. Baseball to softball size hail, pushed by 55 knot winds, struck the Center, causing extensive roof and atrium damage, smashing skylights and windows, and destroying government and privately owned vehicles. The hail also severely cracked and dented satellite data receiving antennas and completely demolished a 1 acre, 504 panel solar array. Total damage to the EDC facility was estimated at \$820,000. (In addition, the recently installed Landsat 7 data reception antenna, owned by NASA and its contractors, sustained damage estimated at \$1 million).

Within days, repairs were underway and replacements for the government vehicles were on order. Contracts were prepared to close in the affected areas of the facility to protect valuable equipment from the coming winter months and new antennas for the data reception capabilities were installed. (The Landsat 7 antenna replacement is scheduled for early 1998).

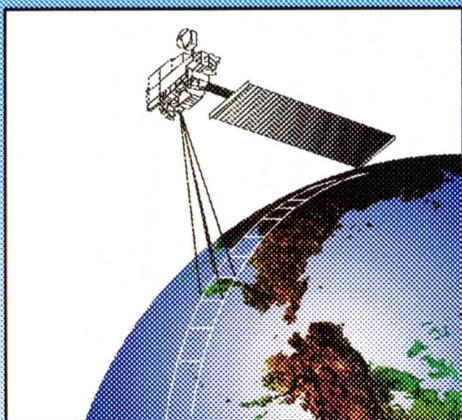
National Satellite Land Remote Sensing Data Archive

In its role as the National Satellite Land Remote Sensing Data Archive, the EROS Data Center has archived, managed, and distributed land remote sensing data and other Earth surface data since 1972. Data acquired from the Landsat multispectral scanner (MSS) and thematic mapper (TM) and NOAA's Advanced Very High Resolution Radiometer (AVHRR) are managed by the Center and total more than 132,000 gigabytes of data – the results of a national investment of more than \$3 billion. The archive also includes more than 880,000 declassified intelligence satellite photographs, as a result of Presidential Executive Order #12951, which authorized the release of imagery acquired from 1960 to 1972 by space-based national intelligence reconnaissance systems. By 2001, holdings will include data from Landsat 7 and the Earth Observing System AM-1 and other planned systems such as the Shuttle Radar Topography Mission (SRTM.), a joint venture of NASA and the National Imagery and Mapping Agency; LightSAR, a NASA synthetic-aperture radar instrument; and NASA's Small Spacecraft Technology Initiative (SSTI). By 2003, the collection will grow by a factor of 15 to approximately 2,000,000 gigabytes of data (figure 1).

The National Satellite Land Remote Sensing Data Archive (NSLRSDA) grew by over 71,000 images this fiscal year. All of the NSLRSDA holdings are accessible through the Global Land Information System (GLIS).

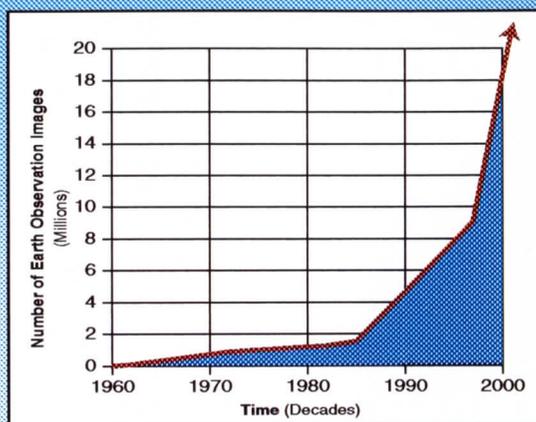
Satellite Land Remote Sensing Data Management

Earth Observation Satellites



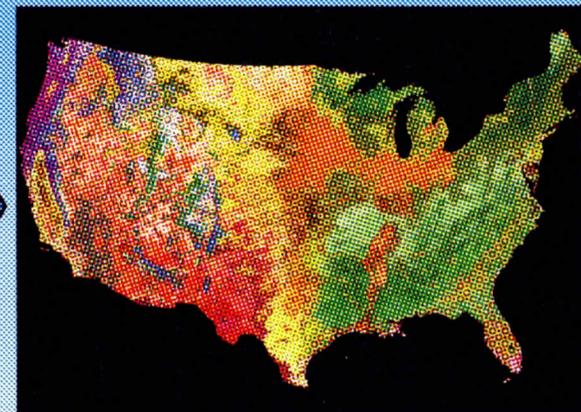
- Declassified Systems
- Landsat 1-5
- NOAA - POES
- Shuttle Radar
- Landsat 7 (1998)
- NASA-EOS (1998)
- High Resolution Systems

USGS National Archive Challenge



- Preserve
- Provide Access
- Process
- Reproduce
- Distribute
- Hold in Trust

Data Applications



- Land Cover
- Fire Danger Rating
- DOI Land Management
- Natural Hazards
- Coastal Zones
- Environmental Monitoring

Expanding to over 18 million images of the earth!

Figure 1. National Archive Holdings

The AVHRR archive continues to grow. A total of 26,450 new scenes were added via direct receipt, network transfer, DOMSAT relay, and foreign station tape shipments this year. The AVHRR archive includes over 158,000 scenes. An additional 2,940 orbital passes were also processed. The orbital segment data base now includes over 11,500 images in support of the USGS's Land Characterization Program and NASA's Mission to Planet Earth Program.

AVHRR Data Management

Information on data in the archive can be obtained online by using GLIS. Users can search for, and access metadata, and place orders for images interactively. Released in 1991, GLIS is an interactive sources of information for land remote sensing and other Earth surface data. In its World Wide Web version, it includes some browse, search, and order capabilities for various data sets. The GLIS web address is: <http://edcwww.cr.usgs.gov/webglis/>

The EROS Digital Image Processing System (EDIPS) was decommissioned on March 19, 1997 (figure 2). The twenty year old system was responsible for all the Landsat MSS archive processing and product generation for data acquired from 1979 through 1996. Over 500,000 unique scenes from Landsat 2-5 were processed during its lifetime. A total of 1.4 million bands of imagery were produced from the EDIPS Laser Beam Recorders. The system has been replaced by TMACS (TM/MSS Archive Conversion System for data archive support) and NLAPS (National Landsat Archive Production System for product generation).

EDIPS

On November 12-13, 1996, the EROS Data Center held a National Satellite Land Remote Sensing Data Archive Workshop to provide an opportunity for exchange of expert opinions regarding the challenges and issues associated with management of the existing and future archive of satellite land remote sensing data. Twenty-one leaders and experts from industry, academia, state, and federal government representing a variety of disciplines relating to remote sensing imaging, archiving, and education attended the workshop. The two-day workshop included a series of plenary sessions on the first day that described the existing archive of satellite remote sensing data currently managed by the USGS; discussed the conceptual characteristics of that archive; and, developed a common strategy for addressing the requirement for providing advice to the archive management staff. On the second day, three splinter groups addressed these issues in more detail, and a final plenary session consolidated remarks and developed recommendations of the workshop.

NSLRSD Workshop

As of October 1, 1996, Landsat TM data distribution is shared between the EDC and Space Imaging EOSAT. EDC will distribute all unenhanced TM data to confirmed members of the U.S. Government and its Affiliated User (USGAU) purchaser group, although 10 years and older TM data can be made available to the general public as well as USGAU. TM data previously purchased by the U.S. Government and its Affiliated User purchaser group and all future purchases of TM data by USGAU can be

TM Distribution

reproduced and redistributed, within the USGAU, for noncommercial purchases, without restriction. The U.S. Government and its Affiliated Users purchaser group includes all U.S. Government agencies; U.S. Government contractors; researchers involved with the U.S. Global Change Research Program and its international counterpart programs; and, other researchers and international entities who have signed with the U.S. Government a cooperative agreement involving the use of Landsat data for noncommercial purposes.

A total of 23,000 thematic mapper (TM) scenes from 442 high density tapes were added to the archive in fiscal year 1997.

Space Imaging EOSAT will retain distribution rights for unenhanced TM data to the general public. The company will continue to operate Landsat 4 and 5 at no cost to the Government until the practical demise of the last of Landsat 4 and 5, and will retain distribution rights for 5 years after the demise of the last of Landsat 4 and 5.

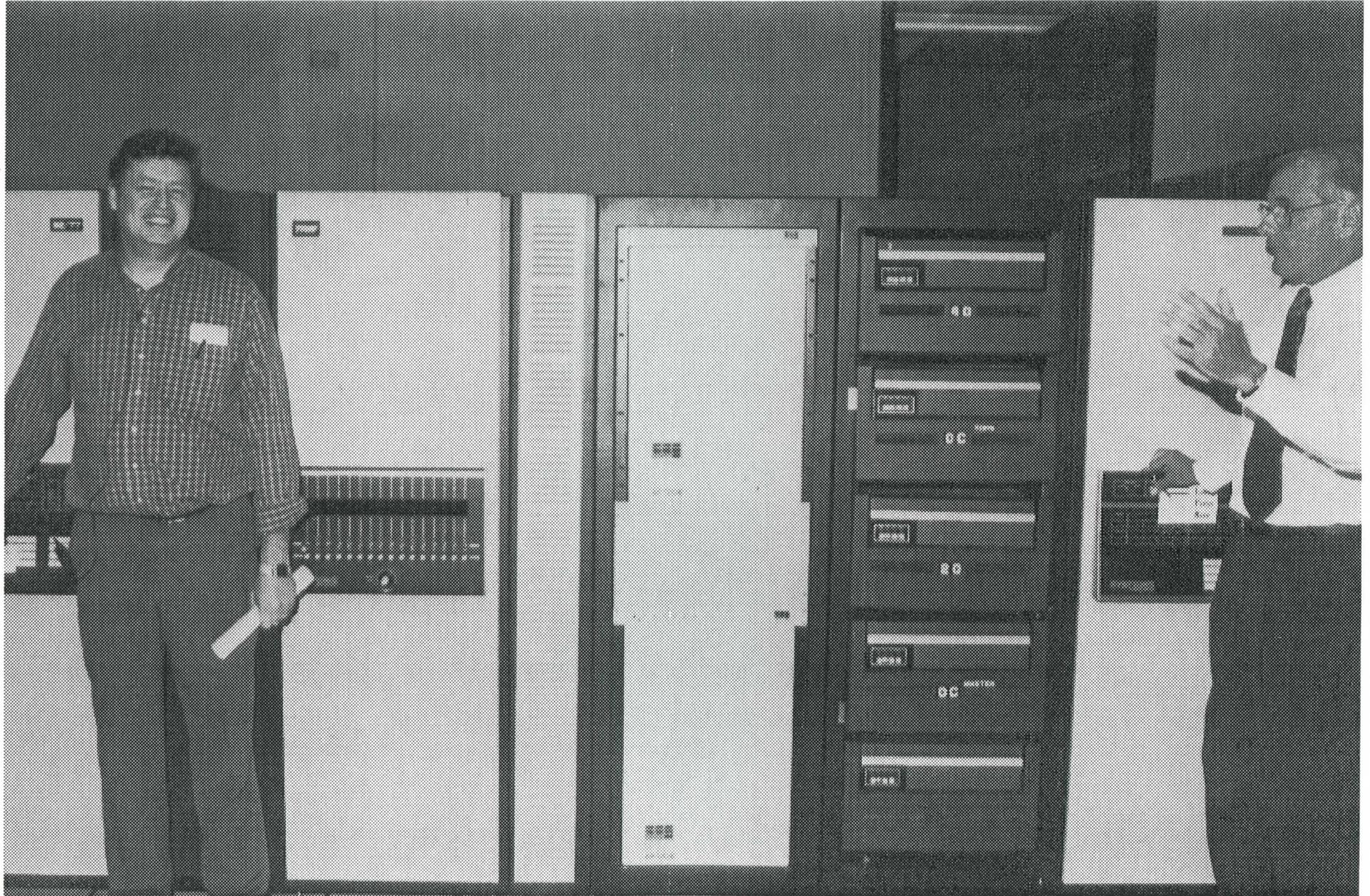


Figure 2. Decommissioning of EDIPS

INFORMATION AND DATA SERVICES

The EROS Data Center is home to the Sales Data Base for the National Mapping Division's digital cartographic products – Digital Orthophoto Quadrangles (DOQ), Digital Raster Graphics (DRG), Digital Elevation Models (DEM), and Digital Line Graphs (DLG). The Sales Data Base grew considerably in fiscal 1997, with 49,000 new files made available through the Global Land Information System, or GLIS.

U.S. GeoData Sales Data Base Activity

The new files include 7.5- and 15-minute DEMs, 1:250,000-scale DEMs, 7.5- and 15-minute DLGs, 1:100,000-scale DLGs, land use and land cover data, county DOQs on CD-ROM, uncompressed DOQs, and DRGs.

Sales of digital cartographic data rose 87 percent over the previous year to \$715,300. The growth was attributable largely to the addition of the DOQ and DRG data sets.

The USGS entered into a cooperative research and development agreement, or CRADA, with Microsoft Corporation, to market DOQs to the public. For Microsoft's part, it is a means of demonstrating the ability of the Microsoft NT server to handle large data sets on the Internet.

Microsoft CRADA

For the USGS, it is a means of massive public exposure for a premier product line.

EDC employees spent much of fiscal 1997 working with Microsoft, as well as with colleagues in NMD Headquarter and in the Western Mapping Center, in preparation for the spring 1998 release of the DOQ data through the Microsoft site. The project is expected to increase DOQ sales quite significantly, but also to create a much higher demand for the National Aerial Photography Program products from which the DOQs are made.

EDC Customer Services handled more than 23,000 orders and almost 81,000 inquires in fiscal 1997. Orders increased by more than 34 percent over the previous year, to \$10.6 million in sales – an average of more than \$40,000 per work day. Landsat Thematic Mapper and NAPP accounted for about two-thirds of data sales.

Customer Services

While orders were up, customer inquiries actually declined by about 7 percent from fiscal 1996. This trend, which is expected to continue, reflects an increasing customer reliance on the World Wide Web version of GLIS (figure 3).

More than 550 people used the Scientific and Technical Browse area, which was established early in 1997 to help visitors to the Data Center with their research and ordering needs.

Customer Services emphasized training during the year, establishing a program to orient and train new employees. Staff members also wrote a series

of training guides to help with ordering and accounting functions of the brokerage program. Some Customer Services staff also attended training sessions on the use of a variety of software programs.

Globe Workshop EDC participation in the GLOBE program – Global Learning and Observations to Benefit the Environment – expanded significantly in 1997 with the first two workshops to train teachers in the program ever to be held at the Data Center.

GLOBE, initiated by the Vice President on Earth Day 1994, is sponsored primarily by NASA and NOAA. It has grown into a worldwide network of students working under trained teachers making environmental observations near their schools. The EDC has assisted GLOBE for three years by preparing and distributing remotely sensed data sets exclusively for use in the program. The effort is now 10 times larger than the initial \$25,000 distribution in 1995, and serves some 3,000 schools around the world. The EDC supplies a Landsat Thematic Mapper data set, each centered over a school, on floppy discs, as well as color prints of the derived images. The program reimburses the EDC fully.

For the training sessions, the GLOBE program supplied six instructors who worked with 56 teachers from the Sioux Falls School District.

Diapositive Production Photographic laboratory diapositives for the federal mapping centers included 178,099 frames, an increase of 34 percent over fiscal 1996. In addition, the EDC purchased 140,000 products from the Agriculture Department's Aerial Photography Field Office in Salt Lake City at a cost approaching \$1 million.

Photo Production The photographic laboratory produced 392,200 units in 1997, up from 376,502 the previous year. Aircraft paper and film came to 136,000 frames in addition to 62,000 NAPP duplicates, the 178,099 diapositives, and 16,200 frames of custom and miscellaneous products.

Two electronic photo control printers were installed to produce both film and paper color products. In addition, the lab installed both black-and-white and color paper processors and a color film processor.

Declassified intelligence satellite photograph production increased over the course of the year from 950 in fiscal 1996 to 3,500 in 1997.

Digital Data Production Production of systematically corrected products from the National Landsat Archive Production System (NLAPS) continued to increase throughout the year. In all, production came to 6,175 systematic products and 381 precision-corrected products. Eighty-three tests were completed early in the year, allowing release of a full complement of precision Landsat products to be

**EDC GLIS Searches Initiated
FY 1997**

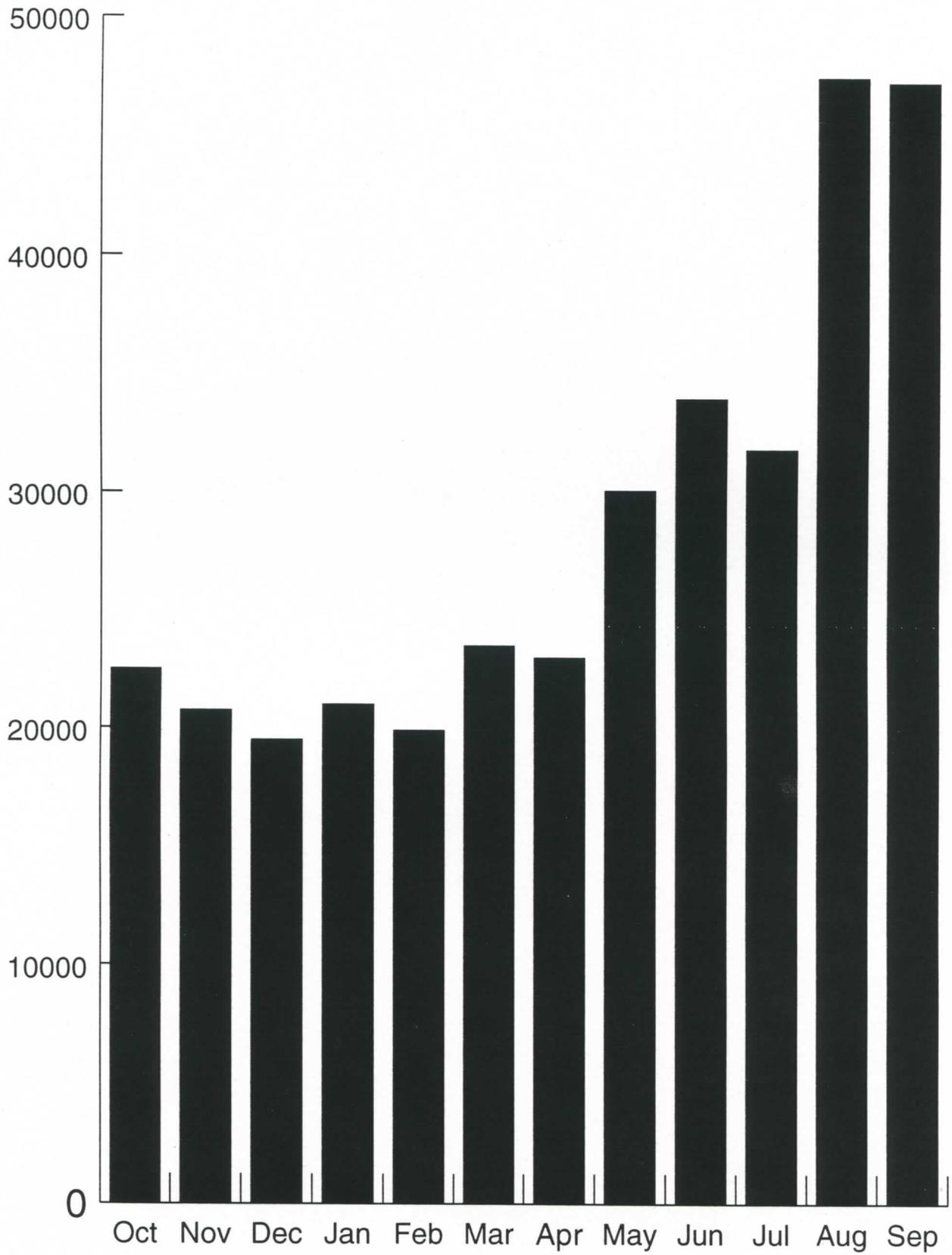


Figure 3. WEB GLIS searches

offered to customers. The production increase required two additional workstations, which were installed in the third quarter.

Digital Data Production (DDP) continues to produce greenness maps of the contiguous United States, as well as areas of the Mideast, the Horn of Africa, the former Soviet Union, and Alaska. In addition, DDP has generated 75 global composites from historical data for use by NASA's science investigators.

DDP also continues to support other EDC projects including North American Landscape Characterization, Multi-Resolution Land Characterization at regional and global scales, Senegal ecological monitoring, global land cover test sites, the Humid Tropical Forest Inventory Project, and monitoring of Madagascar.

In 1997, the marketing activity somewhat took a turn from direct promotion of products toward recruitment of dealers. This came about for several reasons, the most compelling of which is that the increasing demand for digital products threatens to outstrip the EDC's technological capabilities to deliver them in reasonable times without the help of private companies which can distribute them for profit. *Product Marketing*

In cooperation with the NMD's Senior Program Advisor for Data and Information Delivery, the Data Center has worked to establish business partner or dealer arrangements for both aerial photos and digital data. The first four prototypes business partnerships for aerial photos were executed in 1997. The Center also made substantial progress toward a standard agreement for business partners to distribute digital cartographic data.

Promotion of certain product lines directly from the EDC continued, with a focus on World Wide Web access. At different times during the year the EDC's Web Home Page featured several special collections of NAPP products. At the EDC's request, the National Mapping Division's Home Page featured the NAPP collection, boosting sales significantly.

SATELLITE SYSTEMS

After 25 years, the EROS Data Center took a major step to fulfilling the promise of its mid-U.S. location near Sioux Falls, South Dakota with the beginning of a real-time ground reception facility for the Landsat Program. On June 6, 1997, a ten-meter antenna, designed to receive Landsat data was set in place on the EDC grounds (figure 4).

Significant facility preparation and staff support were required to prepare for that installation and the subsequent integration and testing.

However, a July hail storm destroyed the effectiveness of the newly installed antenna. In spite of the set back, efforts are continuing to design and install the remaining Landsat 7 systems. The antenna will be installed in spring of 1998, with integration and testing of all systems continuing until the launch of Landsat 7 (scheduled for the fall of 1998) and completion of on-board system testing in late 1998.

Landsat 7 **I**n preparation for EDC's processing and distribution responsibilities for Landsat 7, staff continued to play an active role in the Landsat 7 Ground System Integration project team. Briefings on the operations of the Landsat 7 Data Handling Facility (DHF) and the development of the DHF staff were presented to the NASA review board. Plans were made for the interface between EDC and NASA's Goddard Space Flight Center for operations procedures, mission readiness test activities and spacecraft integration and verification activities.

EDC staff also had primary responsibility for development of the geometry processing algorithms for monitoring Landsat 7 quality. All algorithm software required for system checkout at launch has been completed and delivered for final integration and testing.

EOSDIS Core System

The EDC DAAC reached a milestone in its preparation for EOS responsibilities with the delivery and installation of the second and largest set of hardware for the EOSDIS Core System (ECS) this past year. Tasks involved included facility electrical and environmental preparation work and document development and review.

Significant attention was given to preliminary integration and testing of early versions of both ASTER and MODIS science algorithms. The DAAC has continued to add to its ECS support staff to support these early system and science software issues and to prepare for DAAC operations.

Testing continues on a new Web based user interface that will allow users to place processing requests for Shuttle Imaging Radar-C (SIR-C) precision data products. The interface uses a modification of the existing USGS data web interface to allow users to select data to be processed and to submit an order electronically.

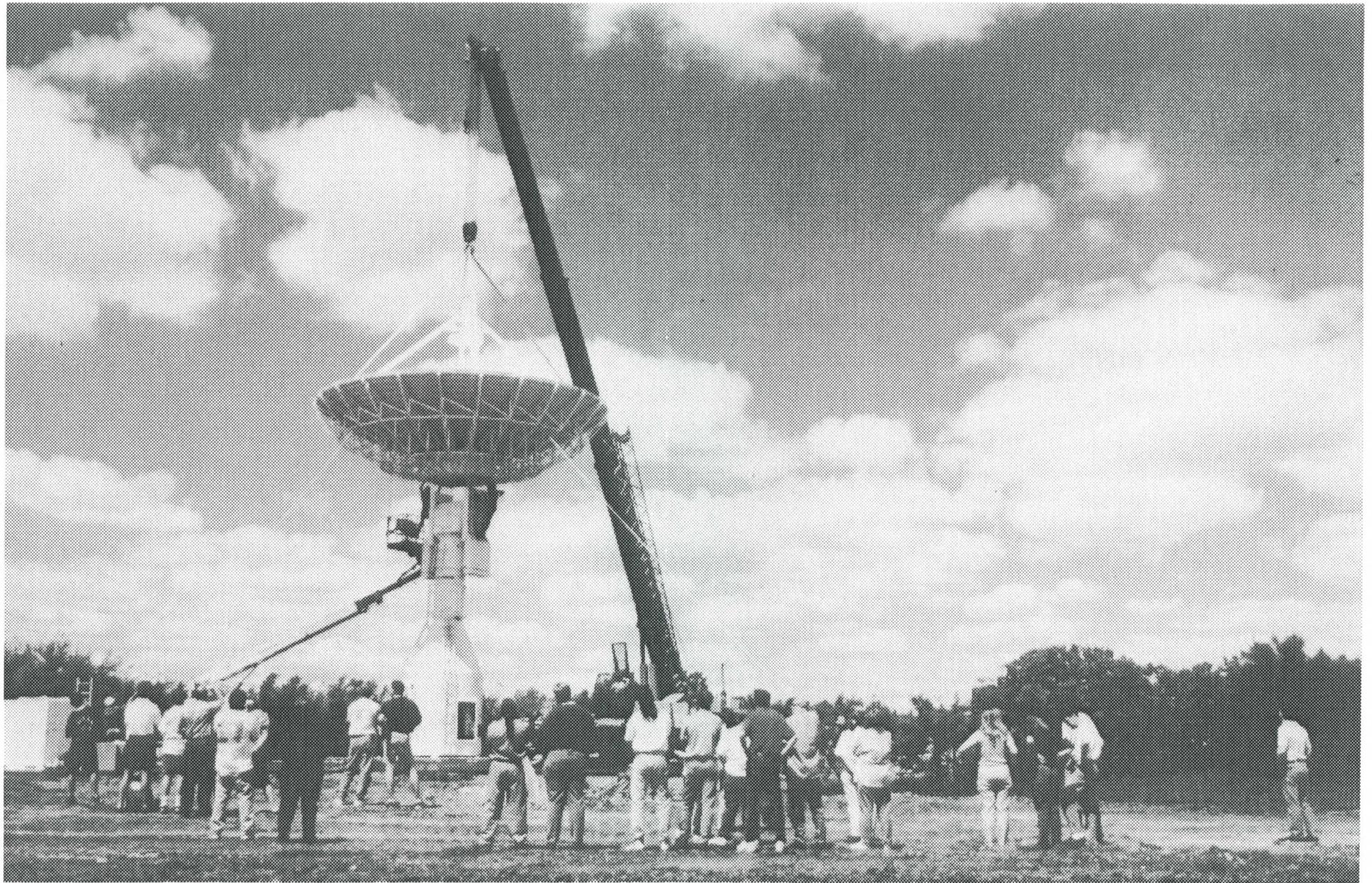


Figure 4. Landsat 7 antenna installation

The Shuttle Imaging Radar (SIR-C) production system installed by Jet Propulsion staff in late FY 1996 became fully operational in early FY 1997, with more than 4,000 precision scenes being produced and distributed through the end of the year.

SIR-C System

New DAAC datasets released for searching and ordering through the system-wide online information system in FY 1997 included: SIR-C Precision; North American Landscape Characteristics (NALC); AVHRR Global 10-day composites; GTOPO30; Global Land Cover Test Sites; and, AVHRR 1 km orbital segments data sets. In FY 1997, the DAAC distributed more than 62,000 hard media products and more than 360 GB of online products to users.

An EDC highlight was when two of our staff members traveled to Washington, DC, to participate in a technological demonstration of the MAGIC project for Vice President Gore. In addition to the briefing, a demonstration of the TerraVision terrain visualization software was given to Vice President Gore, Tom Kalil of the National Economic Council, and Jim Kohlenberger from Mr. Gore's Domestic Policy Council.

Vice President's Briefing

Two projects were initiated which were designed to prepare EDC for upcoming responsibilities for managing and distributing remote sensing products from satellite based radar systems. The first project supports a 1999 shuttle mission to collect radar data for producing a near global, high resolution elevation data set of land masses between 60° north latitude and 57° south latitude. The second project supports a free flying satellite radar instrument designed to collect and process interferometric radar to monitor surface deformation, land cover changes, and other characteristics of the Earth's environment. The EDC will have archiving and data distribution responsibilities for these data.

Satellite Systems Engineering

SYSTEMS DEVELOPMENT

Information Systems

A new effort was initiated this year in support of a Cooperative Research and Development Agreement (CRADA) with the Microsoft Corporation. This CRADA focuses on viewing digital orthophoto quadrangles (DOQ) via the Internet from Microsoft's Terra Server and subsequent ordering of DOQ products from the USGS/NMD/EDC. This required the integration of credit cards or electronic commerce transactions with NMD/EDC systems (DORRAN and GLIS) and coordination with the U.S. Treasury to ensure proper handling of electronic commerce transactions.

With the release of WebGLIS and a revised XGLIS system, the ASCII GLIS system was officially deactivated the first of April. WebGLIS activities continued to focus on adding DRG, DOQ, DOQ County, and NAPP data sets to GLIS. New releases of the XGLIS client were made available to the public for Sun Solaris, Silicon Graphics, and Data General platforms. Additionally, functionality was added which permitted the display of a geographic place name in the GLIS graphics and a higher resolution using 100 K DLG as a background graphics layer.

Several changes were made to DORRAN to improve management of NLAPS orders, including handling of rejected orders, selection of DEM data, and selection of maps. Database changes were made to allow DORRAN to verify that all scenes for a multi-scene NLAPS product have the same HDT source.

Cartographic Systems Project

Software to support loading the National Hydrography dataset into the Feature Operational database and providing those data to cooperators was completed and tested with pilot data. The work on all software components to support batch conversion of Digital Line Graph - 3 (DLG-3) into Digital Line Graph - Feature (DLG-F) was completed and is now in a system test phase. The software development for the first phase of National Hydrography dataset maintenance was completed. The Mapping Applications Center modified some pilot hydrography data and these modifications are being loaded to test the initial implementation of the maintenance software. The conversion of the Feature Operational Database (FOD) to the production SUN server has been completed.

Network Engineering

The process was initiated for augmenting EDC's LAN with technology supporting 155 Mbps or greater. Investigations were made and evaluations started on Firewall and related network security hardware and software. Initial long range strategies were developed to meet future requirements of high performance data delivery and networking systems supporting initiatives to include OhioView, NASA Research and Education Network, and the NSF funded EPSCOR project.

RESEARCH AND APPLICATIONS

A variety of research projects were conducted to develop and test advanced technologies required by the Earth-science community in its pursuit of a better understanding of global change, and new tools for geographic and spatial information analyses. These projects are supported by USGS research funds, as well as by cooperative agreements with other government organizations.

The Mojave Ecosystem topographic data base, a logically seamless coverage created from the 1:24,000 and 1:100,000 USGS Digital Elevation Model's (DEM's), was completed for the Department of Defense. The completed data base was used to compute a shaded-relief graphic for Internet browse imagery. The shaded-relief was overlaid with 1:100,000-scale vector hydrology and quad lines for reference in the browse image.

Mojave Data Base

EDC hosted a National Mapping Division (NMD)/Water Resources Division (WRD) Digital Elevation Data Workshop on May 7-9, 1997. Discussions focused on the status of the DEM production program, characteristics of current and future products, and the requirements of hydrologic applications and national programs.

Throughout the past year the water level in Devil's Lake, North Dakota, has continued to rise. The lake reached record levels during the summer. A small representative subbasin within the Devil's Lake Watershed was selected to demonstrate the application of USGS, high-resolution, 7.5-minute DEM's to the analysis and potential mitigation of the immediate flooding problem, as well as, for the long-term management of the Devil's Lake Watershed. Based on the DEM's, the potential storage volume of the many hundreds of depressions and wetlands in the test basin was computed and extrapolated to estimate the storage potential for the entire Devil's Lake Watershed. In addition to the statistical information, a number of products were derived from the high-resolution DEM's to demonstrate other possible applications and to visually show the quality of the digital elevation data. Among the products were basin delineations ranging from delineation of the entire test basin to delineation of watersheds contributing to individual depressions.

Devil's Lake

A poster created from Landsat thematic mapper (TM) imagery from 1989, 1992, 1995, and 1996 was prepared for the NMD/WRD Digital Elevation Data Workshop held at EDC in May 1997. The poster shows the rising water level of Devil's Lake (figure 5).

With assistance from the UNEP/GRID office located at the EDC, the HYDRO1K data set was completed and released for North America and Africa. These data sets, derived from the recently completed USGS product, GTOPO30, are comprised of eight layers of georeferenced data of

Global Basins

value for continental scale modeling. The Internet distribution of the data sets was begun. Results of the Global Basins research were submitted to the "Journal of Hydrology" and presented at the annual ESRI Users Conference.

*Circumpolar Arctic
Vegetation Mapping
in Support of Global
Change Research*

Working in collaboration with the U.S. Fish and Wildlife Service, the Institute of Arctic and Alpine Research of the University of Colorado, and scientists from eight Arctic nations, the USGS EROS Alaska Field Office (AFO) is involved in the production of the first ever comprehensive and consistent vegetation map of the Earth's circumpolar Arctic region. The Circumpolar Arctic Vegetation Mapping (CAVM) project is being conducted in support of the International CAFF (Conservation of Arctic Flora and Fauna) Initiative whose objective is to identify areas of unique and important biodiversity. This information will be used by the U.S. Government and the other Arctic nations in the development of international conservation strategy for the protection of these unique areas within the context of the Arctic region. In addition, the USGS had the lead in the production of false color infrared (CIR) and normalized difference vegetation index (NDVI) circumpolar Arctic image map products derived from the 1991 and 1992 global AVHRR biweekly composite data bases assembled by EDC. A circumpolar shaded relief map was also generated for the circumpolar region from the EDC global DEM data base to support the CAVM effort. These image and map products serve as the base for the interpretation of vegetation by each of the participating nations. The USGS AFO hosted a workshop in January 1997 at which the mapping methodologies were agreed upon and map unit descriptors were defined, all of which are critical in bringing together the work of each nation into a consistent circumpolar product. The supporting circumpolar CIR, NDVI, and DEM products have been released to the global change community as hard copy products, on CD-ROM, and on the WWW pages of the USGS.

*Arctic Environmental
Data Directory*

The Arctic Environmental Data Directory (AEDD), an Internet-based clearinghouse, is maintained by the USGS AFO on behalf of the member agencies of the Interagency Arctic Research Policy Committee. The AEDD is designed to be the initial repository for information on the Arctic in support of the Arctic Research and Policy Act of 1984. The AEDD contains descriptions of data and provides Internet links to sites with information on global change studies, environmental interactions, Earth sciences, and policy and management. The AEDD is also the United States node to the Arctic Data Directory (ADD), which is an international membership organization comprised of countries and international organizations with major Arctic environmental data holdings. In facilitating access to Arctic environmental data, the ADD has as its primary objective the preservation and use of this information by encouraging member nations to adopt metadata standards to document their holdings and establishing Internet accessible data clearinghouses with ADD defined standards for searching and accessing that information. In 1997, the USGS significantly enhanced its Internet server capabilities and greatly increased the data holdings and links to United States agencies. By encouraging the adoption of FGDC standards by the ADD and its participating member nations and

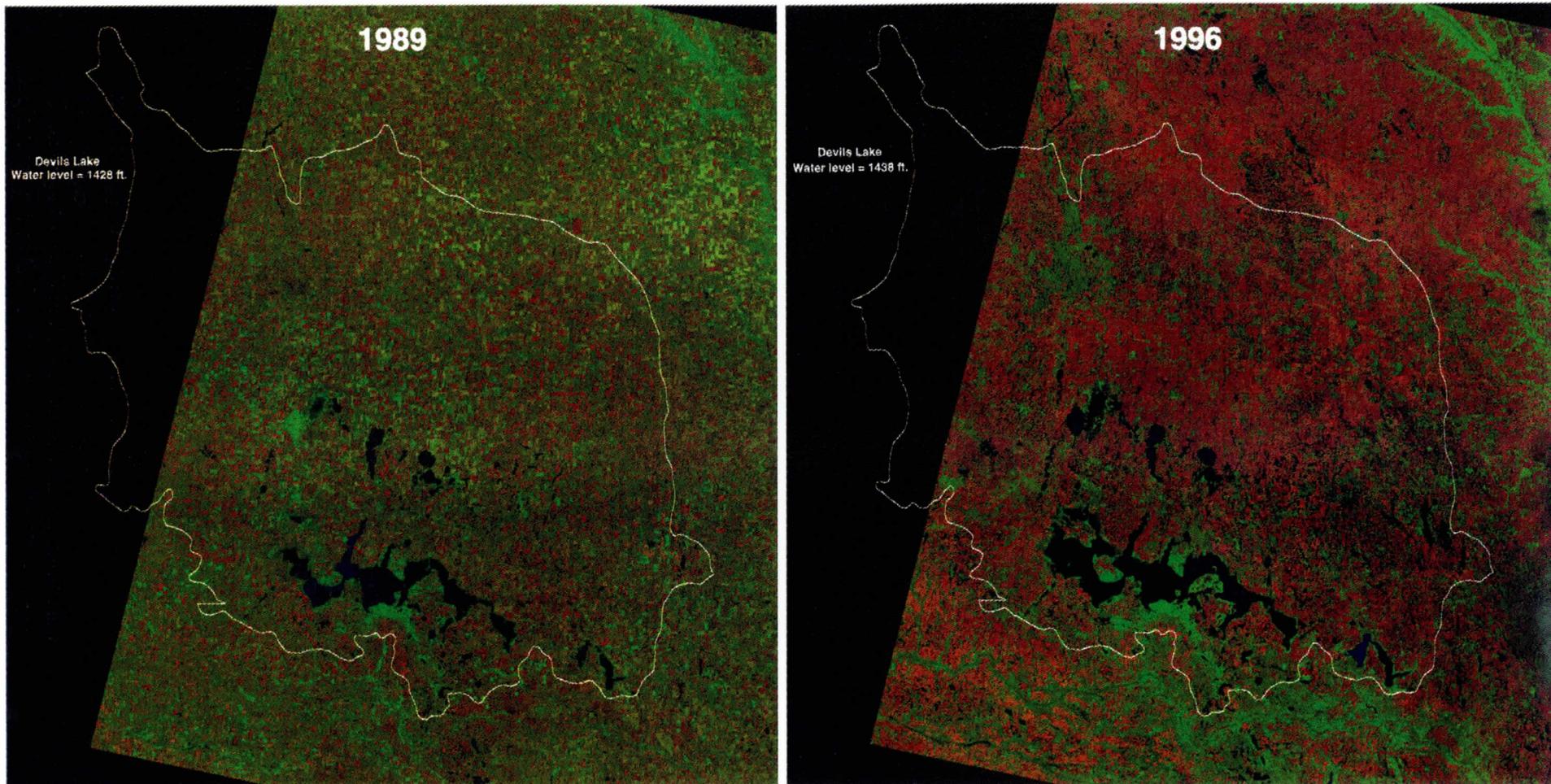


Figure 5. Devil Lake Watershed comparison

organizations, the concept of the National Spatial Data Infrastructure (NSDI) is being extended to the international community.

When airplanes meet clouds of volcanic ash thousands of feet above the Earth's surface, the results can be disastrous. Anchorage International Airport is the largest cargo handling facility, with heavy passenger traffic as well, in the United States, as it serves as the international link to the Orient. That, coupled with the fact that there are over 40 active volcanos in Alaska, makes for a potentially dangerous combination. In an effort to provide up-to-the-minute information to the aviation community to ensure public safety, the USGS AFO is providing remote sensing, computer modeling, and systems support to the USGS Alaska Volcano Observatory (AVO) and their real-time volcanic hazards warning program. The AVO, a joint program which includes partnerships with the University of Alaska-Fairbanks, and the State of Alaska Division of Geological and Geophysical Survey, provides for the detection and monitoring of volcanic events in Alaska and the Russian far east. These activities include tracking ash cloud movements and serving that information to the Federal Aeronautics Administration (FAA) and airline industry as a real time warning system. In 1997, the AFO provided support to the AVO program for the expansion of their Real-Time Ash Cloud Monitoring and Warning system including support for the acquisition and integration of a number of different processing systems and software packages to augment their current system. The new capabilities being developed will allow the AVO to retrieve ash cloud mass and particle size from AVHRR, GOES, and Geostationary Meteorological Satellite (GMS) data. This information is then integrated with climate data into volcanic cloud trajectory and fallout models that allow the AVO to advise FAA on the potential rate and direction that clouds may take as a warning to pilots. This information is also valuable to the communities and citizens of Alaska as active volcanos pose significant risks to people and infrastructure on the ground.

*Real Time
Hazards-Alaska
Volcano Observatory*

In 1994, Federal and State resource and land management agencies in Alaska organized themselves into the Alaska Geographic Data Committee (AGDC) in response to the activities and standards being proposed at the Federal level by the FGDC. The underlying objective of the FGDC is the creation of the NSDI which encompasses policies, standards, and procedures for all organizations to cooperatively produce and share geospatial data. One of the primary components of the NSDI is establishment of a National Geospatial Data Clearinghouse - a distributed network of clearinghouse server nodes in all of the different states and regions of the country. In Alaska, the USGS AFO has created and now manages the geospatial data WWW clearinghouse house for the AGDC and its member organizations.

*Alaska Geospatial
Data Clearinghouse*

During the summer of 1997, many rivers in the Northern Great Plains experienced significant flooding. The 1997 floods were the most recent in a series of flood related disasters that have occurred in the Northern Great

*Monitoring the Red
River Floods,
April 1997*

Plains over the past several years. Estimates of the damage caused by the flooding and associated severe weather approach two billion dollars. The ongoing flooding problems in the region have prompted widespread interest in developing the data, tools, and knowledge to mitigate flood related hazards. Because of the ability to penetrate cloud cover which can be persistent over flood areas and to acquire data during the hours of darkness, synthetic aperture radar (SAR) imagery is a promising resource for monitoring and documenting flood conditions.

SAR is an active microwave radar imaging system which transmits its own energy, and measures the return scattered by the Earth's surface back to the satellite. Sensitive to open water, soil moisture, and surface roughness, SAR images, such as those collected by Canadian Radarsat, are extremely useful in measuring the extent of flooding, monitoring flood water levels, determining standing water beneath canopies, and assisting in the assessment of damage to crops, local populations, and industries.

Radarsat data were used to classify areas of exposed open water in the Grand Forks region on April 24, 1997. Unlike multispectral TM images, Radarsat images are "single parameter" (single band) images. Thus, another (non-spectral) feature space must be used for classification. For this image, a feature space was constructed by forming a multiple band image where each band represents different texture measures based on the single band Radarsat image. Supervised classification was then used on this "multi-texture" image to produce the flood extent image (figure 6).

Mojave Project

Phase I activities for Mojave were substantially completed with a final report submitted in February 1997. In April 1997, a paper and presentation describing the Landsat TM data server was presented at the Desert Science Symposium at Ft. Irwin, California. In May 1997, a demonstration of the server developed in Phase I was made for the desert managers group. With Phase I completed, the Mojave server (<http://mojave.army.mil>) has continued to evolve into a regional resource for scientists and educators working on the Mojave Project, and EDC continues to participate through the Topographic Framework Mojave Prototype as well as the Soils Project that will generate the State Soil Geographic (STATSGO) data base products for the Mojave. Work performed for the Department of Defense on this project will transition into an ecosystem project that USGS will conduct beginning in 1998.

USGS Mississippi Basin Carbon Project

The USGS Mississippi Basin Carbon Project team is conducting research on the carbon budget in soils and sediments of the Mississippi River basin. The project is focused on how human-induced changes of land use, erosion, and sedimentation influence the net interchange of carbon (primarily as carbon dioxide and methane) between soils and the atmosphere. Improved estimates of the global carbon budget are needed to support policy decisions related to global change. The activities at EDC in FY 1997 were directed toward obtaining and preparing data sets and developing techniques of analy-



Grand Forks

Figure 6. Data classification showing flood extent

sis. The EDC staff have georegistered over 400 reservoir locations to a DEM so that the information on reservoir sedimentation rates can be compared to the land cover, soil, and topographic characteristics of the basins above the reservoirs. Improvements were made to methods for analyzing soil information in the STATSGO data base, and related data sets. Techniques for analyzing DEMs to summarize terrain characteristics were also developed. Statistical clustering methods were tested to define similarity trees for watersheds based on land cover, soil, and topographic attributes. In future work, the similarity of watersheds is expected to be a basis for defining areas in which models of erosion, deposition, and soil carbon dynamics can be usefully calibrated and applied. In FY 1998, the focus will be on analysis of carbon dynamics in the Mississippi Basin (figure 7).

Temporal urban mapping of the San Francisco and the Washington/Baltimore regions has spawned a new 3-year project to conduct temporal urban mapping for the metropolitan areas of New York City, Chicago, Philadelphia, and Portland. Teams have been established to perform the necessary research, data base building, and analysis tasks for the four new cities. EDC and RMMC will work as a team on Chicago and Portland, whereas MAC will take responsibility for New York City and Philadelphia will be done by MCMC. Each project will develop an approach that will be sensitive to regional public policy issues, involve collaborators, and complete a geographic analysis of urban land use change documented in the study. Searches have been conducted for historic maps published since the turn of the century for each study area, and contacts are being established with appropriate agencies and organizations to access data and information, discuss issues, and keep them informed of progress. Several image processing procedures were investigated to map urban patterns reliably with Landsat, GIRAS, and digital line graphs. These include image enhancement with principal components and spatial reclassification based on texture. In addition, staff at the University of California-Santa Barbara (UCSB) optimized the Clarke urban growth model and wrote scripts to automate the calibration process. They then recalibrated the San Francisco data and ran a set of urban growth predictions. After creating an excluded lands layer for Washington/Baltimore, they then calibrated the model and ran preliminary predictions. A publication, "Long Term Urban Growth Prediction Using a Cellular Automaton Model and GIS," was presented at a land use and population workshop in Hong Kong. Work began on the land use transition section of the model. A Land Use Modeling Workshop, co-hosted by the National Center for Geographic Information and Analysis, was held at EDC on June 4-6, 1997, and scientists from academia and government attended. A WWW site was created for the workshop at <http://www.ncgia.ucsb.edu/conf/landuse97/>.

Temporal Urban Mapping

The Baltimore/Washington Collaboration met and identified the need for two new temporal coverages for the Chesapeake Bay region - agriculture and forests. These data will be used by the Chesapeake Bay Ecosystem Program to correlate nutrient levels, plant type changes, and sedimentation in

Patuxent Watershed

the Bay to land uses around the Bay over time. A pilot study for these data layers will be conducted in the Patuxent watershed. Availability and accessibility of historical map resources were researched at the USGS office in Reston, Virginia, and at the Library of Congress in Washington, D.C. Contacts were made with a number of organizations about temporal agricultural land use data for the Patuxent watershed. Project staff obtained National Resources Inventory data from the U.S. Department of Agriculture for 1982, 1987, and 1992 and assembled temporal agricultural land use layers for the 1970's, 80's and 90's. Data sets from the National Climate Data Center in Ashville, North Carolina, and NOAA will be down-loaded from anonymous FTP locations to provide a picture of climate conditions over the past 100 years or more in the Chesapeake Bay region. This information will be incorporated in the historical study of agriculture and forest lands in the Patuxent watershed.

***Map Design and
Production -
Ecoregions Mapping***

Four ecoregions maps are being published as a collaborative effort involving the EPA, USGS, and a number of other federal and state agencies. "Ecoregions of North Dakota and South Dakota" is the first product to be developed, and this will be followed by similar maps of Western Oregon/Washington, Tennessee, and Ohio/Indiana. Each map includes legend photographs and detailed information in a table printed on back. Ecoregion delineation and map content are determined by EPA; cartographic editing and production are the responsibility of USGS. The ND/SD map is now in final editing, and is expected to be ready for press in early 1998.

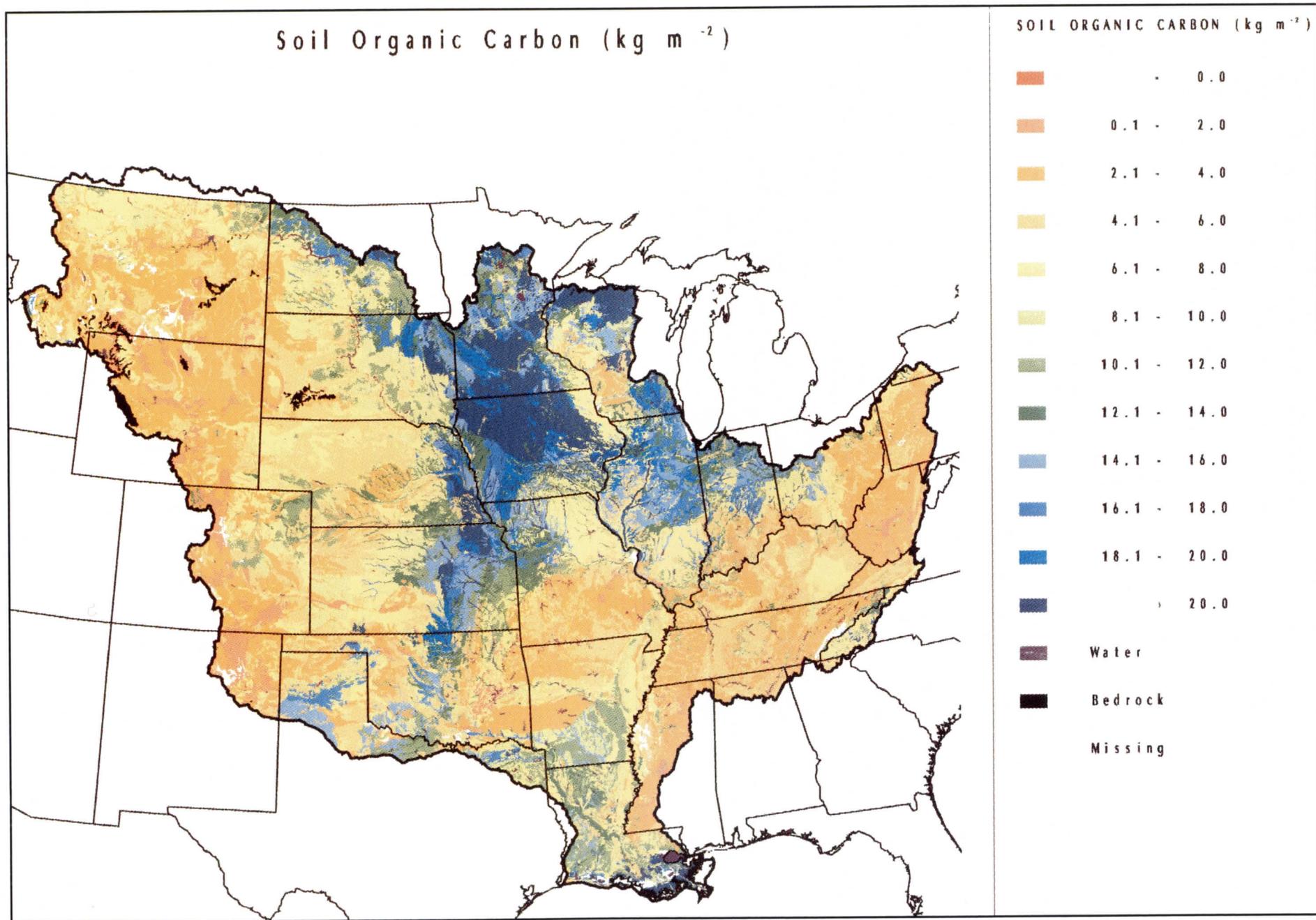


Figure 7. Soil Organic Carbon in the Mississippi River basin

LAND COVER CHARACTERIZATION

The Land Cover Characterization Program is founded on the premise that the Nation's needs for land cover and land use data are diverse and increasingly sophisticated. Program goals are to (1) identify the broad range of user requirements, and (2) identify sources, develop procedures, and organize partners to deliver data and information to meet user requirements. Components of the Program include global, national, and urban elements, with unique but complementary land cover, land use, and associated data products. Using computers and software tools, USGS analysts interpret satellite images and photographs to produce maps of land cover that have a wide variety of applications.

The global land cover characterization research team completed the development of the global land cover characteristics data base. This 1-km data base includes a comprehensive collection of thematic land cover data layers, detailed attributes on seasonality, spectral properties, and site characteristics, as well as all source data used in the analysis (figure 8). One thematic layer, the International Geosphere Biosphere Program (IGBP) DISCover land cover product, will be validated through an independent study to determine the accuracy of that data element. In FY 1997, over 300 scientists from over 30 countries, registered to use the global data base in their research. In addition, the IGBP DISCover layer has been tentatively selected for use as the Moderate Resolution Imaging Spectroradiometer (MODIS) at-launch land cover product. This means that the DISCover data set will serve as the template for the generation of a suite of Earth Observing System MODIS biophysical products, such as surface temperature, leaf area, and net primary production. Also of note was the publication of a special feature on landscape parameterization in the February 1997 issue of the journal Ecological Applications. This feature included seven articles on the role the USGS conterminous United States land cover characteristics data base played in advancing large-area environmental modeling. Papers covered improvements in weather and climate models, biogenic emissions, biogeochemical assessments, and grassland production.

Global Land Cover Characterization

The Regional Land Cover Characterization Project is in the third year of an effort whose goal is the completion of a National Land Cover Data Base. This data base is being developed from 30 meter Landsat TM data and a variety of ancillary data sets including topography, census, agricultural statistics, and wetlands. The regional land cover data sets are being produced in prioritized sequence for Federal Regions. Staff will continue to provide National Water Quality Assessment (NAWQA) Project study units, the EPA, and NOAA with land cover data as the regions are completed.

Regional Land Cover Characterization

INTERNATIONAL ACTIVITIES

The International Program applies remote sensing and geospatial technology to problems of sustainable development and humanitarian assistance. Projects are carried out under agreements with organizations such as the U.S. Agency for International Development (USAID), United Nations, international lending organizations such as the World Bank, and foreign governments. A broad spectrum of geospatial information is utilized for planning, implementing, and assessing the impact of disaster relief and development assistance and of the instructive role it can play in revealing linkages between activities occurring in multiple sectors (agriculture, environment, population/health, transportation, education, commerce) of a developing country.

Long-Term Monitoring of Environmental Change in Senegal

This project is monitoring long-term environmental changes in Senegal, a West African country in the Sahel region. Buffeted by drought, economic hardship, and rapid population growth, Senegal's ecosystems are coming under increasing pressure. The EROS Data Center, in partnership with USAID and Senegal's Ministry of Environment, is developing a long-term monitoring framework to better understand and document the rapid changes occurring in Senegal's environment, with a framework that will be applicable to Africa as well as the United States. The initial findings show linkages between population pressures (growing at 3.0 percent per year), traditional agricultural practices that are no longer sustainable under the present population densities, and the steady degradation of the country's soil and vegetative resources. The project is also documenting many local initiatives that provide hope by managing and caring for the soils, vegetation, and natural diversity.

Early Warning Systems

To support the major goal of the Famine Early Warning System, EDC scientists have developed a procedure to model the effects of current meteorological conditions upon crop development and yields. The model is based upon the Food and Agriculture Organization's (FAO) Crop Water Satisfaction Index (CWSI). The index uses direct weather observations at agrometeorological stations to model how well each crop's changing water requirements are satisfied throughout the growing season. Shortages of water at critical times during the crop growth cycle directly affect yields; thus the model can quickly identify those regions and crops where water shortages cause unrecoverable losses to the season's yields. The EDC procedure uses satellite observations, soils information, and outputs from the National Oceanic and Atmospheric Administration's (NOAA) global weather forecast model to give spatially explicit estimates of evapotranspiration and precipitation, thereby allowing the implementation of the CWSI on a continental basis. Preliminary reviews by agrometeorologists in southern Africa were favorable, and further evaluations are planned for 1998. Figure 9 shows the results of the CWSI have been calculated for 120-day maize in Southern Africa.

EDC expertise was utilized for the establishment of an Advanced Very High Resolution Radiometer (AVHRR) reception station in Addis,

Modified USGS Level II Land Cover Classification

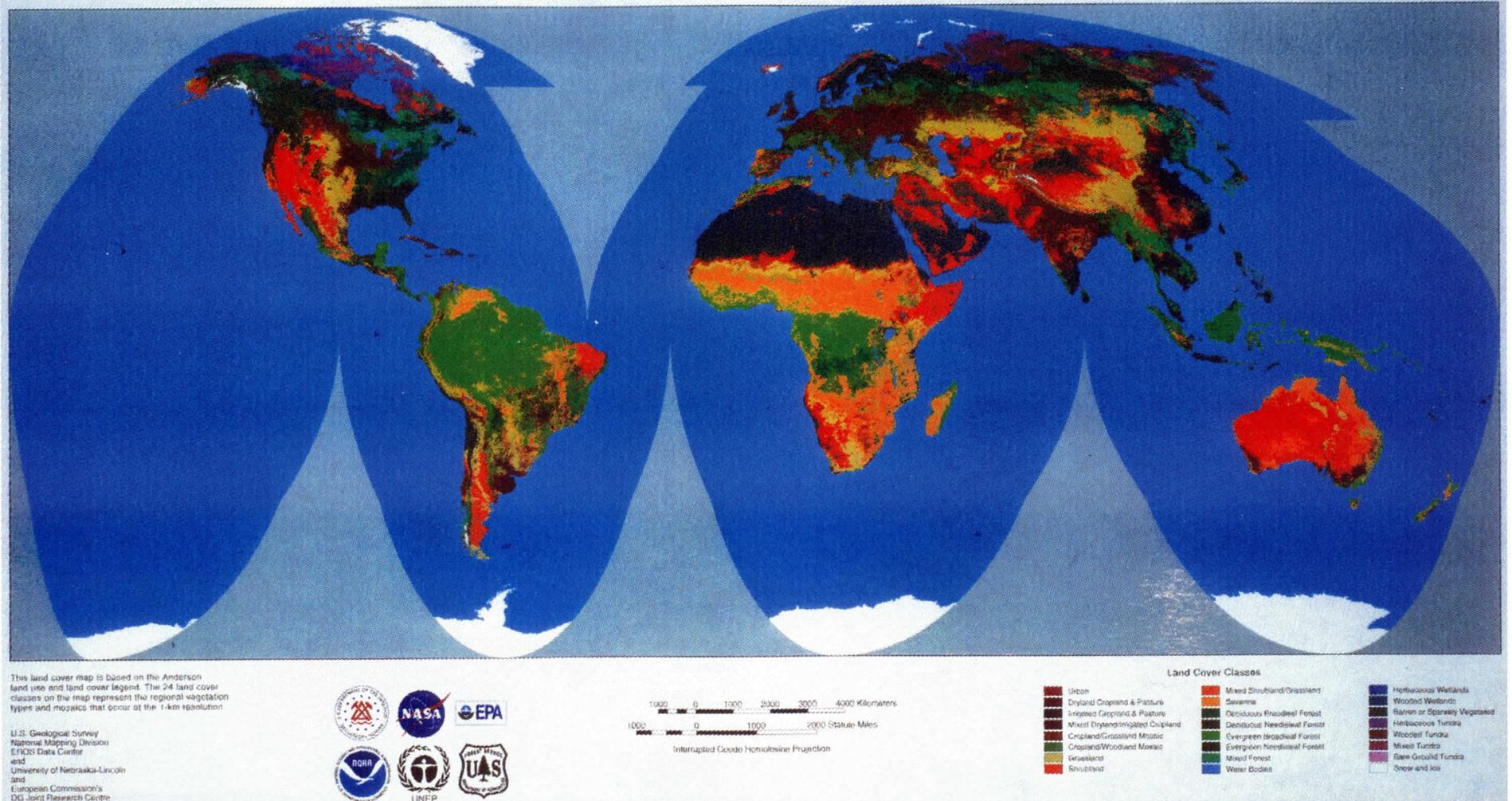


Figure 8. Global Land Cover classification based on the USGS Anderson system

**FAO Index
120-day Maize
October 1996 - May 1997**

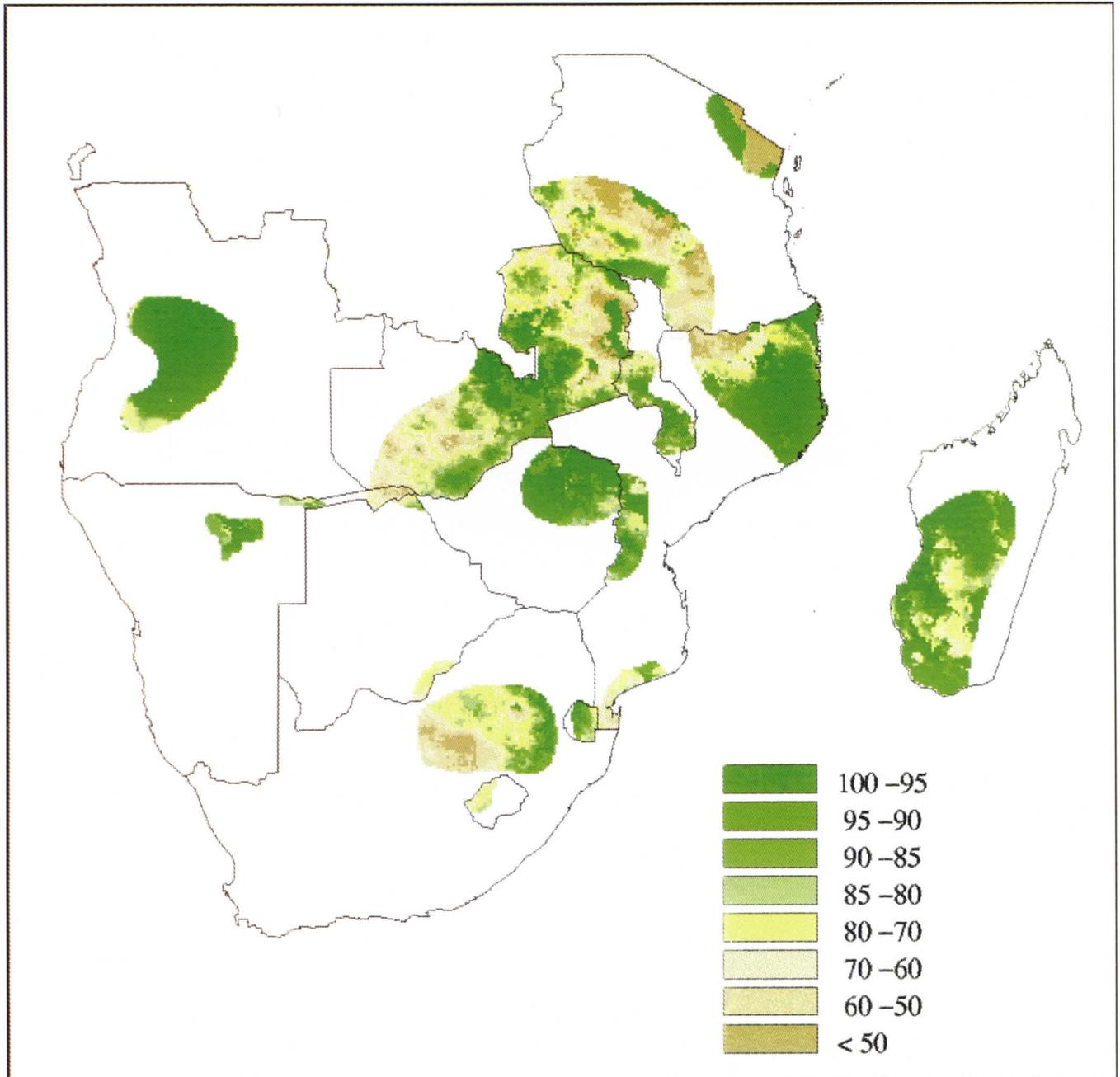


Figure 9. Crop Water Satisfaction Index for Southern Africa

Ethiopia. This will be a major benefit to the FEWS project by providing higher resolution data to FEWS cooperators in East Africa. In addition, the African Data Dissemination Service (ADDS) was developed to provide public access to the FEWS data archive, and this has been enhanced so that it now offers up-to-date decadal satellite images (every 10 days) showing the current distribution of vegetation and the latest estimates of rainfall across the continent. Additionally, the ADDS was designated an official Federal Geographic Data Committee (FGDC) Clearinghouse Node and is now listed on the FGDC home page.

The USGS/EDC, in partnership with USAID in Madagascar, has provided technical support in the fields of GIS and remote sensing to ANGAP (National Association for the Management of Protected Areas) and FTM (National Institute of Geography and Hydrography), as well as to specific USAID/Madagascar projects which support the National Environmental Action Plan. In addition, a variety of map products have been produced, including a digital version of the 1:500,000 topographic map series of Madagascar that was coordinated by EDC through cooperative agreements between FTM, USAID, and USGS. The official transfer of the data to FTM was attended by the Minister of Public Works, the Ambassador of the United States, the Director of USAID/Madagascar, and the Director General of FTM, along with television and newspaper press and other dignitaries. Other products include: an ecotourism image map (in two sections) of Isalo National Park in southwest Madagascar that was published using a combination of Landsat Thematic Mapper (TM) and SPOT imagery; and a poster-size image map of the island generated from a mosaic of about 40 Landsat scenes. Fire and cloud incidence images from DMSP-OLS were acquired from NOAA/NGDC for the periods of August-December, 1992-1996. At EDC, fire and cloud data were transformed to vector format, converted to the Laborde projection, and made available to the USAID/SAVEM (Sustainability Approaches to Viable Environmental Management) project in Madagascar via anonymous FTP (figure 10).

Madagascar Protected Area Management Technical Support

EDC's Inter-American Geospatial Data Network (IGDN) Clearinghouse Workshop was presented to a group of scientists and data base managers representing government agencies and academic institutions that provide and use geospatial data for the Caribbean region and North, South, and Central America. The primary objective of the workshop was to train participants in the use of Internet-related tools and Federal Geographic Data Committee (FGDC)-compliant metadata standards that will enable them to establish IGDN nodes in their home countries. The 30 participants came from Jamaica, the Dominican Republic, Canada, the United States, Mexico, Costa Rica, El Salvador, Colombia, Venezuela, and Brazil. In addition to presentations by EDC instructors, several workshop topics were presented by personnel from the Biological Resources Division (BRD) of the USGS and the Geomatics Canada. The IGDN project is administered under EDC's International Program and has been supported by USAID and the PAIGH.

Pan American Institute of Geography and History (PAIGH) Workshop

*Caribbean
Environment
Programme
Environmental
Information System
(CEPNET)*

EDC has assisted the United Nations Environment Programme (UNEP)/Global Resources Information Database (GRID) Sioux Falls office in developing a geospatial data clearinghouse capability for the UNEP Caribbean Regional Coordinating Unit (CAR/RCU) office in Kingston, Jamaica. This work is part of the United Nations/Inter-American Development Bank (UN/IDB) funded CEPNET project, whose goal is to strengthen information systems for the management of marine and coastal resources in the Caribbean region. Information systems are being developed as tools for use in natural resources management and for inter- and intra-regional exchange of expertise on natural resources management. Regional clearinghouse nodes will initially be established in designated environmental agencies in the six countries of Barbados, Dominican Republic, Jamaica, Nicaragua, Trinidad and Tobago, and Venezuela. Eventually, the network will be expanded to include all 35 nations in the wider Caribbean region. A prototype implementation of the ArcView Internet Map Server displays sample GIS data to provide a data browse capability for the users (figure 11).

*Digital Imagery for
Forest Fire Hazard
Assessment in the
Mediterranean
Ecosystems*

Of the 145,000 wildfires that occur in the United States each year on Federal, State, and private lands, most are quickly controlled by the local protection forces. However, those that aren't contained manage to cause substantial damage to natural resources and property, and loss of life. In order to minimize this threat of loss from wildfires, managers must be able to plan protection strategies that are appropriate for local areas. A prerequisite for this planning is the ability to assess and map for broad areas the local potential for a major fire to occur. In this regard, EDC and the U.S. Forest Service (USFS) developed a methodology to calculate a Fire Potential Index (FPI). Using regions severely affected by forest fires within the Mediterranean ecosystems of Chile, Mexico, Spain, and the United States as study areas, vegetation greenness, 10-hour fuel moisture, meteorological data, fire history data, and fuel models were mapped and incorporated within a GIS to assess fire hazard. (figure 12) The project has been sponsored by the Pan-American Institute of Geography and History's Committee on Cartographic Application (PAIGH/CARS). Spain, Mexico, Chile, and the United States have been participants in this project, with the United States as the technical and logistical lead. The daily FPI was calculated for the United States study area for the period of 1990 through 1994, (1,102 images total), and there was a strong positive correlation of the calculated FPI and actual fire history. The results of the United States study area were published and presented at the 1997 Environmental Systems Research Institute (ESRI) Conference. Copies of the paper were sent to Spain, Chile, and Mexico to aid in technology transfer of the FPI methodology. Detailed instructions on how to organize the data into a data base, run the programs to calculate the FPI for each country, and the documentation of the data were written.

UNEP/GRID

The North American node of the United Nations Environment Programme's (UNEP) Global Resource Information Database (GRID) was established in Sioux Falls, South Dakota, in 1991, to assist UNEP and its

Fires Visible from
DMSP-OLS Data,
October 26, 1997

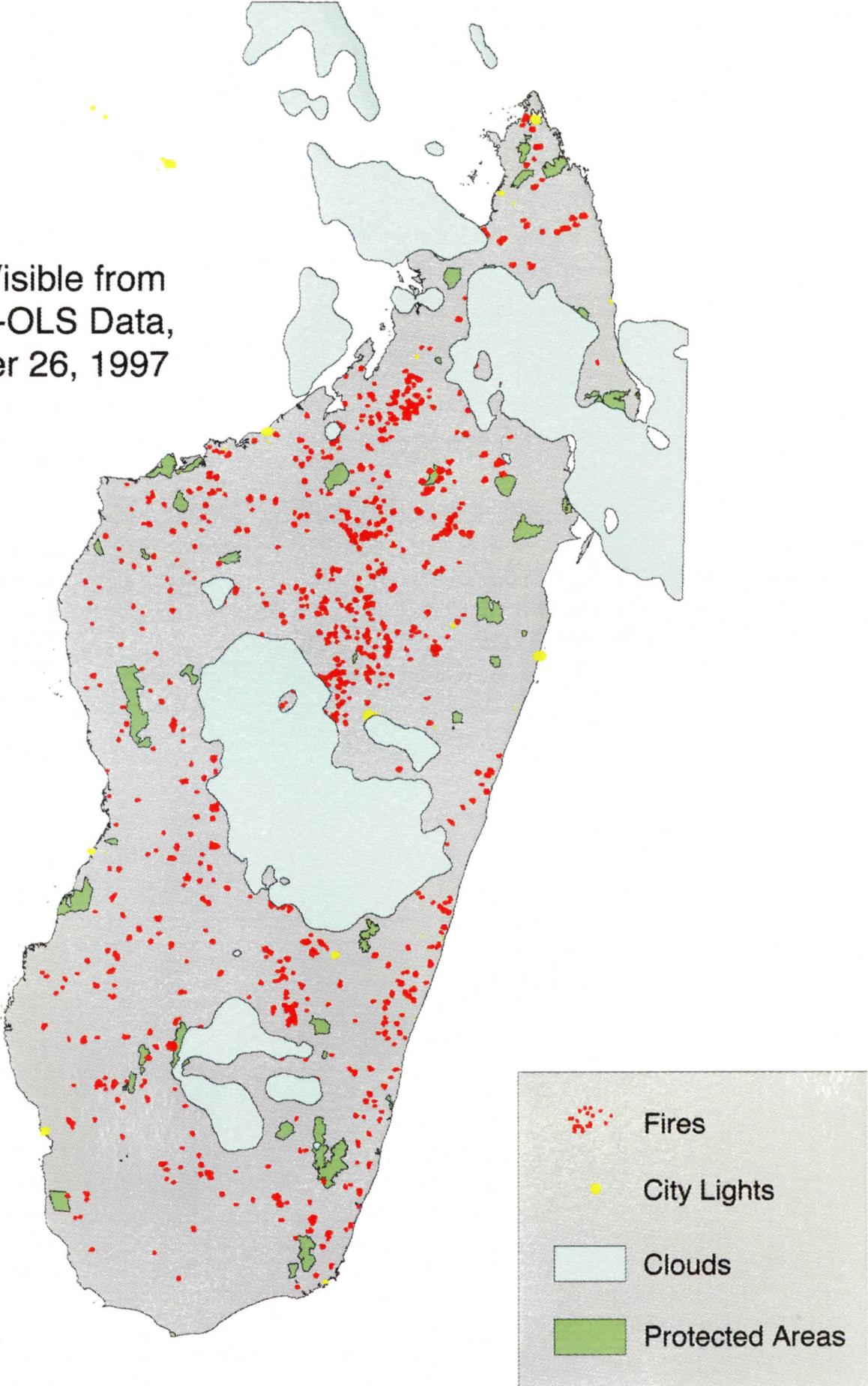


Figure 10. Fires visible in Madagascar from DMSP-OLS data

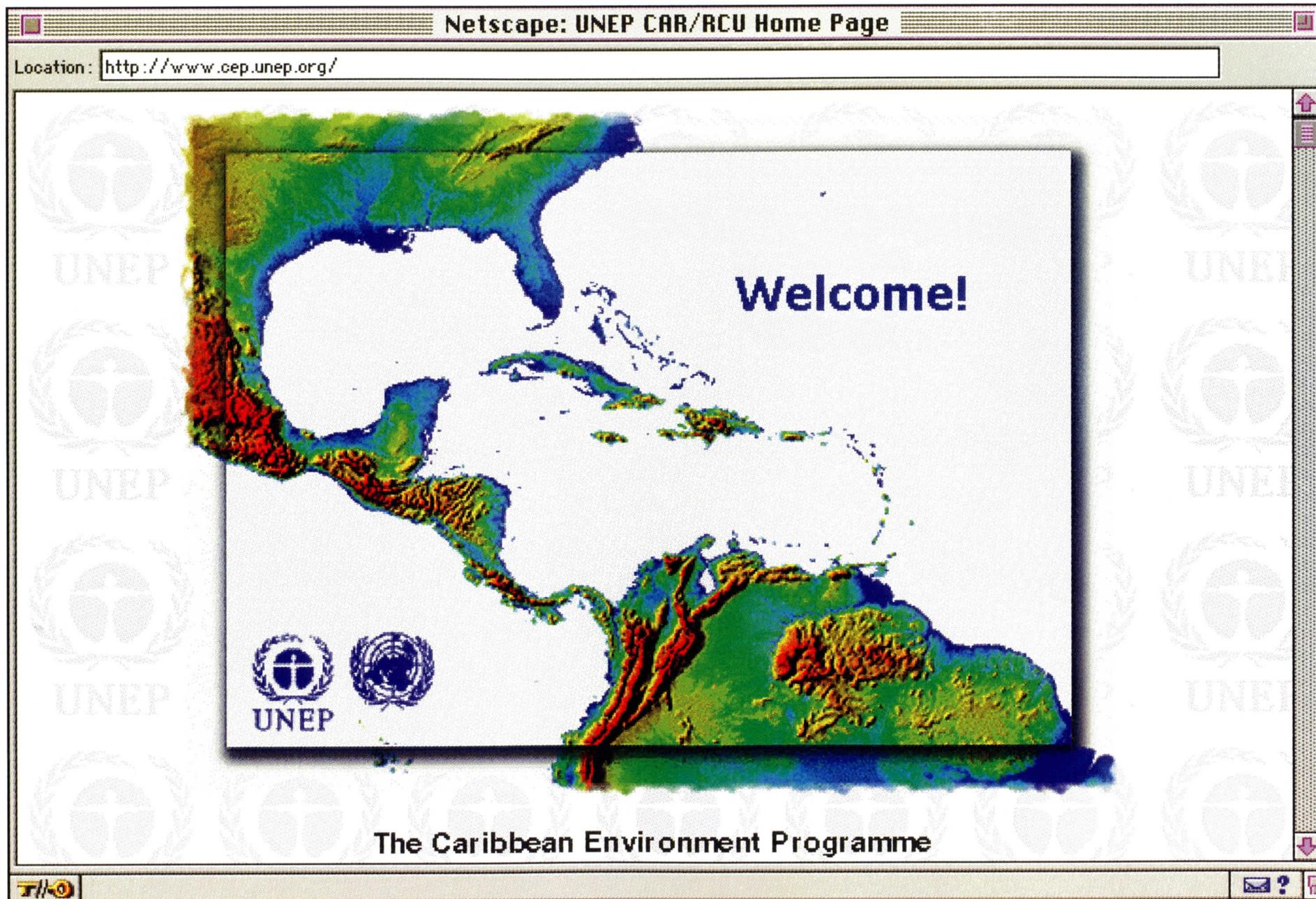
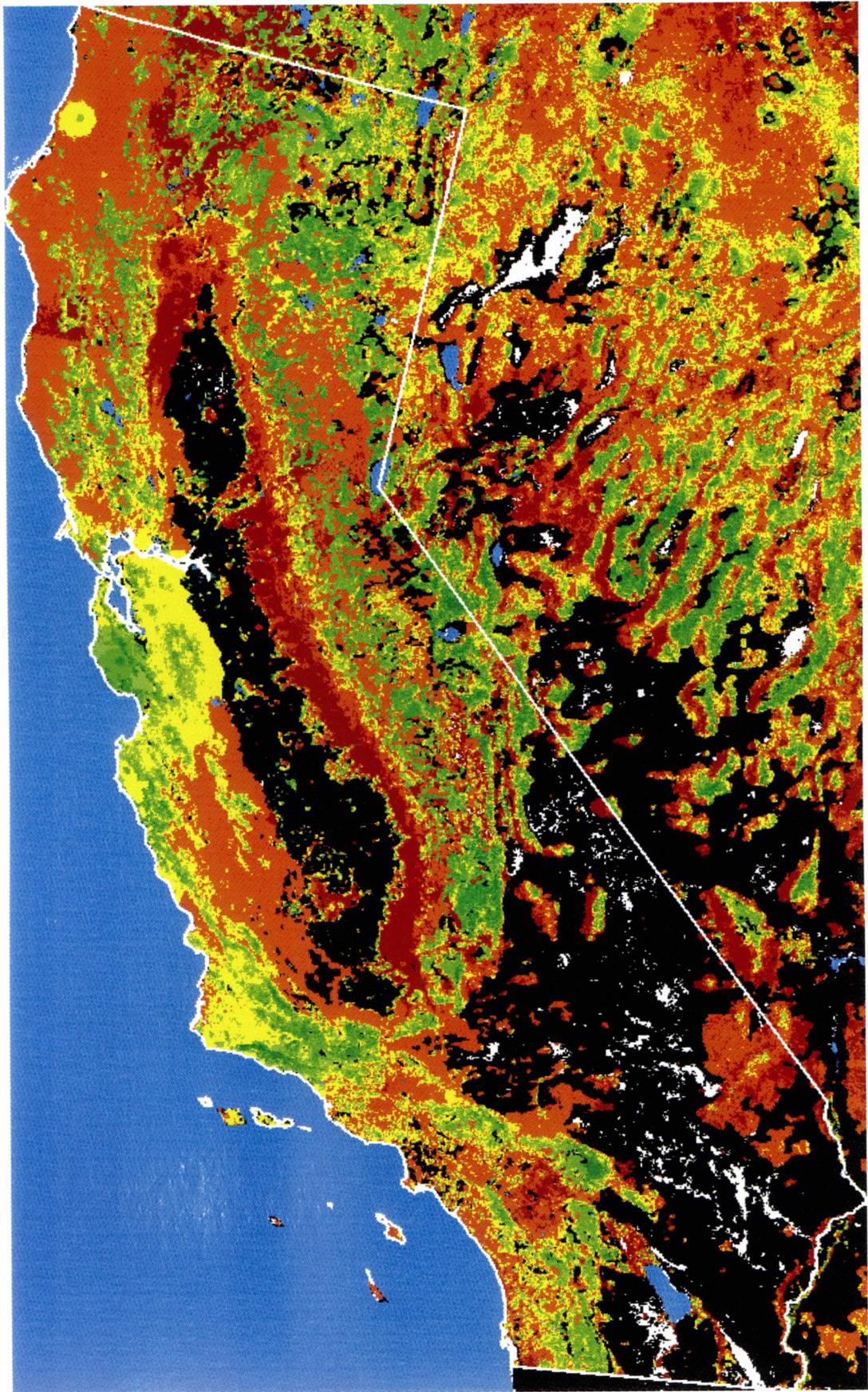


Figure 11. CEPNET home page



Fire Potential
Low High

Figure 12. Fire potential index for the State of California

Mozambique and its Drainage Basins

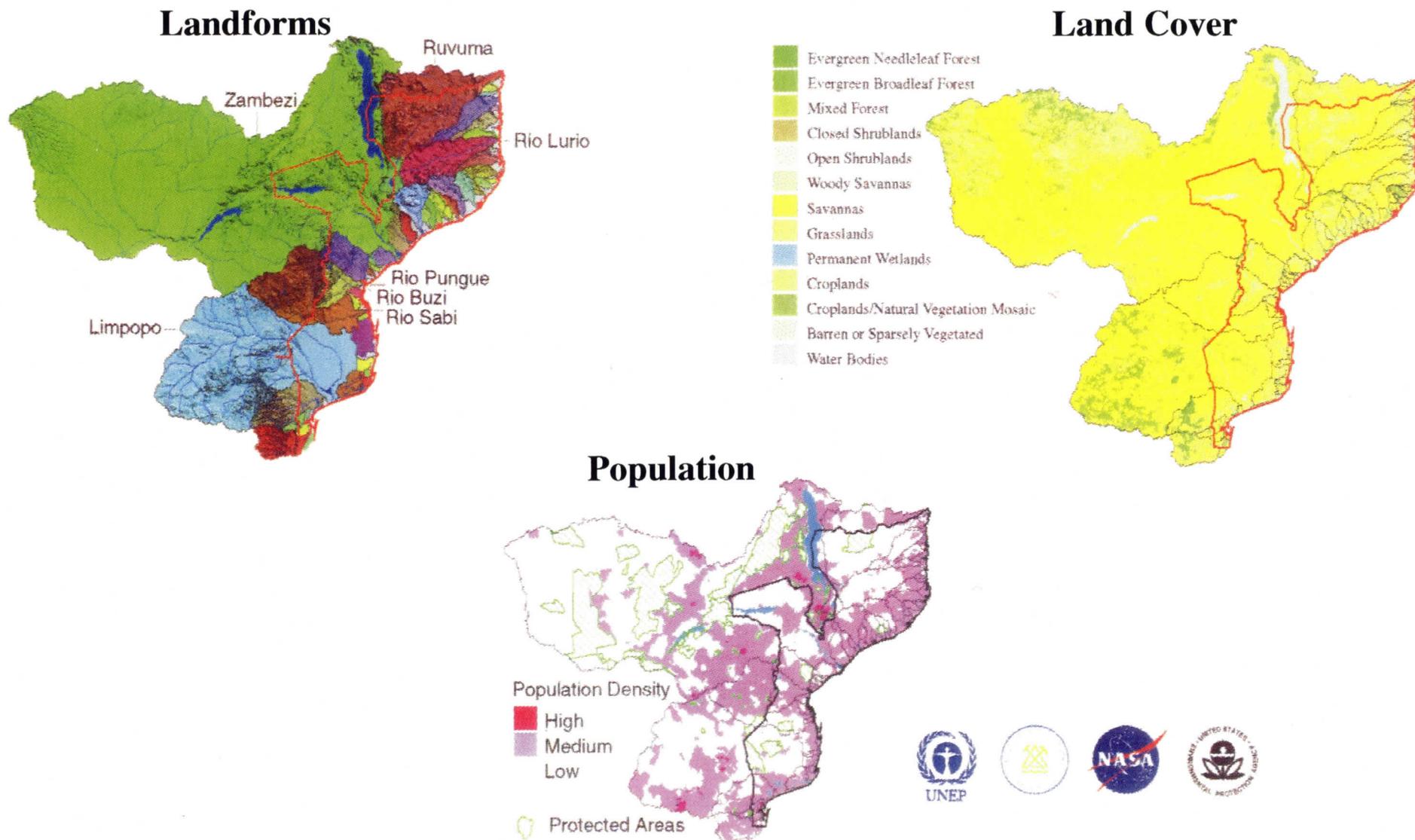


Figure 13. Mozambique drainage basins

partners in better understanding the Earth's processes and their real world impacts. The office is in the forefront of providing information technology tools - remote sensing, GIS, data management, and advanced Internet tools - for the benefit of developing countries. Specific accomplishments this year, in partnership with USGS and NASA, include: completion of the global 1-km land cover characteristics data base using satellite data; completion of the global 1-km digital topographic data base; completion of the drainage basin boundaries data base for North America and Africa (work in progress for other continents); quantification of transboundary aspects of major river basins (on-going); completion of the medium resolution population data base for Africa; development of a prototype geospatial data base for the Great Lakes region of Africa; an analysis of the protection status of biodiversity in Africa (including human dimensions); creation of a World-Wide Web (WWW) site for satellite images of environmental disaster in Southeast Asia; publication of a report entitled "Spatial Data Sets for Environmental Assessment: Towards Bridging the Data Gap;" and initial development of Internet map server technology for data and its dissemination in cooperation with ESRI, Inc. Mozambique and the characteristics of its drainage basins are shown in figure 13. In addition, a number of presentations were made at seminars and conferences, and a set of posters was sent for display in the New York office of the United Nations Secretary General. The office is hosted by the USGS in a unique partnership with UNEP and NASA, and recently, the U.S. Environmental Protection Agency (EPA) and the U.S. Forest Service (FS) became members in the partnership.

OUTREACH ACTIVITIES

EROS Data Center staff participated in many significant outreach activities during fiscal year 1997, and provided coordination, graphic, publication, and audio visual support for a number of EDC events.

Hosting of a traveling exhibit of NASA's International Space Station (for close to 5,000 visitors), two GLOBE teacher training workshops, and a KidSat program were all part of the outreach assignments.

Three-hundred and five public tours were given, and 14,268 visitors came to the Center during fiscal year 1997. EDC staff also took part in statewide science programs that included six Water Festivals for over 4,700 fourth grade students, South Dakota Space Day for 2,400 students and educators, 53 presentations to classrooms, and numerous presentations were given to civic and service clubs.

A 5-minute video was produced for the EDC Annual Meeting which highlighted the accomplishments and activities of EDC employees. Video footage was prepared to document a number of significant events such as the installation of the Landsat 7 antenna and also the severe hail damage the facility suffered in July. In addition to this, a fourteen minute video on the National Satellite Land Remote Sensing Data Archive was produced.

STATISTICAL DATA

This section summarizes EDC sales and distribution of products and services in fiscal year 1997. It also provides information about customer profiles, historical trends, and the contents of the EDC archive and data bases.

In fiscal year 1997, the EDC produced and distributed more than \$10.6 million worth of products and services. Of the total, nearly \$5.4 million were in direct sales to outside customers and more than \$2.6 million were in products and services provided through EDC cooperative repay projects, for a "reimbursable" total of \$8 million. The remaining \$2.6 million were for products and services distributed to users within the U.S. Geological Survey. In addition, more than 1.8 million files of digital cartographic data were distributed free of charge via the Internet.

The EDC purchased almost \$1.4 million worth of satellite data products from commercial satellite operators as a brokerage service for other Federal agencies.

Almost 81,000 user inquiries were received at EDC during the year, and over 23,000 orders were filled.

	<u>Items</u>	<u>Dollars</u>
Photographic Products	379,068	3,940,091
Digital Products/Processing	192,385	6,605,568
Reference Aids	166	11,906
Miscellaneous	<u>18,813</u>	<u>84,259</u>
Total	590,432	\$10,641,824

EDC Annual Sales Report*
Fiscal year 1997

	DIRECT REPAY CUSTOMERS	EDC REPAY PROJECTS	USGS CUSTOMERS	TOTAL
PHOTOGRAPHIC DATA				
AERIAL IMAGES				
NAPP	\$ 1,541,935	\$ 4,961	\$ 1,547,936	\$ 3,094,831
Other	409,203	40	19,572	428,815
SATELLITE IMAGES				
Landsat MSS	34,734	600	1,938	37,272
Landsat TM	7,120	750	2,550	10,420
Landsat Derivative Products	45	60,553	0	60,598
AVHRR	5,228	1,425	2,212	8,865
Declassified Intell. Satellite Photo.	56,241	1,688	9,396	67,325
Other	1,296	120	0	1,416
Digital Film Recorder Products	5,880	16,800	11,421	34,101
Other Photographic Data	<u>66,205</u>	<u>29,462</u>	<u>100,780</u>	<u>196,447</u>
TOTAL PHOTOGRAPHIC DATA	\$ 2,127,887	\$ 116,399	\$ 1,695,805	\$ 3,940,091
DIGITAL DATA PRODUCTS/PROCESSING				
Digital Data Processing	\$ 500	\$ 2,400	\$ 1,300	\$ 4,200
Custom Processing Charges	134,069	817,073	289,428	1,240,569
Landsat MSS	212,160	12,155	34,555	258,870
Landsat TM	1,940,014	568,531	119,312	2,627,857
Landsat Derivative Products	7,710	545,415	16,370	569,495
AVHRR Images	241,487	137,528	339,092	718,107
Digital Cartographic Data				
7.5'/15' 30' DEM	261,532	943	19,988	282,464
250k DEM	5,168	0	428	5,596
24k & 15' DLG	65,723	301	42,150	108,174
100k DLG	7,808	0	140	7,948
LULC	3,402	0	0	3,402
DOQ	35,902	1,717	14,903	52,522
DRG	128,278	42	42,982	171,302
"Large Order" Charges	70,740	720	12,510	83,970
DAAC Products				
SIR-C Educational CD's	2,020	266,324	310	268,654
DAAC ROM DATA	1,664	0	0	1,664
DAAC Tape Copies	3,040	156,861	70	159,971
Other Digital Data	<u>35,059</u>	<u>1,536</u>	<u>4,208</u>	<u>40,803</u>
TOTAL DIGITAL DATA PRODUCTS/PROCESSING	\$ 3,156,276	\$ 2,511,546	\$ 937,746	\$ 6,605,568
MISCELLANEOUS				
Reference Aids	\$ 5,006	\$ 0	\$ 6,900	\$ 11,906
Other Products and Services	<u>80,601</u>	<u>248</u>	<u>3,410</u>	<u>84,259</u>
TOTAL MISCELLANEOUS	\$ 85,607	\$ 248	\$ 10,310	\$ 96,165
GRAND TOTAL	\$ 5,369,770	\$ 2,628,193	\$ 2,643,860	\$ 10,641,824
Satellite Data Brokerage Fees	\$ 65,005	\$ 1,286	\$ 2,555	\$ 68,846
Satellite Data Brokerage Sales	\$ 1,301,853	\$ 25,720	\$ 51,104	\$ 1,378,677

* Does not include no-cost electronic distribution of data.

Product Profile
EDC Photographic Products
Fiscal Year 1997

BLACK-AND-WHITE PRODUCTS		
PRODUCT CATEGORY	ITEMS	DOLLARS
10" Paper	117,925	\$ 605,132
10" Film	65,501	395,064
10" Diapositives Paper	87,714	820,165
10" Diapositives Film	11,041	121,295
20" Paper	5,327	121,271
40" Paper	5,344	241,917
Other	<u>7,473</u>	<u>124,280</u>
TOTAL	300,325	\$ 2,429,124
COLOR PRODUCTS		
PRODUCT CATEGORY	ITEMS	DOLLARS
10" Paper	18,197	\$ 284,218
10" Film	14,969	291,233
10" Diapositives Paper	1,763	14,104
10" Diapositives Film	15,117	181,620
20" Paper	2,514	126,960
40" Paper	4,207	320,989
Other	<u>21,976</u>	<u>291,843</u>
TOTAL	78,743	\$ 1,510,967
GRAND TOTAL PRODUCTS	379,068	\$ 3,940,091

**Customer Profile
EDC Photographic Products
Fiscal Year 1997**

CUSTOMER CATEGORY	ITEMS	DOLLARS
USGS	248,733	\$ 1,812,204
OTHER FEDERAL	<u>42,904</u>	<u>495,374</u>
TOTAL FED. GOVERNMENT	291,637	\$ 2,307,578
STATE/LOCAL GOVERNMENT	5,404	85,154
ACADEMIA	8,820	107,889
INDUSTRY	54,102	1,081,643
INDIVIDUALS	17,137	324,207
NON-U.S.	<u>1,968</u>	<u>33,620</u>
TOTAL	369,068	\$ 3,940,091

Customer Profile
EDC Digital Data Products & Processing
Fiscal Year 1997

Digital Data Products *		
CUSTOMER CATEGORY	ITEMS	DOLLARS
USGS	58,356	\$ 2,339,091
OTHER FEDERAL	<u>19,299</u>	<u>892,402</u>
TOTAL FED. GOVERNMENT	77,655	\$ 3,231,493
STATE/LOCAL GOVERNMENT	6,435	69,457
ACADEMIA	6,559	333,444
INDUSTRY	85,440	743,770
INDIVIDUALS	13,506	254,420
NON-U.S.	<u>2,389</u>	<u>728,215</u>
TOTAL	191,984	\$ 5,360,799

* Does not include no-cost electronic distribution of data.

Digital Data Processing *		
CUSTOMER CATEGORY	ITEMS	DOLLARS
USGS	365	\$ 1,110,200
OTHER FEDERAL	<u>33</u>	<u>127,802</u>
TOTAL FED. GOVERNMENT	398	\$ 1,238,002
STATE/LOCAL GOVERNMENT	0	0
ACADEMIA	0	0
INDUSTRY	3	6,767
INDIVIDUALS	0	0
NON-U.S.	<u>0</u>	<u>0</u>
TOTAL	401	\$ 1,244,769

* Reflects image processing or data capture tasks including image registration and mosaicking, vector data capture, data base development, and image manipulation for greenness monitoring.

EDC ARCHIVES AND DATA BASES

This section describes those data archives, both digital and photographic, that are maintained by the EDC to preserve and catalog remotely sensed, cartographic, and other earth science data. In addition, several data bases refer to data held elsewhere that are of interest to EDC customers.

As of the end of fiscal year 1997, the EDC had archived nearly 11.9 million frames of photographic data and 229,729 tapes. This includes more than 2.8 million frames of Landsat photographic data and 88,046 Landsat data tapes. The International Landsat Data Base maintained by the EDC refers to more than 1 million Landsat scenes archived in the United States, and more than 2.6 million scenes of Landsat data held by foreign ground stations.

Data Archive Report
As of October 8, 1997

PHOTOGRAPHIC DATA	ROLLS	FRAMES
AERIAL IMAGES	58,046	7,723,213
LANDSAT SATELLITE IMAGES	21,260	2,856,047
OTHER SATELLITE IMAGES	<u>20,338</u>	<u>1,301,291</u>
TOTAL	100,644	11,880,551

DIGITAL DATA	MAGNETIC TAPES	SCENES/ FILES
AERIAL IMAGE DATA	21,736	38,981
LANDSAT SATELLITE IMAGE DATA	88,046	1,194,396
OTHER SATELLITE IMAGE DATA	69,749	161,857
DIGITAL CARTOGRAPHIC DATA	66,447	171,829
EARTH SCIENCE DATA	<u>978</u>	<u>7,941</u>
TOTAL	246,956	1,575,004

**Data Archive Report
As of October 8, 1997**

Photographic Data Archived at EDC

AERIAL PHOTOGRAPHY		
SOURCE	ROLLS	FRAMES
U.S. Geological Survey	17,353	2,587,722
NAPP	11,643	1,774,150
Bureau of Land Management	626	125,147
Bureau of Reclamation	294	58,785
National Park Service	81	13,635
Bureau of Indian Affairs	<u>49</u>	<u>9,913</u>
TOTAL DEPT. OF THE INTERIOR	30,046	4,569,352
Army Map Service	1,741	219,794
U.S. Air Force	3,398	339,172
U.S. Navy	6,462	435,621
Corps of Engineers	<u>98</u>	<u>24,078</u>
TOTAL DEPT. OF DEFENSE	11,699	1,018,665
Ames Research Center	5,078	625,640
Johnson Space Center	7,631	1,012,129
Other	<u>1,401</u>	<u>131,862</u>
TOTAL NASA	14,110	1,769,631
OTHER SOURCE AGENCIES	2,191	365,565
TOTAL AERIAL PHOTOGRAPHY	58,046	7,723,213

SATELLITE PHOTOGRAPHY		
SOURCE	ROLLS	FRAMES
Landsat MSS 70mm Film (1/2/3)	7,708	1,342,187
Landsat MSS 9" B&W Film	10,628	1,338,195
Landsat TM 9" B&W Film	2,924	175,665
Skylab	634	44,845
Apollo/Gemini/Apollo-Sojuz	127	18,372
Shuttle (Incl. LFC)	3,186	292,176
Declassified Intelligence Satellite Photography	17,391	945,898
TOTAL SATELLITE PHOTOGRAPHY	42,598	4,157,338

**Data Archive Report
As of October 8, 1997**

Digital Data Archived at EDC

SOURCE	MAGNETIC TAPES	SCENES/ FILES
AERIAL IMAGE DATA		
NASA Data		
TIMS / NS001	1,732	7,323
SIR-C	1,013	10,416
ASAS	166	162
NALC	2,531	2,531
NLDC	7,306	4,046
GTOPO 30	1	35
AVHRR 1-KM Orbital Segments	6,370	11,540
National Park Service	94	N/A
Side-Looking Airborne Radar (SLAR)	<u>2,523</u>	<u>2,938</u>
TOTAL	21,736	38,981
SATELLITE IMAGE DATA		
Landsat MSS/TM Digital Data	88,046	1,194,396
AVHRR		
EDC-HRPT Data	21,692	39,166
LAC Data Received via DOMSAT	24,441	54,729
LAC Data Received from Other Sources	16,010	64,336
SPOT Data	308	308
Department of Defense MSI Data	<u>7,298</u>	<u>3,318</u>
TOTAL	157,795	1,356,253
USGS GEO DATA (Digital Cartographic Data)		
7.5" Digital Elevation Model (DEM)	39,035	42,305
15' Digital Elevation Model (DEM)	542	542
30' Digital Elevation Model (DEM)	N/A	1,285
250k Digital Elevation Model (DEM)	N/A	1,384
24k & 15' Digital Line Graph (DLG)	24,458	102,660
100k Digital Line Graph (DLG)	1,842	20,581
1:2M Digital Line Graph (DLG)	49	323
Land Use Land Cover (LULC)	521	2,749
3.75' Digital Orthoquad Quarter Quad (DOQ QQ)	N/A	45,920
Digital Orthoquad County CD's (DOQ)	N/A	277
Digital Raster Graphics CD's (DRG)	<u>N/A</u>	<u>779</u>
TOTAL	66,447	171,829
EARTH SCIENCE DATA		
National Uranium Resource Evaluation (NURELUB)	957	7,941
Geophysical Research Program	<u>21</u>	<u>N/A</u>
TOTAL	978	7,941
TOTAL DIGITAL HOLDINGS	246,956	1,575,004

N/A = Information not Available.

SELECTED RESEARCH AND TECHNICAL PUBLICATIONS

- Acevedo, William, Foresman, T.W., Buchanan, J.T.**, 1996, Human transformation processes—origins and philosophy of a temporal database: *Sistema Terra* [Remote Sensing and the Earth], v. V, no. 2/3, p. 32-38.
- Almaraz, R.A., Eswaran, Hari, Waltman, S.W., Bliss, N.B.**, and Orozco-Chavez, Francisco, 1997, Soil taxonomy map of Mexico [abs.]: *Agronomy Abstracts*, p. 247. [The American Society of Agronomy publishes abstracts from its annual meeting in a serial instead of publishing a proceedings. The 89th Annual Meeting was held on October 26-31, 1997, in Anaheim, California.]
- Anthony, M.L., Klaver, J.M., and Quenzer, R.J.**, in press, The Inter-American geospatial data network, developing a western hemisphere geospatial data clearinghouse: International Symposium on Hydrology in the Humid Tropic Environment, Kingston, Jamaica, November 17-22, 1996, proceedings: Wallingford, Oxfordshire, IAHS Press.
- Clarke, K.C., Gaydos, Leonard, Hoppen, Stacy**, 1997, A self-modifying cellular automaton model of historical urbanization in the San Francisco Bay Area: *Environment and Planning B: Planning and Design*, v. 24, p. 247-261.
- Crawford, Tom, Lietzow, Ron, and Verdin, Jim**, 1996, 1995 pilot study—cropland use intensity interpreted from satellite imagery of the Mutarara/Sena area, Mozambique: *Hughes STX Center for Global Change*, [newsletter], v. 3, December 1996, p. 6-9, 12-14.
- Danielson, J.J.**, 1997, Verification of drainage basins from 1-km GTOPO30 digital elevation data [abs.], poster presented at 1997 ESRI User Conference, [17th], [San Diego, California], July 8-11, 1997, [Redlands, California], Environmental Systems Research Institute, Inc.
- DeMulder, M.L., Rohde, W.G., and Donnelly, Jay**, 1997, Mapping in the information age—the role of the U.S. Geological Survey: *Geotimes*, v. 42, no. 4, p. 22-25.
- Draeger, W.C., Holm, T.M., Lauer, D.T., and Thompson, R.J.**, 1997, The availability of Landsat data—past, present, and future: *Photogrammetric Engineering and Remote Sensing*, v. 63, no. 7, p. 869-875.
- Eidenshink, Jeffery, and Faundeen, John**, 1997, Acquiring, archiving, and distributing a 6-terabyte global land data set, in Rosenholm, Dan, and Osterlund, Henrik, eds., *ISPRS Joint Workshop, From Producer to User*, Boulder, Colorado, October 7-9, 1997, [Washington, D.C., International Society for Photogrammetry and Remote Sensing], p. [52]-[55].
- Faundeen, J.L., and Rossmeissel, H.J.**, 1996, USGS Cartographic data available online [abs.]: Annual Meeting of the North American Cartographic Information Society (NACIS), XVI, San Antonio, Texas, October 2-5, 1996: Online abstracts. [URL: <http://maps.Unomaha.edu/NACIS/Conference.html>].
- Faundeen, J.L., and Zanter, K.M.**, 1997, Metadata management, integration, and visualization through the U.S. Geological Survey's Global Land Information System, in *IEEE Metadata Conference*, 2d, Silver Spring, Maryland, September

16-17, 1997, Proceedings: [Silver Spring, Maryland], IEEE Computer Society, electronic version, <http://www.computer.org/conferen/proceed/meta97/>

- Fuller, Douglas, Tappan, Gray, and Wood, Eric**, in press, The changing rangeland and agricultural landscapes of Senegal, West Africa, 1983-1996: The Geographical Review.
- Gaydos, L.J.**, 1996, Today's land cover mapping, in Scott, J.M., Tear, T.H., and Davis, F.W., eds., GAP analysis—a landscape approach to biodiversity planning: Bethesda, Maryland, American Society for Photogrammetry and Remote Sensing, p. 67-70.
- Govoni, D.L., Zanter, K.M., and Faundeen, J.L.**, 1997, Role of the Internet World Wide Web in disseminating U.S. Geological Survey geospatial data and information, in URISA '97, Annual Conference of the Urban and Regional Information Systems Association, Toronto, Canada, July 19-23, 1997, Proceedings, CD-ROM, 1 disc.
- Holm, T.M.**, 1997, Data and information management—an institutional commitment [abs.], in GPS/GIS '97, Mapping to Manage, Annapolis, Maryland, May 13-16, 1997, Proceedings: Bethesda, Maryland, GeoResearch, Inc., electronic version, <http://geosearch.com/gri/wrapup97.htm>
- Holm, T.M.**, 1997, National Satellite Land Remote Sensing Data Archive, technical note: Photogrammetric Engineering and Remote Sensing, v. 63, no. 10, p. 1,180.
- Hutchinson, J.A., and Wittmann, J.H.**, 1997, Map design and production issues for the Utah Gap Analysis Project: Cartography and Geographic Information Systems, v. 24, no. 2, p. 91-100.
- Klaver, J.M., Klaver, R.W., and Burgan, R.E.**, 1997, Using GIS to assess forest fire hazard in the Mediterranean region of the United States, in 1997 ESRI User Conference, [17th], [San Diego, California], July 8-11, 1997, Proceedings: [Redlands, California], Environmental Systems Research Institute, Inc., CD-ROM, 1 disc, electronic version, <http://www.esri.com/base/common/userconf/proc97/HOME.HTM>
- Klaver, Robert, Lewis, John, Verdin, James, and Howard, Stephen**, 1997, Development of a water budget model for monitoring agriculture in Africa [abs.], in 1997 ESRI User Conference, [17th], [San Diego, California], July 8-11, 1997, Proceedings: [Redlands, California], Environmental Systems Research Institute, Inc., CD-ROM, 1 disc, electronic version, <http://www.esri.com/base/common/userconf/proc97/HOME.HTM>
- Lauer, D.T., and Eidenshink, J.C.**, 1996, Mapping the global land surface using 1-km AVHRR data, in International Astronautical Congress, 47th, Beijing, China, October 7-11, 1996, Proceedings: Paris, International Astronautical Federation, [10]p. [Available from American Institute of Aeronautics and Astronautics, Reston, Virginia, paper no. IAF-96-B.4.04].
- Lauer, D.T., Morain, S.A., and Salomonson, V.V.**, 1997. The Landsat program—its origins, evolution, and impacts: Photogrammetric Engineering and Remote Sensing, v. 63, no. 7, p. 831-838.

-
- Lewis, J.E., Rowland, James, and Nadeau, Andrew**, in press, Estimating maize production in Kenya using NDVI—some statistical considerations: *International Journal of Remote Sensing*.
- Loveland, T.R.**, 1996, [Section]2, The LCWG classification scheme, in Berwald, A.S., ed., *The IGBP-DIS working paper 13*: Toulouse, France, IGBP-DIS office, p. 15-20.
- Loveland, T.R., and Belward, A.S.**, 1997, The IGBP-DIS global 1 km land cover data set, DISCover—first results: *International Journal of Remote Sensing*, v. 18, no. 15, p. 3,289-3,295.
- Loveland, T.R., and Shaw, D.M.**, 1996, Multi-resolution land characterization: building collaborative partnerships, in *GAP Analysis: A Landscape approach to biodiversity planning*, J.M. Scott, T.H. Tear, and F.W. Davis, editors, American Society of Photogrammetry and Remote Sensing, Bethesda, Maryland, p. 79-85.
- Lu, Zhong, Fatland, Robert, Wyss, Max, Li, Shusun, Eichelberger, John, Dean, Ken, and Freymueller, Jeffrey**, 1997, Deformation of New Trident volcano measured by ERS-1 SAR interferometry, Katmai National Park, Alaska: *Geophysical Research Letters*, v. 24, no. 6, p. 695-698.
- Mah, G.R.**, in press, Internet distribution of remote sensing data at the EROS Data Center Distributed Active Archive Center (EDC DAAC), in *International Symposium on Spectral Sensing Research, Observation to Information*, San Diego, California, December 13-19, 1997, Proceedings: [Bethesda, Maryland, American Society for Photogrammetry and Remote Sensing]. [Also presented at Hughes STX 2nd Annual Science Data Centers Symposium, Science Data Centers Challenges in the New Millennium, Greenbelt, Maryland, November 17-18, 1997, NASA Goddard Space Flight Center.]
- Markon, C.J., and Wesser, Sara**, 1997, The Bering Land Bridge National Preserve land cover map and its comparability with 1996 field conditions: U.S. Geological Survey Open-File Report 97-103, 28 p.
- Ohlen, D.O., Reed, B.C., and Loveland, T.R.**, 1996, Progress in the Development of a global land cover characteristics data base, in Schoolmaster, F.A., ed., *Papers and Proceedings of the Applied Geography Conference*, 19th, Kansas City, Missouri, October 1996, Proceedings: [Kansas City, Missouri], Applied Geography Conference, Inc., p.281-287.
- Olsen, L.M., and Bliss, N.B.**, 1997, Development of a 30-arc-second digital elevation model of South America, in 1997 ESRI User Conference, [17th], [San Diego, California], July 8-11, 1997, Proceedings: [Redlands, California], Environmental Systems Research Institute, Inc., CD-ROM, 1 disc, electronic version, <http://www.esri.com/base/common/userconf/proc97/HOME.HTM>
- Ramachandran, Bhaskar**, 1997, GTOPO30—global 30-arc-second digital elevation model [abs.], poster presented at 1997 ESRI User Conference, [17th], [San Diego, California], July 8-11, 1997, [Redlands, California], Environmental Systems Research Institute, Inc.

- Reed, B.C., and Yang, Limin**, 1997, Seasonal vegetation characteristics of the United States: Geocarto International, v. 12, no. 2, p. 65-71.
- Sayler, Kristi**, 1997, Internet image viewer for Landsat thematic mapper data—a Mojave Desert prototype, in 1997 ESRI User Conference, [17th], [San Diego, California], July 8-11, 1997, Proceedings: [Redlands, California], Environmental Systems Research Institute, Inc., CD-ROM, 1 disc, electronic version, <http://www.esri.com/base/common/userconf/proc97/HOME.HTM>
- Scholz, D.K., Johnson, Dale, Lowell, Kevin, and Sprenger, Karla**, 1997, Internet access to U.S. Geological Survey geospatial data and images, in GIS/LIS '97 Annual Conference and Exposition, Cincinnati, Ohio, October 28-30, 1997, Proceedings: Bethesda, Maryland, American Society for Photogrammetry and Remote Sensing, American Congress on Surveying and Mapping, CD-ROM, 1 disc.
- Singh, Ashbindu, Fosnight, E.A., and Rykhus, Russell**, 1997, Spatial data sets for environmental assessment—towards bridging the data gap, Environment Information and Assessment Technical Report UNEP/DEIA/TR.97.4: Nairobi, Kenya, United Nations Environment Programme, 66 p.
- Steyaert, L.T., Hall, F.G., and Loveland, T.R.**, in press, Land cover mapping, fire disturbance-regeneration, and multiresolution land cover scaling studies in the Boreal Forest ecosystem with multitemporal 1-km AVHRR: *Journal of Geophysical Research*.
- Steyaert, L.T., Loveland, T.R., and Parton, W.J.**, 1997, Land cover characterization and land surface parameterization research: *Ecological Applications*, v. 7, no. 1, p. 1-2.
- Suarez, M.J., Emery, W.J., and Wick, G.A.**, 1997, The multi-channel infrared sea truth radiometric calibrator (MISTRIC): *Journal of Atmospheric and Oceanic Technology*, v. 14, no. 2, p. 243-253.
- Tieszen, L.L., Reed, B.C., Bliss, N.B., Wylie, B.K., and DeJong, D.D.**, 1997, NDVI, C3 and C4 production, and distributions in Great Plains grassland cover classes: *Ecological Applications (Landscape Parameterization Invited Features)*, Washington, D.C., Ecological Society of America, v.7 no.1, February 1997, p.59-78.
- U.S. Geological Survey**, 1997, A permanent record of the Earth's surface, [brochure]: [Sioux Falls, South Dakota], EROS Data Center, 2 p. [fold out] [Brochure authored by T.M. Holm.]
- Verdin, K.L.**, 1997, A system for topologically coding global drainage basins and stream networks, in 1997 ESRI User Conference. [17th], [San Diego, California], July 8-11, 1997, Proceedings: [Redlands, California], Environmental Systems Research Institute, Inc., CD-ROM, 1 disc, electronic version, <http://www.esri.com/base/common/userconf/proc97/HOME.HTM>
- Verdin, K.L., and Verdin, J.P.**, in press, A topological system for delineation and codification of the Earth's river basins: *Journal of Hydrology*.

-
- Vogelmann, J.E., Sohl, Terry, Campbell, P.V., and Shaw, D.M.**, in press, Regional land cover characterization using Landsat thematic mapper data and ancillary data sources, in Third EMAP Research Symposium, 3rd, Albany, New York, April 8-11, 1997, Proceedings. [Proceedings are being published in a special edition of Environmental Monitoring and Assessment.]
- Vogelmann, J.E., Sohl, Terry, and Howard, S.M.**, in press, Regional characterization of land cover using multiple sources of data: Photogrammetric Engineering and Remote Sensing.
- Waltman, S.W., Lacelle, Barbara, Tarnocai, Charles, Bliss, N.B., and Orozco-Chavez, Francisco**, 1997, Soil organic carbon map and data base for North America [abs.]: Agronomy Abstracts, p. 259. [The American Society of Agronomy publishes abstracts from its annual meeting in a serial instead of publishing a proceedings. The 89th Annual Meeting was held on October 26-31, 1997, in Anaheim, California.]
- Worstell, B.B., Baumgardner, M.F., and Bliss, N.B.**, 1996, Intergrating soil and DEM data for developing a small scale soil and terrain (SOTER) database [abs], in Annual Meeting of the American Society of Agronomy, Indianapolis, Indiana, November 3-6, 1996, Proceedings.
- Wood, E.C., Tappan, G.G., and Mbaye, Massaer**, in press, Aerial videography for local and national natural resource management in Senegal, in Biennial Workshop on Color Photography and Videography, 16th, Weslaco, Texas, April 29-May 1, 1997, Proceedings: Bethesda, Maryland, American Society for Photogrammetry and Remote Sensing.
- Yang, Limin, Zhu, Zhiliang, Li, Jiayong, and Qiu, Zhicheng**, 1997, Seasonal land cover characteristics data base of China for global change research, in ACSM/ASPRS Annual Convention and Exposition, 57th/63d, Seattle, Washington, April 7-10, 1997, Proceedings: Bethesda, Maryland, American Society for Photogrammetry and Remote Sensing, American Congress on Surveying and Mapping, v. 2, p. 82-86.
- Yang, Wenli, Yang, Limin, and Merchant, J.W.**, 1997, An assessment of AVHRR/NDVI-ecoclimatological relations in Nebraska, U.S.A.: International Journal of Remote Sensing, v. 18, no. 10, p. 2,161-2,180.
- Zhou, Weiyang, and Benson, Keith**, 1997, An efficient algorithm for extracting one-pixel-wide linear features from a digital image, in ACSM/ASPRS Annual Convention and Exposition, 57th/63d, Seattle, Washington, April 7-10, 1997, Proceedings: Bethesda, Maryland, American Society for Photogrammetry and Remote Sensing, American Congress on Surveying and Mapping, v. 3, p. 136-145.
- Zokaites, David, Wivell, Charles, and Zhou, Weiyang**, in press, Planning a second-generation system for precise global AVHRR registration [abs.], in Satellite Applications Conference, [1st], Asheville, North Carolina, March 4-6, 1997, Proceedings: Asheville, North Carolina, National Climatic Data Center.