

**EROS DATA CENTER
ANNUAL REPORT**

FISCAL YEAR 1994



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

U.S. Geological Survey Mission

As the Nation's largest earth-science research and information agency, the USGS maintains a long tradition of providing "Earth Science in the Public Service."

The USGS, a bureau of the U.S. Department of the Interior, was established to provide a permanent Federal agency to conduct the systematic and scientific "classification of the public lands and examination of the geological structure, mineral resources, and products of the national domain."

As a Nation we face serious questions concerning our global environment. Will we have adequate supplies of quality water available for national needs? How can we ensure an adequate supply of critical water, energy, and mineral resources in the future? In what ways are we irreversibly altering our natural environment when we use these resources? How has the global environment changed over geologic time, and what can the past tell us about the future? How can we predict, prevent and mitigate the effects of natural hazards?

Collecting, analyzing, and disseminating the scientific information needed to answer these questions are the primary mission of the USGS. This information is provided to the public in many forms, such as reports, maps, and data bases, that provide descriptions and analyses of the water, energy, and mineral resources, the land surface, the underlying geologic structure, and the dynamic processes of the Earth.

The 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."

The Mission of the EROS Data Center

The fundamental mission of the 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 U.S. Geological Survey's EROS Data Center (EDC) remains committed to providing remotely sensed land-surface data and technical assistance to organizations that manage land and monitor environmental activities at home and abroad. In keeping with this commitment, the Data Center provided scientific expertise, products, and data management support to land managers and Earth scientists worldwide in 1994.

The EROS Data Center hosted the Scientific Assessment and Strategy Team (SAST), an 17-member, interdisciplinary team of scientists and engineers from different Federal agencies and states. The Team drew on the EDC's experience in working with diverse types and large volumes of earth-science data to study flooding in the Upper Mississippi and Lower Missouri River basins.

We are pleased one of our remote sensing scientists became the first EDC staff member to be selected as the USGS Mendenhall Seminar Lecturer for research in developing comprehensive and dynamic land characterization data bases. A new project in Madagascar for the U.S. Agency for International Development (USAID) marked the Data Center's first opportunity to address conservation as well as biodiversity issues. In addition to the above successes, the EDC continued to support major efforts such as the Digital Line Graph-Enhanced (DLG-E) projects, the Global 1-Km Advanced Very High-Resolution Radiometer (AVHRR) Data Set Project, and global topographic research. Other accomplishments included converting Landsat MSS data to a durable media, and implementing the National Mapping Division's (NMD) digital sales data base.

The Data Center looks to the future with optimism as it takes part in a comprehensive national satellite land remote sensing data management program. Critical to the Center's future is a 65,000 square foot building addition, which will house the Land Processes Distributed Active Archive Center (LPDAAC), a part of NASA's Earth Observing System (EOS) Program. Initiated in May of 1994, building addition construction is scheduled to conclude in the winter of 1995/96.

The EROS Data Center's team of professional and dedicated scientists, technicians, and clerical staff support these and other major activities by following internationally recognized standards of excellence in data management, product generation, computer systems development, and spatial data research reflected in this report.

Therefore, it is with great pride and pleasure we provide this annual report, which highlights the activities and successes of the EROS Data Center during the 1994 fiscal year.

*Donald T. Lauer
Chief, EROS Data Center*

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Cover

This false-color mosaic of southern Florida was assembled by combining 9 scenes acquired by the Thematic Mapper (TM) sensor aboard Landsat 5 from March of 1992 to April of 1993. It was produced to aid studies of land use practices and conditions in the frail Everglades ecosystem. The "natural" green appearance of vigorous vegetation was simulated by combining TM bands 7, 4, 3. As a result of using this band combination, clear lakes appear dark. The Everglades and Florida Bay appear blue because of reflection of turbidity. Fallow cropland looks red while more barren land appears light tan. A red-purple color represents mainly urban areas and their connecting transportation corridors.

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, the EROS Data Center manages earth-science data bases, develops computer systems, and shares technical expertise with users from Missouri to Madagascar. 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 the world's largest collection of images of the Earth acquired by spacecraft and aircraft. These holdings include over 10.4 million frames of photographic data and over 139,000 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, distribute, and apply earth-science data. These and other map and geographic data support many types of scientific studies, resource management, and environmental monitoring activities worldwide. Earth scientists from many disciplines combine expertise with engineers, technicians, and professionals in systems development, telecommunications, and computer science to support the mission of the U.S. Geological Survey.

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 in the late 1990s. 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 distribute data and research techniques for timely environmental studies by member nations.

In addition to NASA and the United Nations, EROS' state-of-the-art research facilities allow it to cooperate with many other Federal agencies, universities, and other organizations. EROS research facilities include:

- *advanced data and information analysis laboratories,*
- *data processing systems for product generation,*
- *digitizing capabilities,*
- *business and scientific systems,*
- *software development,*
- *geographic information systems development and use,*
- *on-line computer access to data on the Center's holdings and archives at other facilities.*

In addition to inhouse facilities, the Data Center operates field offices or assigns scientists to sites in Anchorage, Alaska, Fort Collins, Colorado, Mountain View, California, and Harare, Zimbabwe to support resource and environmental studies in those locations.

A Highlight Report – The Flood of 1993

In response to extensive flooding in the Midwest during the summer of 1993, the White House Interagency Floodplain Management Task Force, co-chaired by: T.J. Glauthier, Associate Director for Natural Resources, Energy, and Science of the Office of Management and Budget; Katie McGinty, Director of the White House Office of Environmental Policy; and John Lyons of the U.S. Department of Agriculture signed a directive in November 1993 to establish a Scientific Assessment and Strategy Team (SAST) that would support a floodplain management review.

Subsequently, the Task Force created the Interagency Floodplain Management Review Committee (IFMRC) and assigned its directorship to Brigadier General Gerald E. Galloway. The goals of the IFMRC included conducting an intensive investigation to understand what happened during the Flood of 1993 as well as soliciting opinions and making recommendations as to what changes in current Federal policies and related floodplain management practices would minimize most effectively the regional economic impacts of flooding in the Upper Mississippi River Basin.

The task of providing scientific and technical advice and assistance to the IFMRC was given to the SAST. The SAST was composed of senior-level scientists and engineers from various Federal agencies who were brought together to gather and analyze data and information pertaining to watersheds and floodplains in contributing and affected areas within the basin.

Scientific Assessment and Strategy Team activities began on January 3, 1994 at the EROS Data Center. The EDC is a national archive and distribution center for many kinds of spatial data (satellite imagery, aerial photography, and digital thematic maps) with an on-site scientific and technical staff experienced in the coordination and execution of diverse types of basic and applied multidisciplinary research. The extensive archive and digital data analysis capabilities available at the EDC, coupled with its experience in the development, application, and management of large spatial databases, were the principal reasons for conducting SAST activities at this U.S. Geological Survey facility. In Figure 1, satellite imagery (1:350,000-scale) processed for the SAST's preliminary report, "Science for Floodplain Management into the 21st Century," depicts pre-flood, flood, and post-flood conditions.

The 17-member SAST represented the U.S. Department of Agriculture's Soil Conservation Service, the U.S. Army Corps of Engineers, the U.S. Environmental Protection Agency, the Federal Emergency Management Agency, and several agencies within the U.S. Department of the Interior including the U.S. Geological Survey, the National Biological Survey, and the U.S. Fish and

Wildlife Service. These and other Federal, state, and non-governmental agencies contributed additional support on an ad-hoc basis.

One of the team's main objectives was to develop a digital database containing geographically referenced information that could be used to answer flood-related questions posed by the IFMRC as well as to assist floodplain managers and local, state, and Federal agencies responsible for flood recovery. SAST activities related to this objective included:

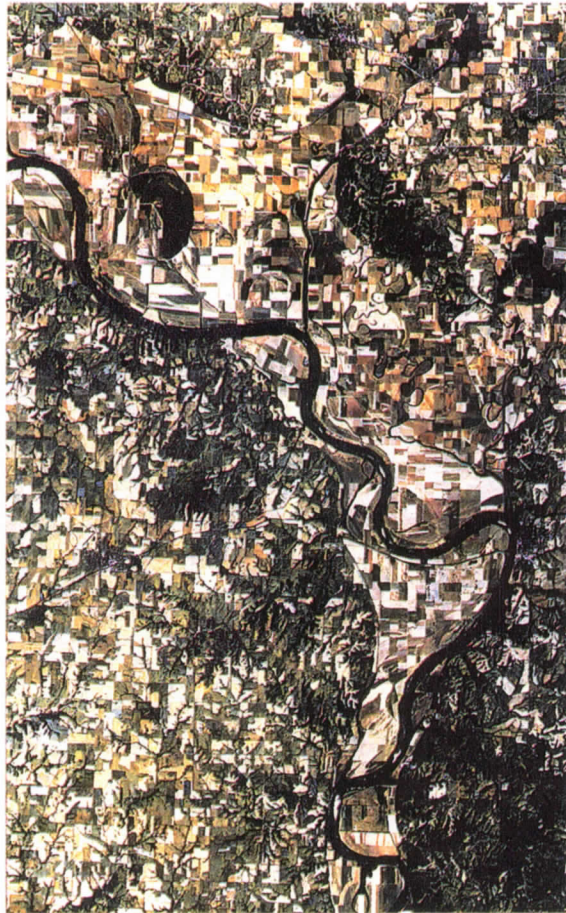
- acquisition and organization of existing data and information that was readily available;
- conversion of non-digital datasets (maps, charts, and tables) into a geographically referenced digital format;
- analysis of spatial relationships among features and variables that either control or influence the extent of flooding and the severity of its affects;
- production of thematic maps that show base-category information, areas that are vulnerable to flooding, and areas that are suitable for alternative landuse and management practices;
- preparation and distribution of reports that documented SAST products and the methods used to produce them;
- recommendations for continued and additional collaborative research, data management, and data distribution activities required to support a regionally integrated river basin management plan.

Information on the Upper Mississippi River Basin compiled by the SAST included:

- human-made structures (levees, dams, dikes),
- hazardous and toxic waste sites (EPA Superfund sites, sewage treatment facilities, point source pollution),
- demographics and economics (flood insurance, land values),
- geology (land forms, elevations, soil types and water-holding capacity),
- biology (threatened and endangered species),
- hydrology and hydrography (streamflow, wetland areas).

These and other types of information were gathered from both Federal and state agencies as well as non-government organizations. Special computer-mapping techniques were also developed to provide graphic models for analyzing short- and long-term effects of alternative river basin management practices. Current SAST activities are related to the development and implementation of an interagency, on-line "clearinghouse" for the dissemination of digital datasets and derivative products associated with this investigation. The clearinghouse mechanism for earth-science data management and distribution will provide scientists, resource managers, policy makers, and the public-at-large with real-time access to information to address local, regional, and national environmental issues.

Pre Flood (Sept. 1992)



Peak Flood (Sept. 1993)



Post Flood (Oct. 1993)



Figure 1

Results from the SAST database development and analysis effort include (1) new legislation regarding applications for the Federal flood insurance program, (2) relocation strategies for individuals and towns situated in the floodplain, and (3) applications to new floodplain management practices by other Federal, State, and Local government agencies.

An analysis of geographically referenced economic data by the SAST showed that many individuals residing in the major floodways were acquiring flood insurance only 15 days before the actual event. Since the waiting period for flood insurance to take affect is 5 days, according to law, many people were receiving benefits by becoming part of the program only when they knew for sure they would be flooded. Based on these SAST analyses, the Interagency Floodplain Management Review Committee recommended to the Administration and Congress that the waiting period be extended to 15 days. It was written into legislation as 30 days with a consequent savings to the Federal government estimated in the millions of dollars per major event.

Information compiled and analyzed by the SAST was used by contractors working for Federal Emergency Management Agency (FEMA) as they planned the move of Valmeyer, Illinois. In this effort, more than \$10,000 was saved by applying information provided by the SAST. Data base contents are being used similarly in other areas at this time.

Portions of the SAST data base also are being used by the U.S. Army Corps of Engineers in their assessment of the flooding, levee systems, and management practices in the upper Mississippi River Basin with a corresponding savings in Federal dollars that would have been spent for data collection and compilation.

National Satellite Land Remote Sensing Data Archive (NSLRSDA)

Since the launch of the first Landsat satellite in 1972, the Earth Resources Observation Systems (EROS) Data Center (EDC) has archived and distributed Landsat image data, which provides a multi-year, multi-sensor baseline of historical information about conditions and changes of the Earth's resources that cannot be provided from any other source. These data also will give the earth-science community a head start for long-term monitoring of the Earth's resources.

The importance of preserving and ensuring long-term access to Landsat and other land remote sensing satellite data is recognized in the Land Remote Sensing Policy Act of 1992, Public Law (P.L.) 102-555, passed on October 28,

1992. The Act directs the Department of the Interior (DoI) to establish and manage a National Satellite Land Remote Sensing Data Archive, the responsibility which has been delegated to the National Mapping Division's EROS Data Center. The Archive, as defined by P.L. 102- 555, provides for the preservation of and access to satellite-acquired land remote sensing data, with related research activity. While Landsat data are currently the largest single element of the Archive, other satellite data are also important elements. Currently, the Archive includes all U.S.-held Landsat 1-5 data, acquired before October 28, 1992, all Advanced Very High Resolution Radiometer (AVHRR), Gemini/ Apollo, Skylab, and Shuttle data now held at EDC, and will include all EOS land processes data acquired by NASA, all Landsat 7 data to be acquired by the U.S. Government, and selected subsets of satellite land data acquired by non-U.S. satellites and ground receiving stations.

The Data Center, in its role as the National Satellite Land Remote Sensing Data Archive, is investigating new techniques to improve the quality and accessibility of products and services from the Archive. To that end, the Archive activities include:

- determination of the initial and future content of the Archive,
- science support, definition of product characteristics and community-consensus algorithms to guide data processing systems,
- systems engineering and development, continued data conversion of historical Archive data and development of new data conversion systems for future Archive data,
- archive population and preservation, data ingest and processing of current and future satellite data systems and data preservation,
- customer services, maintenance and development of information systems to provide information about Archive content as well as references to data held by other land data archives,
- and production processing, development of systems to provide unenhanced data products from all Archive data sets.

The value to global change research scientists for archiving these data sets is shown by Figure 2, which compares the extent of deforestation of the tropical forest in Rondonia, Brazil over time. The scale for the image in Figure 2 is 1:1,000,000.

The following are selected activities related to the Archive that occurred during fiscal year (FY) 94.

Landsat Operations

Landsat 4-5 Landsat 4 has been placed in standby mode, however Landsat 5 continues to operate nominally, acquiring Thematic Mapper (TM) data and down-linking through X-band transmission only. Both spacecraft have lost the capability for

Humid Tropical Forest Project

Rondonia, Brazil

June 19, 1975

August 1, 1986

June 22, 1992



Figure 2

Tracking and Data Relay Satellite System (TDRSS) communication.

The Landsat Commercial Operator's contract with the U.S. Government expires on December 31, 1994. NOAA intends to extend the contract with the Earth Observation Satellite Company (EOSAT) through the life of Landsat 4/5. As directed in Public Law 102-555, Section 103, the Landsat Program Management (LPM), represented by NASA, the Department of Commerce and the Department of the Interior, have negotiated pricing, distribution, acquisition, archiving and availability of data from Landsat with EOSAT in the period up to the initial operational capability (IOC) of Landsat 7.

On April 11, 1994 LPM and EOSAT reached agreement in principle on Provisions for Landsat 4 and 5 operations. The provisions provide for a phased transition to a Landsat data policy consistent with the Landsat 7 data policy while meeting the eight goals in Section 103(a) of the law by Landsat 7 IOC. Such a transition ensures EOSAT will continue to operate Landsats 4 and 5, at no cost to the Government, until their practical demise. Provisions have been sent to NOAA for implementation through a change to the existing NOAA/EOSAT contract.

Data Management

P.L. 102-555 requires the U.S. Government to maintain Landsat data for long-term scientific analysis and study. To ensure that these data are available in the future, EDC has embarked on a major program to transfer all U.S. Landsat data to a new storage media. After evaluating several types of archival media, the Digital Cassette Recording System-incremental (DCRSi) technology was selected because of its reliability, low cost, high data density (48 gigabytes/cassette) and high transfer rates (107 megabits/second). The Thematic Mapper/Multispectral Scanner (MSS) Archive Conversion System (TMACS) began converting the MSS data, acquired between 1979-1992, to DCRSi cassettes in December 1992. In July 1994, the conversion of these MSS data was completed. A total of 12,500 high density tapes containing 352,000 scenes were copied to 400 digital cassette tapes.

Landsat Data Conversion and Maintenance

The TM conversion, started in November 1993, has copied 5,000 high-density tapes (containing 90,000 scenes) to 550 digital cassette tapes. As a result of converting these 5,000 TM high-density tapes, over 26,500 unprocessed and uncatalogued scenes were processed, inspected, and catalogued. These "new" TM scenes are now referenced in the Global Land Information System (GLIS) and are available from EDC. Figure 3 illustrates the extent of coverage and the acquisition of the 26,500 scenes identified and rescued.

Throughout the conversion process, those data with a hydrolysis problem -- where the magnetic coating on a computer tape absorbs water vapor causing damage to the tape binder -- were recovered using a baking process at 130 degrees F (55 degrees C) for 24 hours. Data would have been lost if this baking process was not used. So far, EDC has had 100% success in recovering data from the tapes with the severe hydrolysis problem.

***National Landsat
Archive Production
System***

The USGS has consolidated all Landsat 1-5 data at the National Land Remote Sensing Data Archive at EDC and is converting most of those data to a modern, high-density cassette magnetic media. At the same time, a new product generation system, which will be compatible with this new media, is being developed under contract that will replace an obsolete MSS processing system and add the capability to produce fully corrected TM scene and multi-scene products. The National Landsat Archive Production System (NLAPS) is scheduled to be operational by late summer 1995. NLAPS will be capable of generating radiometrically and geometrically corrected products from raw and partially processed TM data and from partially- and full-processed MSS data, as acquired by Landsats 1-5. Systematically-corrected, precision-corrected, and terrain-corrected products will be produced in a user-friendly "fast" format on 8 millimeter cassette, 3480 cartridge, or 6250 BPI round-reel media. The geodetic accuracy of systemically-corrected products is limited by the accuracy of the satellite position at the time data were acquired. Typically geodetic accuracy will be within 5-15 pixels for TM and 10-20 pixels for MSS data. To achieve one-pixel accuracy, products will be registered to U.S. topographic maps. Products may be referenced to any of 30 map projections and several Earth datums, and resampled to a wide range of output pixel sizes. Daily production capacity is limited to approximately 20 TM or 60 MSS products.

Until the operational release of NLAPS, systematically-corrected MSS products will be produced on the existing EDC system. In addition, systematic- and precision-corrected TM products will be produced on an interim commercial Landsat production system called the Geocoded Image Processing System (GICS). The GICS product characteristic will be similar to, but a subset of, the NLAPS product.

***Global Land
Information
System (GLIS)***

In FY 94, nine new data sets were added to GLIS including geographically searchable inventories for foreign held MSS and TM data. Eleven of the 16 Landsat ground receiving stations have provided metadata (data about data) in support of this release. Five stations thus far have not contributed metadata, and are being encouraged to do so. The foreign-held Landsat database totals over 2.2 million records, which is by far the largest searchable database in GLIS. GLIS activities in support of Information Data Services are noted on page 23.

***AVHRR Data
Management***

The EDC continues to receive AVHRR data via direct reception, network transfer, DOMSAT relay, and tape transfer from 31 receiving stations in

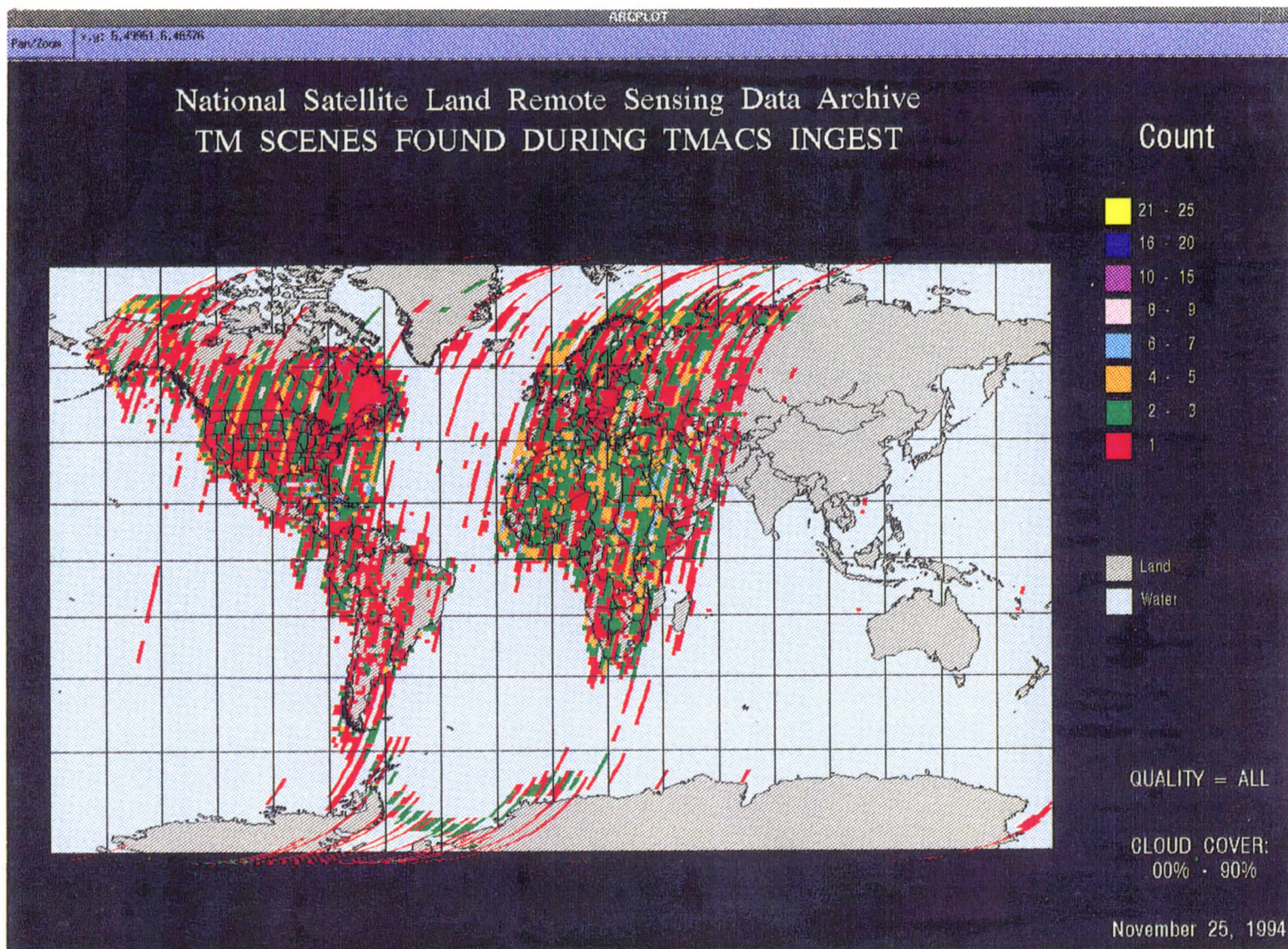


Figure 3

Antarctica, Argentina, Australia, Brazil, Canada, China, Egypt, France, Germany, Italy, Japan, Kenya, Niger, Norway, Philippines, Saudi Arabia, South Africa, Spain, and the United States. There are currently 93,578 AVHRR scenes referenced in the database inventory including 3,570 combined orbital passes. The orbital passes, within track stitching of individual AVHRR scenes, are being generated in support of the EDC Mission to Planet Earth Program (MTPE) global 1-Km project. About 40,000 of the 93,578 AVHRR scenes have been collected in direct support of the 1-Km project. All AVHRR metadata and browse information are available through GLIS.

EDC continues to produce comprehensive time series data sets of vegetation greenness condition. These products are useful for monitoring vegetation condition in forest, agricultural, and grassland ecosystems. In 1994 EDC produced 31 greenness products. These included:

- 16 biweekly periods over the conterminous United States,
- nine, 10-day periods covering the Newly Independent States (former Soviet Union) for June through August,
- and six, 15-day periods covering the Middle East for March through June.

The greenness products are distributed on CD-ROM, electronically, or on magnetic tape.

*Greenness Mapping
Production*

Following the commercialization of the Landsat system in 1984 (P.L. 98-365), the USGS established a purchasing agreement to assist Federal agencies in obtaining Landsat products and services from the EOSAT Company, the commercial operator of the Landsat satellite system. In 1987, a similar agreement was established with the French SPOT Image Corporation, the exclusive distributor of SPOT satellite data in the United States. These purchasing agreements eliminated the need for each Federal agency to establish and administer separate agreements to purchase civil satellite data and provided a mechanism for each Federal agency to issue a single purchase order for both Landsat and SPOT satellite products and services. While the use of the agreements is optional, since 1985, 30 different Federal agencies have purchased over \$32 million of data through these agreements, with \$4.6 million purchased in FY 94.

*Centralized Data
Search and Order*

Land Processes Distributed Active Archive Center (LPDAAC)

In support of NASA's Mission to Planet Earth Program, the EROS Data Center is serving as one of eight Earth Observing System (EOS) data archive centers. As the LPDAAC of the EOS Data and Information System, the Data Center is responsible for processing, archiving, distributing, and related science support for land processes data acquired and produced by the EOS Program.

EDC Building Addition

This 65,000-square-foot building addition will support the long-standing partnership between the U.S. Geological Survey (USGS) and the National Aeronautics and Space Administration (NASA). It will serve as the data archive, processing, and distribution facility for land data to be acquired later this decade by the Earth Observing System (EOS), a major part of NASA's Mission to Planet Earth. Space in the new addition will provide for high performance computer systems, advanced telecommunications networks, and skilled personnel required to process and distribute EOS land data through the EOS Data and Information System. These data will be used by researchers to study the Earth as an integrated system and by others to map the extent and distribution of natural resources, monitor land surface changes, and assess environmental conditions.

An Invitation for Bid (IFB) was issued February 14, closing on April 8, 1994. A site visit and pre-bid conference was held at EDC on March 1, with a favorable response from the construction industry, resulting in a highly competitive bid atmosphere. A groundbreaking ceremony on May 31 included the South Dakota congressional delegation, the Lt. Governor, State of South of Dakota, the Director of the USGS, the Deputy Assistant Secretary for Water and Science, the Department of the Interior, the Director, Operations, Data and Information Systems Division Office of Mission to Planet Earth, NASA, as well as many dignitaries and business people from the local community. Construction started early June 1994, with completion expected by January 1996. Present plans are to enclose the building perimeter and complete substantial floor structure so that work can continue through the 1994-95 winter season. Figure 4 shows the progress of construction in early October.

Global Land 1Km AVHRR Data Set Project

Following the successful completion of production system hardware and software development and prototyping activities, the operational production of global 1-Km 10-day vegetation composites began in February 1994. Thirty-six 10-day composites of North America, and 18 global composites, were completed in fiscal year 1994. Processing is continuing, with a plan to complete the production of 18 months of global composites by the end of fiscal year 1995.

At full resolution, each 10-day global vegetation composite involves more than 10 gigabytes of data (one gigabyte equals slightly over a billion bytes). To support the challenge of effectively and efficiently distributing such large quantities



Figure 4

of data to the science user community, activities during this fiscal year included the prototype development of new network data distribution capabilities that employ sophisticated data compression technologies to reduce network data transfer volumes. This prototype allows the user to select interactively a geographic subset of the 10.5 gigabyte composite dataset at full or reduced spectral resolution through a World Wide Web graphical user interface. Feedback from this prototype is being used to finalize design and implementation plans for an operational system planned to be completed and released in January 1995.

Production of a global 30 arc-second Digital Elevation Model (DEM) product using Digital Chart of the World (DCW) contour and hydrology data continued in fiscal year 1994. The 30 arc-second DEM of Africa (Figure 5) was completed and released to the scientific community in September. Production and validation of the North American DEM is nearing completion. Processing is underway on the South American DEM. Upon completion, these products are being staged to disk for on-line network access.

Digital Elevation Model (DEM) Development

A draft document, "A Strategy for Meeting the Topographic Data Requirements of EOS," was completed and distributed for review in August. Research and investigations involving the generation of elevation data using a stereo photogrammetric workstation continued. SPOT stereo data were used to develop elevation datasets for test sites in the Drum Mountains in Utah, Rinker Lake in Canada, and Bolivia. Comparisons of SPOT-derived elevation data along with other sources were conducted, and investigations of techniques to remove source data artifacts were performed.

CD-ROMs containing survey data from the first SIR-C (Shuttle Imaging Radar-C) instrument flown on the space shuttle Endeavour in April 1994, began arriving at the Data Center in August from the NASA Jet Propulsion Laboratory for distribution to the general science community. The EDC DAAC expects to receive approximately 66 sets of CD-ROMs from the first shuttle mission, with an additional 60-70 sets from the second (October) SIR-C mission planned for receipt beginning in January 1995. The EDC DAAC Data Distribution System, currently under development, will facilitate an interim network distribution capability.

Shuttle Imaging Radar Data

Although not part of the first EOS platform, Landsat 7 is a primary land remote-sensing instrument in the EOS program. Landsat 7 essentially is a replacement for the Landsat 6 Enhanced Thematic Mapper (ETM+) that failed to achieve orbit in 1993. EDC is a partner with NASA in the development, and with NOAA for operation, of a ground data system to provide direct reception, archiving, and distribution of raw products to Federal and public users. EDC has undertaken, for NASA, the design and development of an image assessment system (IAS) to radiometrically and geometrically calibrate and quality assess the ETM+ data. Assistance also is being provided to NASA in the design of the

Landsat 7

ground station and the preprocessing system that will receive and format the data for subsequent archiving and product dissemination by the DAAC. Specialists in sensor systems and orbital mechanics at EDC are contributing algorithms to perform many calibration, correction, and analysis functions of the IAS. After additional processing is applied to the DAAC-distributed raw products, these data will be useful in land use, global change, resource analysis, and other land applications using geographic information systems technology.

*The Earth
Observing System
Data Information
System (EOSDIS)
Information
Management
System (IMS)*

A graphical user interface version of the EOSDIS Version 0 Information Management System (IMS) was released to the public on August 31, 1994. This system provides users the ability to search for, select and electronically order scientific data from one or more of the eight EOSDIS Distributed Active Archive Centers (DAACs) and the NOAA Satellite Active Archive (SAA). This graphical version of the system also provides visual data browsing and geographic coverage map services to users. The EDC DAAC has a number of data sets visible and available through the IMS including aircraft scanner data and Landsat and NOAA satellite data from the National Satellite Land Remote Sensing Data Archive. An example of an IMS session showing AVHRR satellite data available from EDC is shown in Figure 6.

Research and Technology

Researchers at the EROS Data Center conduct a variety of projects to develop and test advanced technologies and methods required by the earth-science community in its pursuit of global change studies and geographic and spatial information analysis. These projects are supported by NMD research funds, as well as by cooperative agreements with other government organizations.

Global Change Research

*Multi-Resolution
Land
Characterization
(MRLC)*

The Multi-Resolution Land Characteristics Monitoring System (MRLC) project involves a consortium of cooperators needing land cover characteristics data for their environmental assessment and land management programs. MRLC consists of three objectives, each defined to meet the needs of a particular set of program and science issues. The objectives are:

- Develop a global 1-Km land cover characteristics data base. This activity is part of the USGS Global Change research program. Collaborators include the University of Nebraska - Lincoln, U.S. Environmental Protection Agency (EPA), U.S. Forest Service (USFS), and the United Nations Environment Programme.

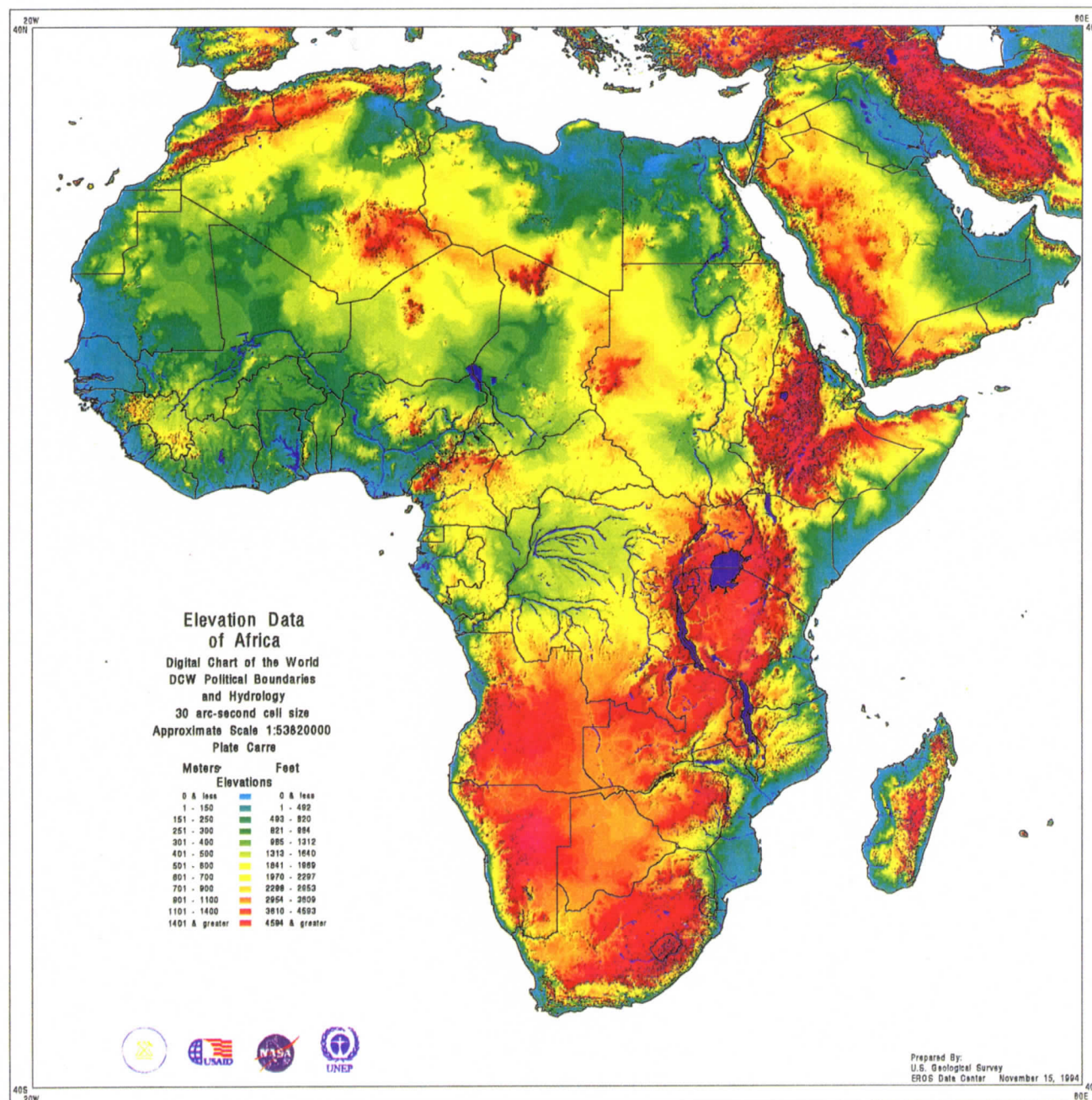


Figure 5

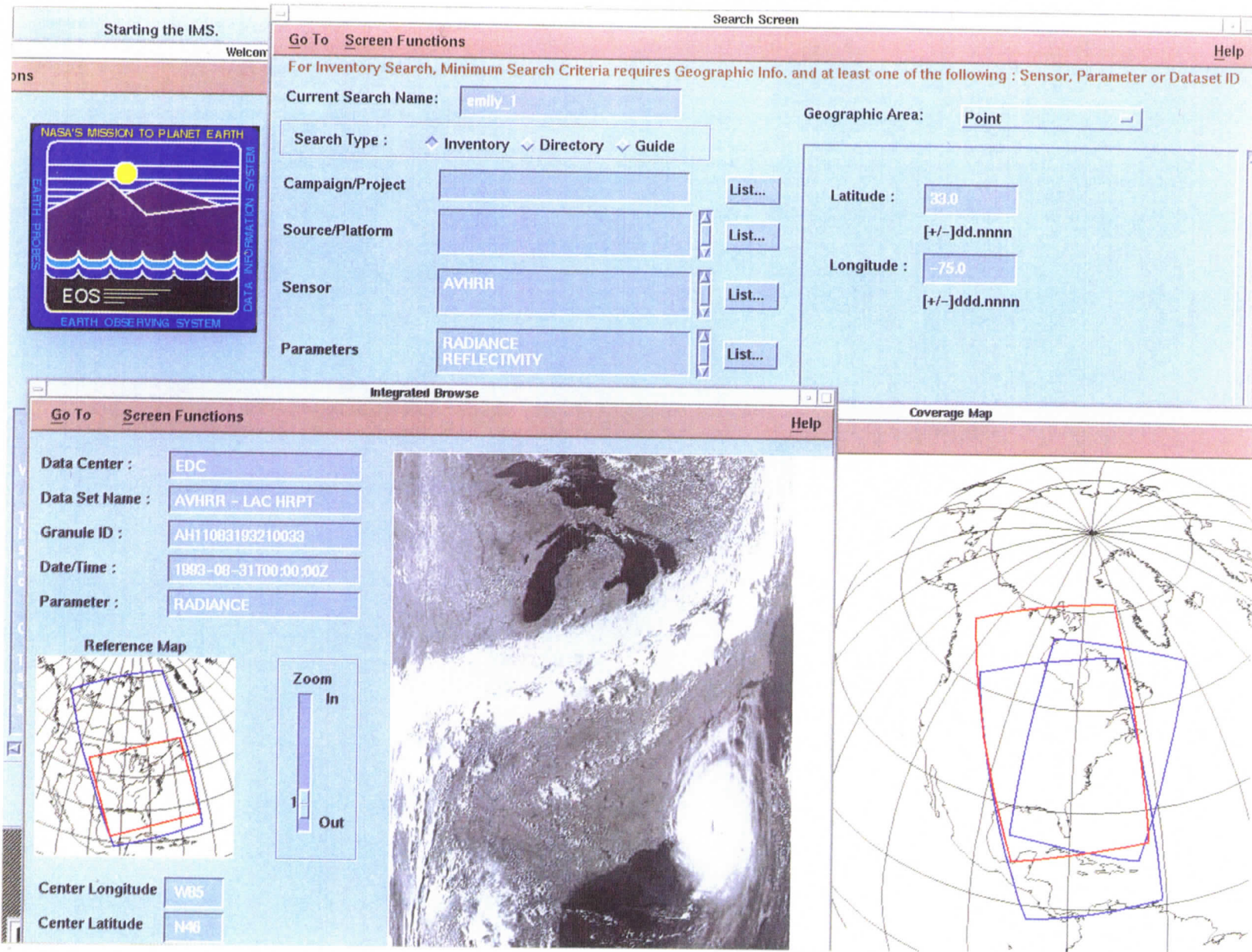


Figure 6

- Develop regional 30-meter land cover characteristics data bases. The EDC is producing a national set of georeferenced Landsat TM data for use in the USGS National Water Quality Assessment (NAWQA), National Biological Survey Gap Analysis Program (GAP), EPA Ecological Monitoring and Assessment Program (EMAP), and National Oceanic and Atmospheric Administration (NOAA) Coastal Change Analysis Program (C-CAP).
- Develop a multi-resolution monitoring system that permits the targeting and assessment of land cover changes. This long-term objective will tie the multi-resolution land characteristics data from the first two objectives into a monitoring framework that addresses issues relevant to Federal land and environment programs.

The global land characterization objective is a continuation of the conterminous U.S. land characterization project. Initial priority is the development of land characteristics data bases for North and South America.

The conterminous U.S. land characterization effort concluded this year with the printing of both a CD-ROM containing the full data base and the publishing of the 1990 Seasonal Land Cover Regions of the United States map. This two-sided map displays the 159 seasonal land cover regions on one side and maps of general land cover and seasonal properties (time of onset and peak of greenness, and length of green period) on the back. Both products are available through the National Mapping Division's Earth Science Information Center (1-800-USA-MAPS). The U.S. data base now is being used in several operational national programs including USFS fire danger modeling, EPA biogenic emissions modeling, and U.S. Department of Agriculture crop condition assessment. In addition, NOAA's National Meteorological Center is working toward incorporating the U.S. data base into its numerical modeling strategies for weather and storm forecasting.

The production of a national Landsat TM data base to support NAWQA, GAP, EMAP, and C-CAP is progressing with the generation of over 200 georeferenced and terrain-corrected scenes. The complete national TM data set will include nearly 650 scenes covering 430 path/rows and will be completed in fiscal year 1995. Processed scenes are being delivered to each cooperator where the data are being classified into land cover classes needed by each program. The final classified land cover data of each program will be sent back to the EDC for archiving and redistribution to anybody requiring 30-meter regional land cover data sets.

In addition to the production responsibilities, the EDC also is conducting research and applications assistance in large-area Landsat TM land cover mapping. The research component includes development of improved strategies for large-area land characterization and adaptation of the land characteristics

data base strategy to high resolution satellite data. The applications component is geared to provide direct assistance to NAWQA study units needing land cover data. This effort ultimately will involve the EDC and NMD mapping centers.

***Terrain Data
Development and
Analysis***

The project provides digital topographic data that are critical to most other projects that involve spatial analysis. EDC researchers assemble these topographic data sets, test their quality and applicability, and collaborate and publish the results of their work.

Using data from the Digital Chart of the World, EDC staff produced a shaded-relief representation of the 1 Km elevation model of Africa. This image was selected by the Environmental Systems Research Institute (ESRI) for the cover of its 1994 Map Book. Digital Elevation Models (DEM) of the Boreal Ecosystem-Atmosphere Study (BOREAS) site were generated from Canadian 1:250,000-scale digital hypsography and drainage data and delivered to the Goddard Spaceflight Center.

EDC scientists have compiled data sets focused on digital elevation for three test sites, including the Drum Mountains in Utah, Bolivia, South America, and Rinker Lake in Canada. Digital Elevation Models will be developed from SPOT and other satellite sources, and from USGS aerial photography and the data sets will be used to evaluate and characterize these sources. The data sets will be made available to researchers in NASA, USGS, and other members of the science community.

The Modular Mapping System (MMS), a public-domain time-series model parameterization capability was installed at EDC. The MMS, developed by USGS Water Resources Division and the Terrestrial Ecosystem Regional Research and Analysis (TERRA) Lab, will be used at EDC to examine the effects of a variety of sources and scales of elevation and other spatial data on the results of the modeling process.

EDC scientists produced a shaded relief elevation plot of the Goma, Zaire refugee area at the request of Geologic Division. Geologists will use the elevation data to monitor active volcanoes in the Goma region.

***Global Soils Data
Set Development
and Analysis***

This project makes regional scale soil information available to many users who do not have the resources to assemble and compile it. The project provides data sets that represent a rich source of information at a variety of scales about the zone of the Earth's surface where most human interaction occurs.

Data from the Soil Conservation Service State Soil Geographic (STATSGO) data base were overlaid with EDC's Seasonal Land Cover Regions (SLCR) data set for a ten state area in the Great Plains. Combining these data sets improves

the characterization of land use and vegetation conditions on the soils, and provides additional information to describe the Land Cover Regions. The results of this work have been used to calculate proportions of rangeland plant production by photosynthetic types and analyze soil properties useful to mesoscale climate modelers.

Digitizing for the 1:1,000,000-scale Soil Map of Mexico was completed by EDC staff and sent to Mexico for quality assurance. When attributes are added by the National Soil Survey Center in Lincoln, Nebraska, a soil carbon map will be produced for Mexico. This data set will be combined with existing maps of Canada and the United States to produce a soil carbon map of North America.

Project staff provided numerous reports and maps to the Scientific Assessment and Strategy Team for their analysis of the 1993 Midwest floods. Maps showing available soil water capacity, depth of ponding, hydric soils, permeability, slope, and soil order were prepared for the 14-state region of the Upper Mississippi and Lower Missouri River Basins.

The cooperative project between the USGS, EPA, and Environment Canada to produce an Ecoregions map for North America and the circumpolar Arctic continued. The "Alaska Ecoregions" map, with an accompanying manuscript, is in the review process for publication as a USGS Professional Paper. The National Biological Survey informally has adopted the Alaska Ecoregions map as the base it will use for its program activity.

Alaska Field Office (AFO) staff participated in and provided support for a Circumpolar Arctic Vegetation Mapping workshop held in St. Petersburg, Russia. With support from EDC Digital Data Production, part of the 1-Km global AVHRR data base was reformatted into a Lambert Azimuthal Equal Area polar projection and presented at the workshop as a means to assist the mapping effort.

Staff from the AFO participated in a working group meeting for the Conservation of Arctic Flora and Fauna (CAFF) Initiative in Reykjavik, Iceland. The Alaska Land Characteristics data sets developed by the AFO were used as a prototype for CAFF activity in the circumpolar Arctic. The CAFF is addressing identification of rare and endangered species in the Arctic region, and the conservation status of lands in the eight participating nations with a focus on the level of protection afforded to areas of important biodiversity.

The NALC staff produced over 100 Landsat MSS triplicates in FY 94 for a total of over 220 to date. To improve scene-to-scene registration, the processing flow was modified to include full terrain correction of each of the data sets (1970s, 1980s, and 1990s) as well as more rigorous verification of the geocoded products. Global Land Information System (GLIS) contains an

Arctic Land Processes Studies

North American Landscape Characterization (NALC)

overview of the NALC project, processing and product documentation, the production status map, and a list of the path/rows for which triplicates are completed. The same information is presented through World Wide Web/MOSAIC. Subscenes for the Lake Tahoe-Reno area are presented, and a set of sample products may be retrieved via ANONYMOUS FTP. These access points were established as part of an active public outreach for NASA's Landsat Pathfinder program.

***Human
Induced Land
Transformations***

The project staff created an animated visualization depicting the spread of urban land development in the San Francisco Bay Region from 1850 to 1990. The animation, recorded on videotape, used historic data from topographic maps and Landsat image data. An article titled "An Analysis of Human-induced Land Transformations in the San Francisco Bay/Sacramento Area" was approved for publication in the *World Resources Review*. A press release and the videotaped animation was provided to local television stations during the Association of American Geographers meeting in San Francisco. The project description and images are available on a MOSAIC server via World Wide Web, <http://sun1.cr.usgs.gov/eros-home.html>, under EDC Affiliates-EROS Ames Research Group.

***Terrestrial
Ecosystem Regional
Research and
Analysis (TERRA)
Lab***

TERRA is supported by the Department of Agriculture and the Department of the Interior to help integrate the broad multidisciplinary research being conducted on terrestrial ecosystems by agencies within the U.S. Global Change Research Program. The following activities for fiscal year 1994 support this mission. TERRA staff enhanced its Active Response Geographic Information System (AR/GIS) and demonstrated these enhancements at the GIS 1994 meeting in Vancouver, Canada. AR/GIS, which adds spatial data capability to electronic meeting software, now provides a mechanism for individual members of a decision-making group to digitize their geographic opinions. Once digitized, these opinions may be compiled and analyzed spatially and statistically. In addition, electronic meeting tools such as brainstorming, priority setting, and voting provide unique methods for input to land managers. AR/GIS is being used by the Forest Service to compile and analyze public comment on the current Forest Plan for the Arapaho-Roosevelt National Forest.

TERRA staff collaborated with bureaus of the Department of the Interior, other Federal agencies, and state agencies to study the sediment contribution of the Rio Puerco Drainage Basin to the Rio Grande River. Preliminary results show the importance of vegetation in controlling the incision and erosion of arroyos and the production of sediment. The data sets and field observations from the Rio Puerco study are featured as examples in an Ecosystem Management training program TERRA is developing for EPA managers.

Mapping and Information Science

A study to estimate albedo using Advanced Very High Resolution Radiometer (AVHRR) data for the Konza Prairie Field Experiment site in Kansas was completed. By simulating the atmospheric conditions during 1991 with meteorological data, researchers demonstrated that albedo can be estimated to an accuracy of about 0.1 of channel 1, and 0.3 for channel 2 without accounting for the effects of residual clouds escaping the cloud screening process. An article prepared for publication in the Journal of Geophysical Research describes an approach to reduce the sensitivity of the reflectance models to determine albedo in the presence of atmospheric contamination with very few measurements.

Working with Production Operations and the Mapping Applications Center (MAC) in Reston, and with the National Biological Survey and the College of Natural Resources at Utah State University, EDC staff developed and produced the data layers for four maps in support of the GAP Analysis Project in Utah. The maps include a Thematic Mapper image map, Vegetation Cover, Land Ownership and Administration, and Biodiversity Management Status. Delivery of data for all maps is to be completed in December 1994. Expected publication date is March 1995.

In cooperation with the U.S. Department of Agriculture and NASA/Ames, a prototype data set was developed to assess crop estimation capability. Existing software programs were used in building a manual procedure for registering and merging the spectral information of Landsat Thematic Mapper (TM) data with the high spatial resolution of a digital orthophotoquad (DOQ). DOQ quarter quadrangles for the San Mateo County, California coast were combined with TM data for the Franklin Point 7.5' quadrangle. A sample product was created in the process of developing the framework required for an automated procedure, demonstrating the utility of combining both DOQ and TM data.

Geographic and Spatial Systems

The MAGIC project seeks to demonstrate high-speed, real-time network application in a geographically distributed framework that accommodates massive on-line data storage and retrieval, ultra high-speed network switching and applications, and high-resolution dynamic interactive terrain visualization coupled with high-speed communications.

In support of this effort, EDC and SRI International produced a mosaic of digitized aerial photography from 30 photographs over the National Training Center at Fort Irwin, California. The mosaic, with a one meter spatial resolution, was processed on the Army High Performance Computing Research

*Development of
Advanced Feature
Extraction and
Change Detection
Techniques Using
Remotely Sensed
Data*

*Cartographic
Product
Generation from
Image Data*

*Applications of
Digital
Orthophotoquad
Area Frame
Development*

*Advanced Research
Projects Agency
(ARPA) -
Multi-dimensional
Applications and
Gigabit
Inter-network
Consortium
(MAGIC)*

Center's Connection Machine in Minneapolis, Minnesota via the high-speed wide area Asynchronous Transfer Mode (ATM) network supported by MAGIC. This data set was used in demonstrations at the Battle Command Battle Laboratory in Fort Leavenworth, Kansas, and at the Armed Forces Communications and Electronics Association (AFCEA) and the Army of the United States of America (AUSA) Conferences in Washington, D.C.

As a further test, EDC generated sample airphoto and satellite imagery over Virginia, Hawaii, and San Diego, California for a Joint Warfare Integration Demonstration. These data were staged on the MAGIC Image Storage Server and accessed via the high-speed Asynchronous Transfer Mode (ATM) network. The demonstration portrayed two major natural disasters occurring concurrently - hurricanes in Virginia and Hawaii. The demonstration affirmed the use of national networked resources, such as the EDC National Satellite Land Remote Sensing Data Archive, for use in damage prediction and assessment, and in logistical support for disaster relief agencies.

With these efforts, EDC staff demonstrated the ability to extend the MAGIC network beyond the Midwest region of the U.S., and handle very large data volumes and multiple geographic areas.

Scientific Collaboration

Over 10,800 hours were contributed to research projects in the Science and Applications Branch in FY 94 through this collaborative activity. Participants included 12 visiting scientists, three USGS Volunteers for Science, and four Hughes STX summer interns. The participants gave a variety of seminars, and wrote reports and papers to document their work. This important activity provides excellent professional opportunities for a variety of students and scientists, support for research projects, and a network of colleagues who are familiar with EDC operations.

International Program

Famine Early Warning System (FEWS)

The U.S. Geological Survey supports the U.S. Agency for International Development (USAID) Famine Early Warning System (FEWS) through a Participating Agency Service Agreement. The purpose of the FEWS project is to establish a famine early warning system for selected countries in Africa to provide timely information on food security problems and monitor fluctuations in vulnerability to food security. The USGS provides support to FEWS in the following areas: data archiving, data processing, geographic information systems, remote sensing, contingency support, and software development.

During FY 94 FEWS has accomplished the following:

- Compiled, integrated, and documented a comprehensive baseline, natural resource, and climate data archive for 12 FEWS countries.
- Provided continued analytical and scientific support to FEWS vulnerability studies, targeting methodology, and food security studies.
- Completed enhanced versions of data management software used for the archive and analysis of agricultural statistics (AGMAN) and rainfall data (RAINMAN).
- Provided data and analysis for the Greater Horn of Africa Task Force relating climate, agriculture, natural resources, and population for a 10-country region, including Sudan, Eritrea, Ethiopia, Djibouti, Somalia, Uganda, Kenya, Rwanda, Burundi, and Tanzania. These materials were presented in August to the Horn Task Force, to senior USAID/Washington officials, and to the Horn USAID Mission Directors conference in Nairobi, Kenya. Figure 7 is a composite of AVHRR images showing the 10-country region.

Agricultural-Hydro logical-Meteorologi cal (AGRHYMET) Technical Support

Five years of technical support to the AGRHYMET Program of West Africa, sponsored by USAID, were completed on December 31, 1994. During this time, an operational capability for monitoring seasonal changes in vegetative condition with NOAA AVHRR imagery was established at the AGRHYMET Regional Center in Niamey, Niger. The Sahelian staff manages production of 1-Km resolution regional and national greenness maps every 10 days during the May-September growing season. When geographic information systems (GIS) technology was introduced, two minicomputers, 72 microcomputers, nearly 100 peripheral devices, and hundreds of software packages were installed throughout the nine AGRHYMET countries. Over 600 Sahelians received formal training in workshops on remote sensing, GIS, climate data management, hydrology and agroclimatology applications, and office automation.

*Madagascar
Protected Area
Management
Technical Support*

The International Program began a new project in support of the establishment of a distributed GIS with ANGAP, the protected area management agency of Madagascar. The project began with a requirements analysis and development of a specification plan for acquisition of basic hardware, software, and training services. Consultation was provided on the technical standards which must be met by those providing map digitization services to ANGAP. Custom data sets, both national and over individual parks and preserves, were prepared, including satellite image maps and digital elevation models. Special software was developed to transform Global Positioning System (GPS) coordinate observations collected in the protected areas to Madagascar's unique Laborde map projection.



Madagascar

*Monitoring Land
Responses*

The development of a framework for long-term monitoring of Senegal's natural resources is jointly funded by USGS and USAID. The framework includes data collection at nearly 600 ground sites (established in an earlier USAID natural resources mapping project, 1982-84) by field visits, airborne videography, and satellite remote sensing. Three major field campaigns were conducted in FY 94. Sites were visited on the ground, with the participation of Senegalese scientists (a botanist and a social scientist) on the team. A report of preliminary evidence from field sites was released in June 1994. Examples of degradation, improvement, and stability were found. In one region, Landsat image interpretations (1972 and 1987) revealed rapid expansion of agricultural lands at the expense of natural vegetation formations. An airborne videography mission was undertaken in September with participation of the U.S. Forest

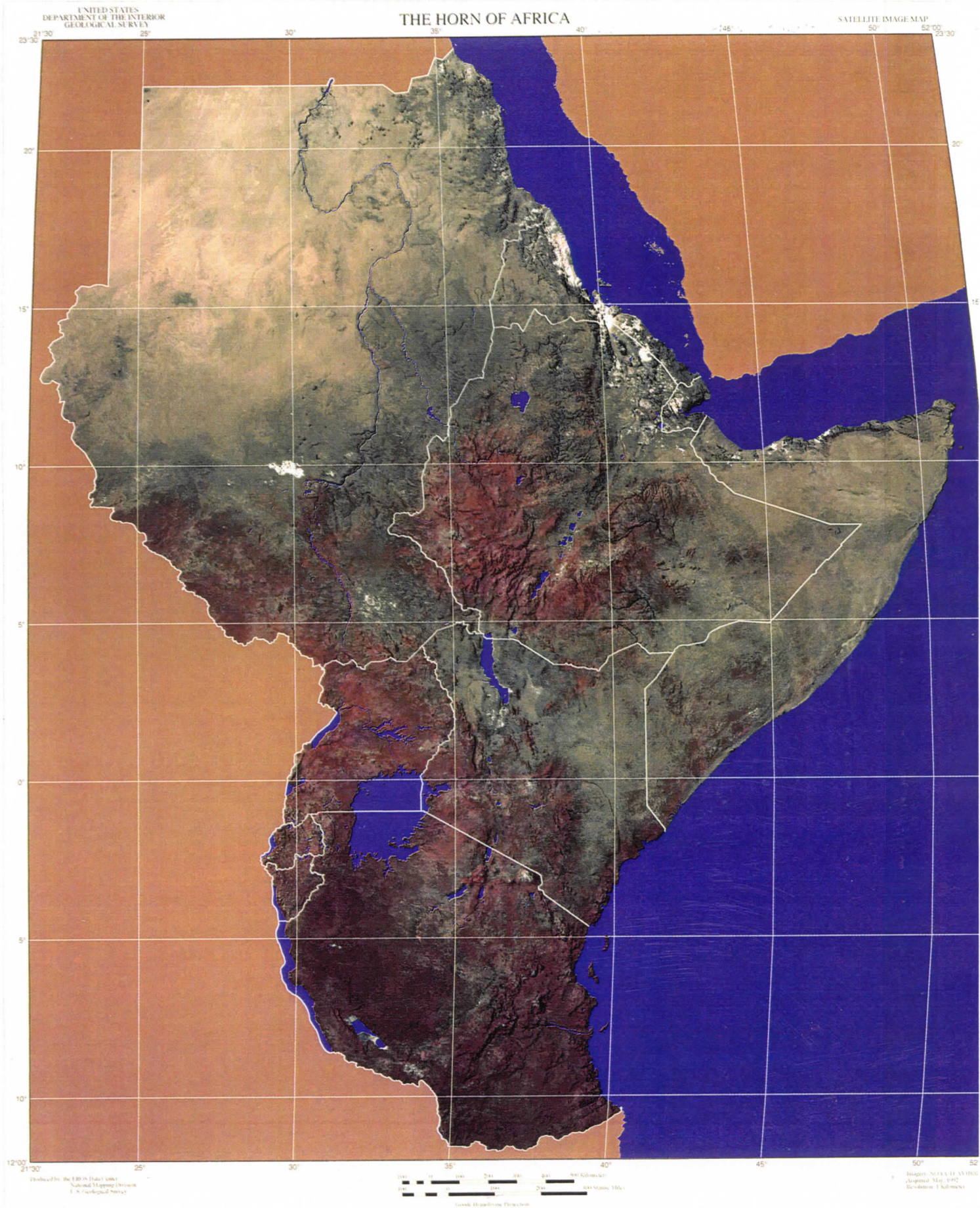


Figure 7

Service. Close ties have been established with the Ecological Monitoring Center in Dakar to ensure full Senegalese participation in the design and implementation of the long-term monitoring framework.

A new agreement between USAID and USGS was established to begin the development of a monitoring, evaluation, and reporting (MER) information system. A full-time EDC staff person is posted to Harare to assess requirements, formulate solutions, and implement systems. The system will bring together agro-physical and socioeconomic data to permit the evaluation of indicators of development project impact, as required by Congress. Basic equipment and software were ordered in FY94. A series of interviews with Mission staff was conducted to collect basic information needed for MER information system design.

*USAID/Zimbabwe
Mission Information
System*

The North American node of United Nations Environment Programme/Global Resource Information Database (UNEP/GRID), designated as GRID-Sioux Falls, is located at the EROS Data Center (EDC) of the United States Geological Survey (USGS) in Sioux Falls, South Dakota, USA. The broad objective is to assist UNEP and its partners by contributing data and information on methodology and technology that leads to better policies on environmental issues and helps advance sustainable development initiatives.

*(UNEP/GRID)
Support*

GRID-Sioux Falls has been operational since 1991 and functions as a partnership between the United Nations Environment Programme (UNEP), the U.S. Geological Survey (USGS), and the National Aeronautics and Space Administration (NASA). The operation of GRID-Sioux Falls is guided by an Advisory Committee which meets every 6 months. The first North American GRID Users Meeting was held May 12-13, 1994 at the EDC. The Users Meeting provided a means to measure the programme's effectiveness and identify strategies on how GRID-Sioux Falls can improve its services. GRID-Sioux Falls has an active programme dealing with data set development, data access, metadata standards, and data management. To some extent, the programme has facilitated the flow of developing data on countries to the North American scientific community.

GRID-Sioux Falls contributed to the process of building new data sets that are relevant to both developed and developing nations. For example, GRID-Sioux Falls has been working with the USGS, U.S. Environmental Protection Agency (EPA), U.S. Forest Service (USFS), and NASA to build a global land cover characteristics data base from 1-Km Advanced Very High Resolution Radiometer (AVHRR) imagery, a global digital elevation model (DEM) from Digital Chart of the World (DCW), and a global watershed database from the global DEM. Further contributions to the development of a global land characteristics database included research on derivation of seasonal parameters from time series vegetation index data, the development and implementation of a filter to

remove cloud contamination, and the acquisition of ancillary maps and data to assist in the image classification process for Mexico. The GLOBTEX data set was put in the GRID system to assist climate modelers to make better use of global soil data sets.

GRID-Sioux Falls has been working to increase awareness and access to their data holdings by establishing protocols within the World Wide Web (WWW) network using MOSAIC. A Home Page was implemented that permits users having access to the Internet to explore the GRID data holdings. Links and pointers to other metadatabases also were established.

GRID-Sioux Falls has been investigating the potential for using the U.S. National Biological Survey Gap Analysis strategy for international biodiversity assessments. GRID has developed an electronic gap analysis users manual that explains the principles of gap analysis and the availability of U.S. data sets. The users manual is available using MOSAIC and the WWW.

GRID-Sioux Falls published the results of the 1993 Survey of GIS & IP software systems. In addition, a number of papers in peer-reviewed journals, proceedings of seminars, and reports have been published and distributed widely within the UN system and developing nations.

China Protocol

In October 1993, two EDC scientists traveled to Beijing, People's Republic of China (PRC) as part of the ongoing exchange of technology and personnel under the protocol between the National Bureau of Surveying and Mapping (NBSM) of the PRC and the USGS. Accomplishments during the visit included discussion of initial phases of vegetation characterization of a test area in PRC, AVHRR data processing, and conversion of DEM drainage software to MS-DOS. Global 1-Km AVHRR data acquisition activities also was discussed. In May 1994, two NBSM scientists visited EDC as part of the continuing protocol exchange. Their efforts focused largely on completing the previously selected land characterization of the test area in the PRC. Discussions also were held regarding the production of composites of the PRC for future land characterization activities.

The Joint Working Group (JWG) meeting to plan activities for the 1994-1995 period was held in Reston, Virginia in August 1994. Activities approved include:

- land characterization of a second test area in China,
- providing Calcomp plots of four 1992 Normalized Difference Vegetation Index composites of China,
- providing software and limited consultation for establishment of AVHRR processing in China,
- land further discussions of the use of neural networks for spectral classification.

Advanced Cartographic Systems

Software to support mass conversion of existing 1:100,000-scale Digital Line Graph (DLG) data to DLG-Enhanced was delivered and used for a production pilot. Based on feedback received from the pilot, changes were made that resulted in mass conversion requiring only eight percent of the projected interactive effort. A portion of this savings was achieved by using the phase I implementation of the Working Database.

*Mass Conversion of
DLG Data*

A cooperative USGS/EPA production process has been defined. Software has been developed to support this process and much of it has been tested. This effort supports the initial prototype of Framework hydrography data.

*Prototype Framework
Data Sets*

A cooperative USGS/Census Bureau development prototype was completed and is being used to support a production prototype. This production prototype combines the best aspects of USGS, and Census Bureau transportation data, as well as state and private sector data. This effort is the initial prototype of Framework transportation data.

The version 1.0 Digital Standards Database was completed and released. This database is being used to define and maintain the standards for National Mapping Division 1:24,000 and 1:100,000-scale DLG data.

Standards Database

National Map & Digital Data Production

Landsat image map production for three Antarctic study sites, Dry Valleys, Byrd Glacier, and Victoria Land, continues. Dry Valley is being prepared for lithographic reproduction at Mapping Applications Center (MAC); Byrd Glacier is on hold pending the receipt of ground control from NMD; and imagery is being processed for Victoria Land at EDC.

*Antarctic Image
Mapping*

The original six-scene LandsatTM data set was expanded by three scenes to cover all of southern Florida. A three-band "green vegetation" combination was selected for lithographic reproduction at 1:500,000-scale. A simple collar with title, external 25,000 meter Universal Transverse Mercator (UTM) grid ticks, locations diagram, bar scale, image index and credit note will also be produced. The final product is scheduled to be completed in the 1st quarter of FY 1995.

*South Florida
Ecosystem Initiative*

*National Aerial
Photography
Program (NAPP)*

This year's production amounted to 64 rolls duplicated, which contained a total of 9,905 frames. Production rate is expected to increase through next fiscal year as more NAPP color photography is being flown to support growing requirements by State and Federal agencies.

*Diapositive
Production*

In support of mapping center requirements, 10,750 diapositives and 8,450 associated paper prints were produced. A total of 71,500 diapositives and associated paper products were produced during FY 1994.

Information & Data Services

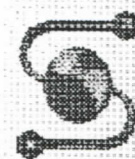
*The National Digital
Cartographic Data
Base (NDCDB) Sales
Data Base*

The National Digital Cartographic Data Base (NDCDB) Sales Data Base was implemented at the Data Center in early June 1994 to serve USGS customers seeking digital cartographic products. The development included the automation of the NDCDB product generation processes. This automation entailed loading all NDCDB data files on the EPOCH optical disc file server, and linking knowledge of the location of these files to the production system. Automating product generation and integrating with EDC's existing computer systems allowed the Division to expand the suite of NDCDB products to several new media including 8 millimeter tape cassettes, 3480 cartridges, and network file transfer protocol delivery. Plans are to add Compact Disc-Recordable (CD-R) product media early in fiscal year 1995. Typical turnaround on product generation ranges from 2 hours to 2 days, depending on the size of the order.

*Internet World
Wide Web*

Internet World Wide Web access to the USGS NDCDB GeoData products was implemented in April 1994. The Home Page (Figure 8) was released as a self-serve tool for USGS customers to learn about NDCDB products and to locate and download GeoData cartographic and topographic data files over the network. NDCDB data featured on the GeoData Home Page include 1:2,000,000-scale DLG, 1:100,000-scale DLG (hydrography and transportation only), 1-degree DEM, and Land Use Land Cover data. By the end of fiscal year 1994, USGS customers were downloading over 70,000 NDCDB data files each month. Figure 9 shows the amount of customer network activity for NDCDB product requests during fiscal year 1994. An innovative series of digital index maps was included, which gave customers the use of their workstation mouse to select USGS quadrangles for downloading. This project was selected as one of Vice President Gore's nominees for the "Heroes of Reinvention" Silver Hammer Award in August for listening to what USGS customers were requesting, and providing an innovative solution to meet their needs.

Document Title: EROS home page

Document URL: <http://sun1.cr.usgs.gov/eros-home.html>

Welcome to the National Mapping Division's EROS Data Center (EDC)

- **General information about EDC**

- ☐ [Who We Are and What We Do](#)
- ☐ [Department of the Interior Mission Statement](#)
- ☐ [U.S. Geological Survey Mission Statement](#)
- ☐ [National Mapping Division Mission Statement](#)
- ☐ [EDC Mission Statement](#)

- **EDC Affiliates**

- ☐ [NASA EOSDIS Land Processes DAAC](#)
- ☐ [EROS/Ames Research Group](#)
- ☐ [World Data Center](#)
- ☐ [National Satellite Data Archive](#)

NDCDB Sales Data Base

Network Activity Report

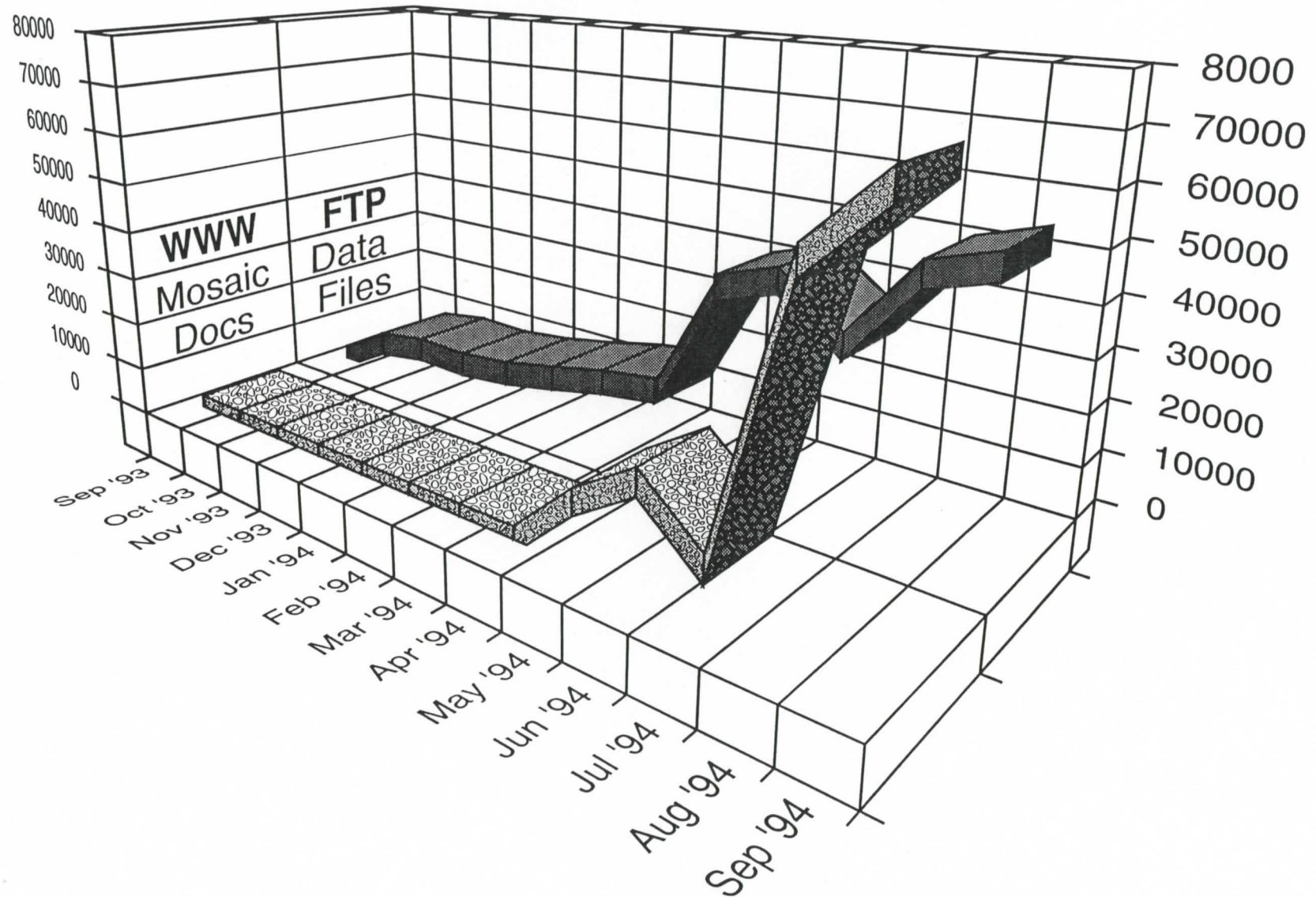


Figure 9

The Global Land Information System (GLIS) was enhanced significantly in fiscal year 1994. A complete Graphical User Interface (GUI), XGLIS Version 2.0, replaced the partial GUI used since March of 1993. Along with that release was the incorporation of the World Wide Web MOSAIC hypertext viewer used for all text files in GLIS. This viewer is stable, easy to use, and is gaining international acceptance. By the end of fiscal year 1994, GLIS was averaging more than 8,000 user sessions each month and had over 5,000 registered users actively using the system. To date, users from over 90 countries have accessed GLIS. The new GUI release was recognized by the Summit of Intergovernmental Enterprise at the Interchange '94 Conference held in Washington D.C., and given the "Best of Open Systems Solution" award for architecture and network implementation. This award was sponsored by several agencies including the Intergovernmental Council on Computer Solutions.

Global Land Information System (GLIS)

A 5-year contract was awarded to Colorcraft Laboratories Inc., an aerial photography mission-support company, to provide film indexing services to the USGS for aerial photography. Many photographic frames added to the USGS film archive in the 1970s and 1980s, prior to current archive requirements that such film be accompanied by geospatial metadata, would remain unsearchable without being indexed and added to the database. The contract provides for photographic frame titling, and the collection of mission, frame, and geospatial location metadata compatible with existing USGS production data bases. The contract effort represents a significant step toward fully automating the query and retrieval of photographic products held within the USGS archive.

Film Indexing Services

Outreach Activities

Project Earthlink, supported by the 13 Federal agencies of the United States Global Change Research Program, conducted a two-part Mid-Continent Regional Planning/Workshop Meeting in Lincoln, Nebraska, during July and November. The November workshop included a national video conference to promote global change awareness and education to six regional sites. EDC staff participated in both meetings, providing instruction in the use of Earth observing satellite imagery data to detect changes of the Earth's surface. Project Earthlink activities will support the National Science and Technology Week program at the annual Earth Day event, April 21-29, 1995, in Washington, D.C.

Project Earthlink

EDC staff participated in several Water Festivals held throughout South Dakota. The Festivals, held on college campuses and conducted under a grant from the U.S. Environmental Protection Agency, are designed to introduce elementary students and their teachers to the dynamics of water, and its relationship to the

Water Festivals

earth-sciences. EDC conducted tutorials regarding the use of satellite images to detect the impacts of water on the Earth's surface. Nearly 10,000 students attended the Festivals.

National Teacher for a Day

Fifteen EDC staff participated in the "National Teacher for a Day" activities at junior and senior high schools in the Sioux Falls, South Dakota area last May. With expertise in earth-science and mapping knowledge, EDC staff assisted students in hands-on problem solving exercises. At one local high school, an EDC computer staff scientist helped a Russian exchange student from Tyumen, Siberia solve a "Point-in-Polygon" problem.

Take Our Daughters to Work Day

Over 40 young women, ages nine-to-15, participated in "Take Our Daughters to Work Day" in a multifaceted experience designed by EDC staff to introduce them to a variety of possible career opportunities in science and technology. The event included a video presentation, tour, hands-on sessions, and presentations by women scientists, technicians, and other professionals at the Center.

Statistical Data

This section summarizes EDC sales and distribution of products and services provided in fiscal year 1994. It also provides information about customer profiles, historical trends, and the contents of the EDC archives and data bases.

Products and Services

In FY 94 EDC produced and distributed over \$7.2 million of products and services. Of this total, \$2.9 million were direct repay sales and \$4.3 million were products and services distributed for USGS/project customers.

	<i>Items</i>	<i>Dollars</i>
Photographic Products	260,568	\$3,257,726
Digital Products/Processing	18,265	3,865,329
Miscellaneous	NA	45,808
Total	278,833	\$7,168,863

The following tables show in more detail the level of activity for products and services provided during FY 94.

EDC Annual Sales Report

Fiscal Year 1994

	DIRECT REPAY CUSTOMERS	USGS/PROJECT CUSTOMERS
PHOTOGRAPHIC DATA		
AERIAL IMAGES		
NAPP	\$1,594,712	\$ 610,340
SLAR	6,990	3,673
Other	354,441	23,601
SATELLITE IMAGES		
Landsat MSS/TM	58,151	42,188
AVHRR	4,635	21,911
Other	5,073	0
Digital Film Recorder Products	2,060	210,376
Other Photographic Data	<u>24,534</u>	<u>295,041</u>
TOTAL PHOTOGRAPHIC DATA	\$2,050,596	\$1,207,130
DIGITAL DATA		
PRODUCTS/PROCESSING		
Digital Data Processing	\$ 1,259	\$1,869,091
SLAR Images	7,648	1,088
Landsat MSS/TM Image Data	591,620	997,190
AVHRR Images	92,590	154,604
NDCDB Data	62,029	9,178
NURE Data	2,320	0
Other Digital Data	<u>19,066</u>	<u>57,646</u>
TOTAL DIGITAL DATA PROCESSING	\$ 776,532	\$3,088,797
MISCELLANEOUS		
Reference Aids	\$ 12,580	\$ 6,055
Other Products and Services	<u>20,841</u>	<u>6,332</u>
TOTAL MISCELLANEOUS	\$ 33,421	\$ 12,387
GRAND TOTAL	\$2,860,549	\$4,308,314
Satellite Data Brokerage Fees	\$ 109,381	\$ 95,407

Product Profile
EDC Photographic Products
Fiscal Year 1994

BLACK-AND-WHITE PRODUCTS		
PRODUCT CATEGORY	ITEMS	DOLLARS
10" Film/Paper	149,087	\$ 982,215
10" Diapositives	36,101	254,305
20" Paper	10,432	181,427
30" Paper	(1)	(27)
40" Paper	5,993	217,472
Other	<u>3,365</u>	<u>63,722</u>
TOTAL	204,977	\$1,699,114
COLOR PRODUCTS		
PRODUCT CATEGORY	ITEMS	DOLLARS
10" Film/Paper	35,043	\$ 876,092
10" Diapositives	6	144
20" Paper	4,247	193,447
30" Paper	(18)	(1,044)
40" Paper	3,704	274,638
Other	<u>12,609</u>	<u>215,335</u>
TOTAL	55,591	\$1,558,612
GRAND TOTAL PRODUCTS	260,568	\$3,257,726

Customer Profile

EDC Photographic Products

Fiscal Year 1994

CUSTOMER CATEGORY	ITEMS	DOLLARS
USGS	130,217	\$1,207,130
OTHER FEDERAL	<u>24,850</u>	<u>431,292</u>
TOTAL FED. GOVERNMENT	155,067	\$1,638,422
STATE/LOCAL GOVERNMENT	29,229	344,486
ACADEMIA	10,357	121,322
INDUSTRY	49,964	854,419
INDIVIDUALS	14,554	276,162
NON-U.S.	<u>1,397</u>	<u>22,915</u>
TOTAL	260,568	\$3,257,726

Customer Profile

EDC Digital Data Products & Processing

Fiscal Year 1994

Digital Data Products

CUSTOMER CATEGORY	ITEMS	DOLLARS
USGS	6,689	\$1,219,706
OTHER FEDERAL	<u>1,308</u>	<u>81,158</u>
TOTAL FED. GOVERNMENT	7,997	\$1,300,864
STATE/LOCAL GOVERNMENT	155	7,131
ACADEMIA	1,546	106,509
INDUSTRY	5,794	391,212
INDIVIDUALS	669	29,117
NON-U.S.	<u>973</u>	<u>160,146</u>
TOTAL	17,134	\$1,994,979

Digital Data Processing

CUSTOMER CATEGORY	ITEMS	DOLLARS
USGS	1,130	\$1,869,091
OTHER FEDERAL	<u>1</u>	<u>1,135</u>
TOTAL FED. GOVERNMENT	1,131	\$1,870,226
STATE/LOCAL GOVERNMENT	0	0
ACADEMIA	(1)	(100)
INDUSTRY	1	224
INDIVIDUALS	0	0
NON-U.S.	<u>0</u>	<u>0</u>
TOTAL	1,131	\$1,870,350

This section describes data archives, both digital and photographic, maintained by EDC to preserve, reference, and distribute remotely sensed, cartographic, and other earth-science data. Several of the data bases reference data held elsewhere that are of interest to USGS customers.

*EROS Data Center
Archives and Data
Bases*

Ending FY 94, the Data Center archived over 10.4 million frames of photographic data and over 179,000 digital tapes. This includes over 2.8 million frames of Landsat photographic data and nearly 80,000 Landsat data tapes.

The following tables show in more detail the status of the EDC archives and data bases.

Data Archive Report As Of October 5, 1994

SUMMARY OF DATA ARCHIVED AT EDC

PHOTOGRAPHIC DATA	FRAMES
AERIAL IMAGES	7,306,646
LANDSAT SATELLITE IMAGES	2,856,047
OTHER SATELLITE IMAGES	250,120
TOTAL	10,412,813

DIGITAL DATA	MAGNETIC TAPES
AERIAL IMAGE DATA	4,470
LANDSAT SATELLITE IMAGE DATA	79,795
OTHER SATELLITE IMAGE DATA	93,228
NDCDB DATA	703
EARTH SCIENCE DATA	978
TOTAL	179,174

Data Archive Report As Of October 5, 1994

PHOTOGRAPHIC DATA ARCHIVED AT EDC

AERIAL PHOTOGRAPHY		
SOURCE	ROLLS	FRAMES
US Geological Survey	17,360	2,589,634
NAPP	9,409	1,424,182
Bureau of Land Management	625	125,048
Bureau of Reclamation	301	60,343
National Park Service	85	14,551
Bureau of Indian Affairs	49	9,913
TOTAL DEPARTMENT OF THE INTERIOR	27,829	4,223,671
Army Map Service	1,682	213,931
US Air Force	3,375	329,933
US Navy	6,393	432,275
Corps of Engineers	86	23,732
TOTAL DEPARTMENT OF DEFENSE	11,536	999,871
Ames Research Center	4,562	580,499
Johnson Space Center	7,632	1,012,642
Other	1,413	125,427
TOTAL NASA	13,607	1,718,568
OTHER SOURCE AGENCIES	2,102	364,536
TOTAL AERIAL PHOTOGRAPHY	55,074	7,306,646

SATELLITE PHOTOGRAPHY		
SOURCE	ROLLS	FRAMES
Landsat MSS 70 mm 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)	2,133	186,903
TOTAL SATELLITE PHOTOGRAPHY	24,154	3,106,167

Data Archive Report As Of October 5, 1994

DIGITAL DATA ARCHIVED AT EDC

SOURCE	MAGNETIC TAPES
AERIAL IMAGE DATA	
NASA Data	
TMS 8-Channel Data	761
TMS 12-Channel Data	656
TIMS 6-Channel Data	317
M2S 11-Channel Data	76
AOCI 10-Channel Data	44
National Park Service	93
Side-Looking Airborne Radar (SLAR)	<u>2,523</u>
TOTAL	4,470
SATELLITE IMAGE DATA	
Landsat MSS/TM digital Data	79,795
AVHRR	
EDC-HRPT Data	26,497
LAC Data Received via DOMSAT	39,741
LAC Data Received From Other Sources	24,020
Federally-Owned Landsat Data (FOLD)	1,225
SPOT Data	303
Department of Defense MSI Data	<u>1,442</u>
TOTAL	173,023
NDCDB DATA	
Digital Elevation Model (DEM)	159
1:2 Million Digital Line Graph (DLG)	8
1:100k DLG; 1:25k LULC; 1 DEG & 24k DEM	<u>536</u>
TOTAL	703
EARTH SCIENCE DATA	
National Uranium Resource Evaluation (NURE)	957
Geophysical Research Program	<u>21</u>
TOTAL	978
TOTAL DIGITAL HOLDINGS	179,174

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