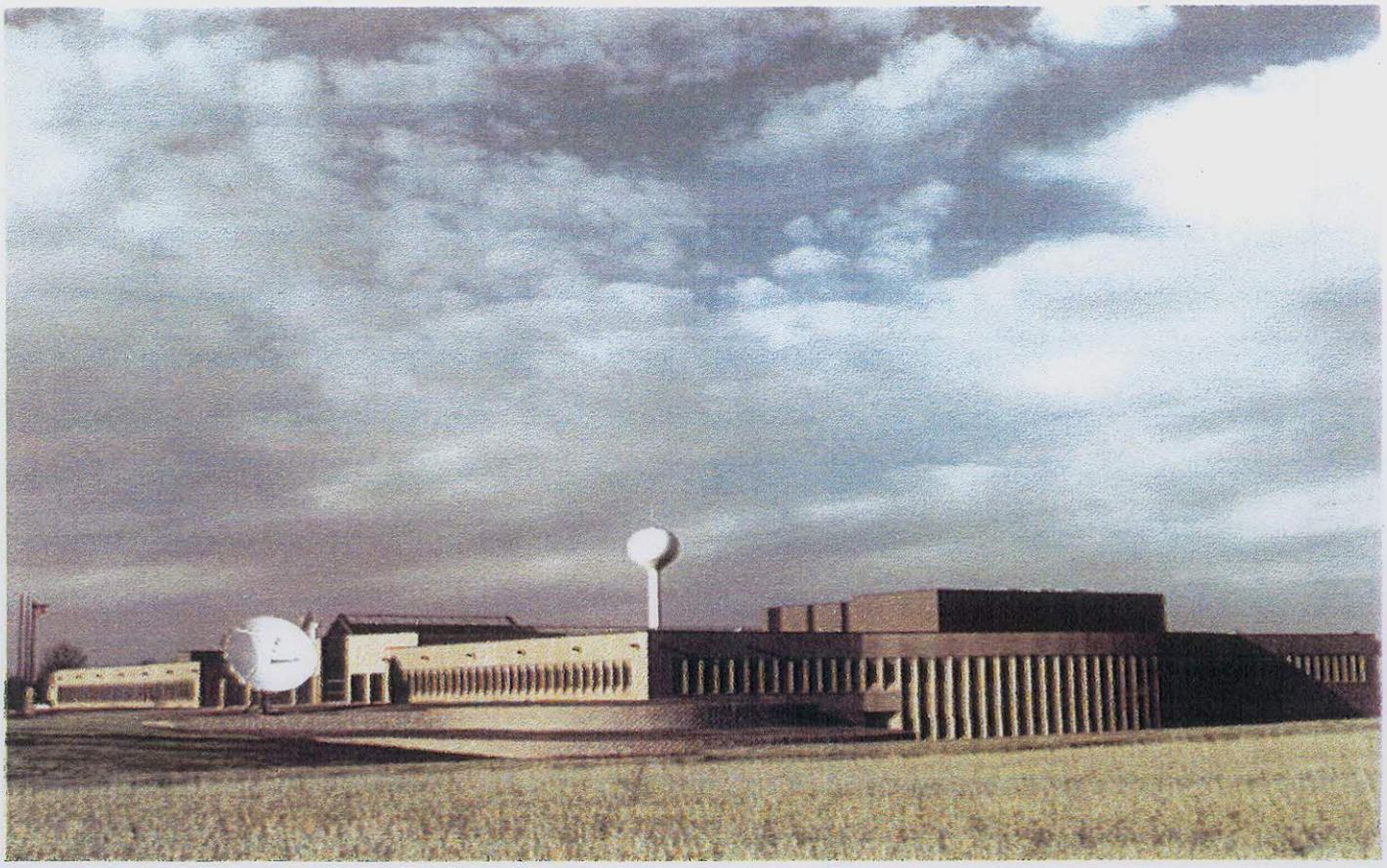


Figure 1. Completed EDC Facility.

Figure 2. Formal Ribbon Cutting.

Land Processes Distributed Active Archive Center (LPDAAC)

EOS Support

DAAC User Services staff processed 299 orders involving a total of 25,967 items for over 16.9 terabytes of data shipped to users during the last quarter of the fiscal year. Of the total items shipped that quarter, 24,098 were for SIR-C Educational CD-ROMs (18,081 for Volume 1 and 6,017 for Volume 2). Requests for SIR-C Educational CD-ROMs continue to arrive via E-mail at the rate of over 100 per day. For the entire fiscal year, DAAC User Services has fulfilled 753 orders involving a total of 39,979 items for over 54 terabytes of data. Electronic (network) distribution of DAAC products for the last quarter involved 8,717 files with a volume of 49 gigabytes. Electronic distribution for the entire fiscal year involved 58,800 files with a volume of 169 gigabytes.

IMS/Client Workshop

In response to a recommendation made by the LPDAAC Science Advisory Panel, the EDC DAAC hosted an IMS/Client Workshop at the EROS Data Center on August 12-13, 1996. The purpose of the workshop was to bring together representatives of the land science user community, expose them to existing operational and prototypical information systems, and gather comments and recommendations regarding key functional capabilities in future information systems. In particular, these recommendations are intended to serve as land science community inputs to the EOSDIS Core System (ECS) Client design.

During the workshop the participants were given the opportunity to use, or view demonstrations of, the Version 0 Information Management System (IMS) X-windows interface, the Version 0 IMS Web Gateway, the prototype USGS GLIS Web interface, the ECS EP-7 web interface, and the ECS funded UNH and UCSB prototypes. Following each system session, participants were given an opportunity to share observations and make recommendations for that system. In general, the participants seemed pleased with the overall direction of the EOS information systems. The group seemed to be particularly impressed and encouraged by the future potential of the ECS EP-7 Web interface. Even though the EP-7 prototype did not offer end-to-end functionality, it did demonstrate the potential power of the new Java technology. At the end of the workshop, the participants were asked to identify those capabilities or features that would be of particular importance or utility in future systems. The DAAC plans to send these recommendations to the ECS Release B Client Development leads on both the government and contractor side.

Aircraft and Radar Data Sets

Aircraft data continue to be received and processed from NASA/Ames Research Center and NASA/Stennis Space Center. A meeting was held at NASA/Jet Propulsion Laboratory (JPL) to discuss the future plans for cooperative work with the Advanced Visible and Infrared Imaging Spectrometer (AVIRIS) program where it was decide that JPL would process all the AVIRIS data to radiance images, which the EDC DAAC will distribute to the general public using a simple tape-copy product generation system.

The Shuttle Imaging Radar-C (SIR-C) processor was installed at the DAAC in mid-August. Operator training was held at JPL in late July and again at the

DAAC in August as part of the integration and checkout of the processor. Installation proceeded smoothly and staff were able to produce the first image product two days after the system was delivered at the DAAC. Testing and operations readiness activities have been proceeding with plans for the system to be operational in the late October or early November timeframe.

NASA and JPL sponsored a workshop in late August for an industry briefing about a new start for a LightSAR program. The program seeks to develop a commercial partnership with NASA to develop and fly the instrument and commercially process and distribute the acquired data. The DAAC group has been asked by NASA and JPL to support the program as an archive and processing center for NASA- and Government-acquired data. The DAAC is currently defining its role in the program in response to a request form JPL for a proposal funded by NASA new-start money in their FY97 budget.

ECS Development Support

The EDC DAAC moved existing EOSDIS Core System (ECS) Interim Release hardware, and installed additional ECS Release 1 hardware, into the new computer room in the new EDC building addition. This work included the completion of all room preparations, such as cooling system, uninterruptible power system, and electrical power receptacle installation. The EDC DAAC is going through significant planning work in preparation for the first phase of major ECS Release B hardware deliveries in November of 1996 and February of 1997, with commensurate new staff arrivals beginning in June of 1997.

Landsat 7 Activities

A Bidder's Conference was held at EDC for the construction tasks required to complete site preparation for the Landsat 7 antenna installation. The tasks which will be completed by mid-November include building the antenna pad and foundation; power from the antenna to the building; a trench or duct for cables between the antenna and the building; and construction of an access road to the antenna site. Construction is scheduled to begin in early October, 1996.

Landsat 7 project staff participated in a workshop entitled "Landsat 7: A User's Perspective" which directly followed the thirteenth Pecora symposium. EDC presentations included Level 0R Characteristics and Processing; Level 1 Processing; Image Assessment System; and EDC DAAC User Interface. Plans have been finalized with NASA regarding the transition, installation, and acceptance criteria for testing the Landsat 7 Processing System. Landsat 7 budgets were discussed and submitted to NASA for fiscal years 1997 and 1998. Landsat 7 project staff hosted several meetings this past quarter including facility and site preparation reviews, operational working groups, and project status reviews with NASA Landsat 7 Project Managers at Goddard Space Flight Center (GSFC).

Significant progress was achieved on the planning, staffing, and deliverables associated with the Landsat 7 Image Assessment System (IAS). Agreement was reached with the Goddard Space Flight Center (GSFC) Science Office on the content of the work to be performed at EDC that includes the Level 1 geometry processing, geometry characterization, and geometry calibration software for the IAS (figure 3), and support of GSFC development activities for integration of the IAS as a whole.

Level 1G Image Generated by IAS Prototype from Level or Data

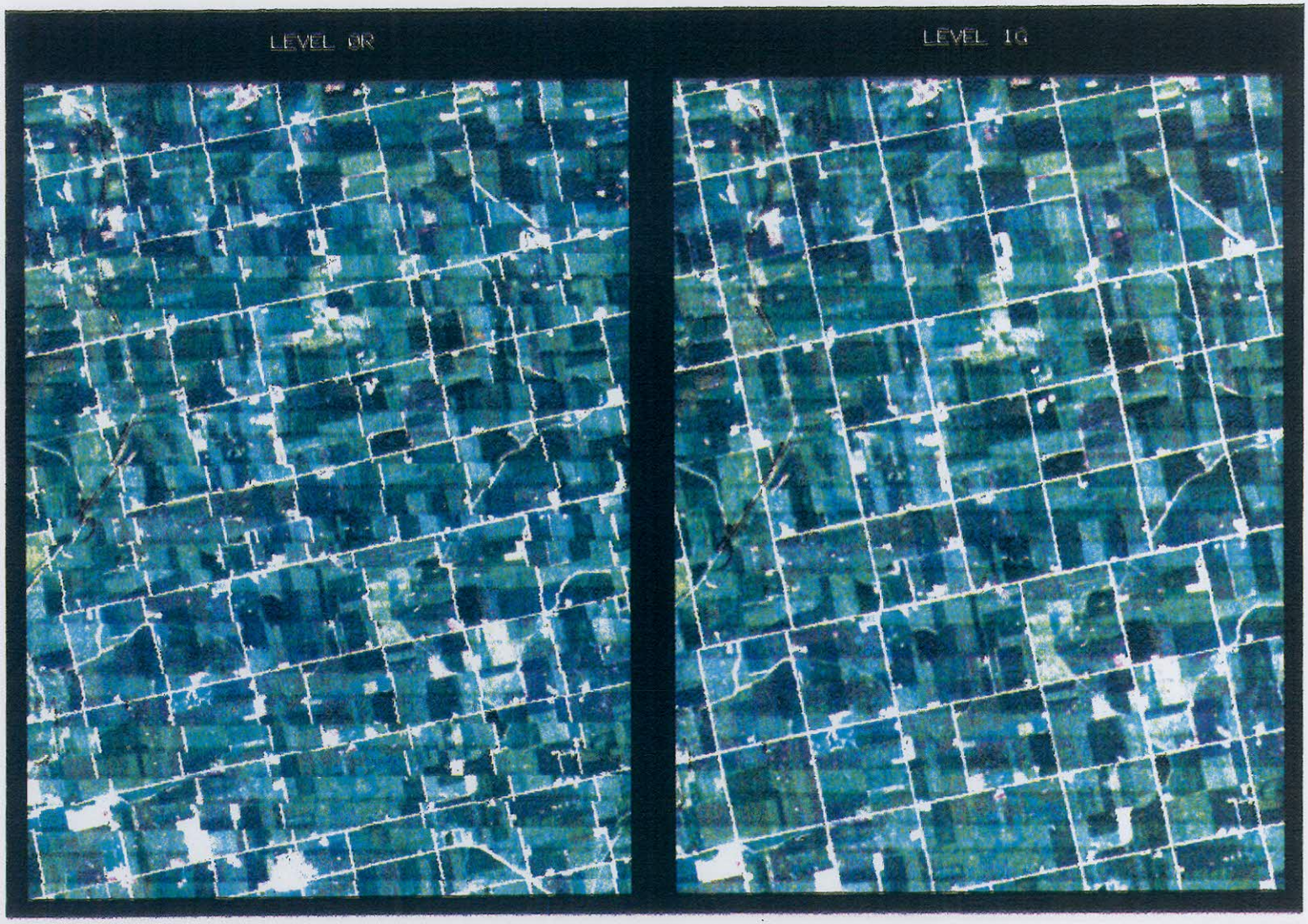


Figure 3

High Performance Computing and Communications

EDC has supported several NASA remote demonstrations of TerraVision. During these demonstrations data stored at EDC were shown on a remote graphics workstation. At the remote site, the data were rendered and displayed using head-mounted display technology. Groups attending the demonstrations include the ATDnet Steering Committee, guests of the Director, GSFC, and conferees at Supercomm'96.

EDC has begun to port satellite image processing software to two high-performance computers. One of the systems is a PowerChallenge Array at the Army Research Laboratory in Aberdeen, MD. This computer consists of 8 SGI Power Challenge SMP (symmetric multiprocessor system, or shared memory system) computers. Each individual system can be utilized as a component node in an 8-node distributed memory system. The PowerChallenge machines are interconnected via high speed I/O devices. EDC will use this system to study the use of SMP architectures. EDC is also porting the software to a Cray J90 computer at GSFC. Staff have some experience porting EDC applications software to Cray Research, Inc. (CRI) supercomputers. Although lower in cost and performance that CRI's high end systems, the J90 system has vector registers and processors. The J90 systems can also be used as an SMP system, which would provide useful comparisons and contrasts between manufactures and architectures. Both of the computers are accessible via the ATM wide-area network.

Information and Data Services

The U.S. GeoData Sales Data Base

Significant expansion of the U.S. GeoData Sales Data Base (formerly referred to as the NDCDB Sales Data Base) occurred with the addition of the 1:24,000-scale Digital Line Graph data and metadata to the archives. These data can now be identified and ordered online through the Global Land Information System, and are being delivered as products on a wide variety of media, including CD-recordable discs and file transfer on the Internet. Linkages were developed between the NMD production centers' operational data bases and the sales data base for planned operational release early in FY1997 which will ensure timely customer access to new Division products.

Internet World Wide Web

Internet World Wide Web access to USGS GeoData products has completed its second year of operation with a record 286,407 GeoData products downloaded at no charge to the customer (figure 4). This represents a significant savings in staff, media, and shipping expenses compared to delivering products the traditional way which would have involved customer services staff, accounting and billing staff and computer time, and media product generation staff and computer systems. The EDC also administers Web servers in support of the International Program, UNEP/GRID, SAST/MOJAVE, DLG-Framework, and the DAAC.

The EDC formed a Web Advisory Group comprised of Web-knowledgeable project and task managers representing all EDC Branches and Programs. This group acts as a catalyst and sponsor for ensuring the top two tiers of EDC's pages are professional in appearance and easy to use. The group has overseen the design of an updated look to these pages which are undergoing internal review for a planned public release early in FY 1997.

Global Land Information System

The Global Land Information System (GLIS), an online directory of data products distributed on behalf of the USGS by the EDC, underwent a significant enhancement in fiscal 1996 with the release of its new World Wide Web user interface, coined WebGLIS. The April release of WebGLIS resulted in the number of customers conducting self-serve product searches increasing from 4,000 per month the first of the year, to over 17,000 by fiscal year's end. The type of customers who use GLIS to search for USGS products has changed over the past year to be almost half commercial and state and local government (figure 5). WebGLIS received three Internet recognition awards since its release for providing a valuable, content-packed resource to network users. Plans are underway to add USGS paper maps, NAPP aerial photography, DOQ's, and DRG's to GLIS in FY 1997.

USGS GEODATA Products

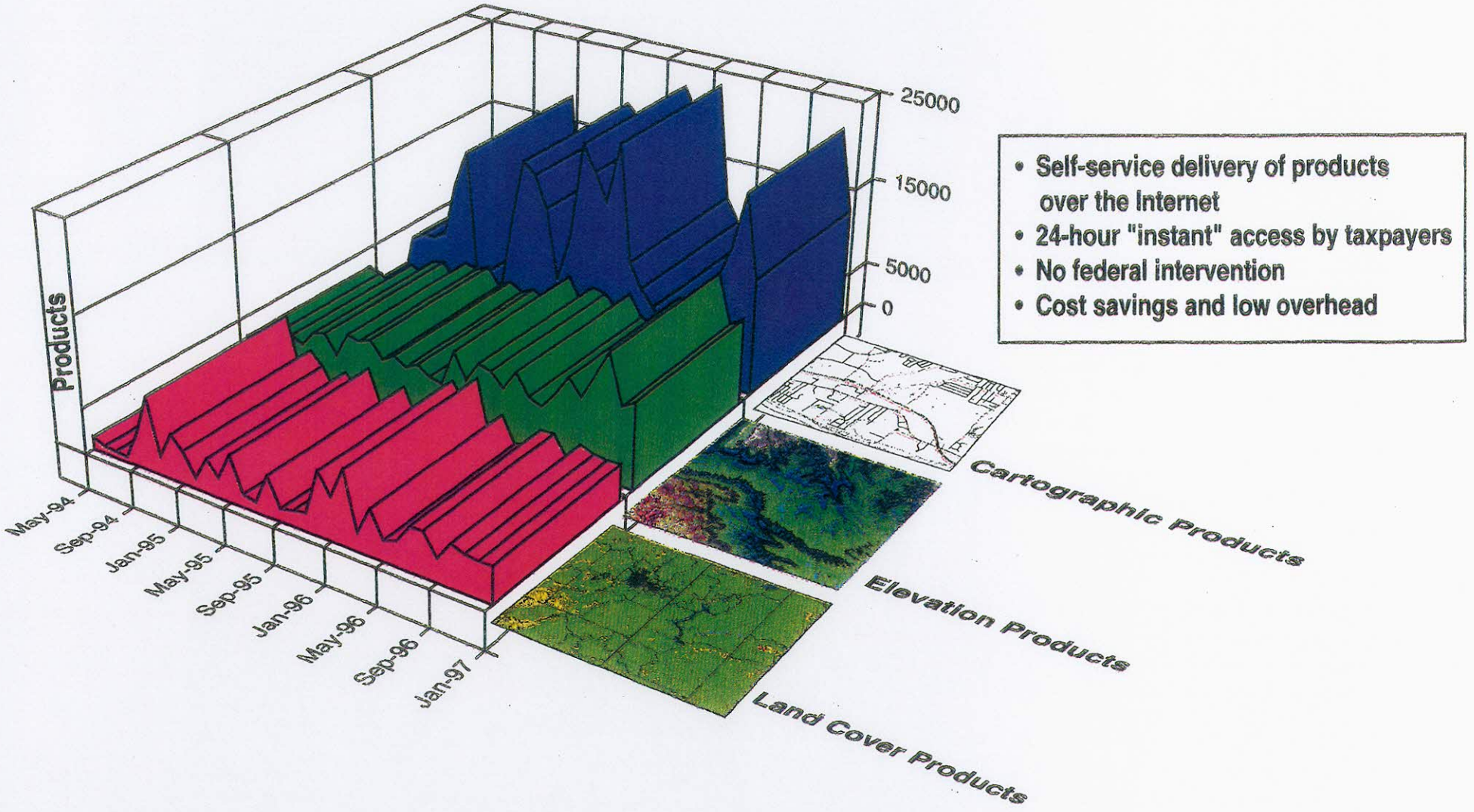


Figure 4

USGS Global Land Information System

Customer Profile for FY 1996

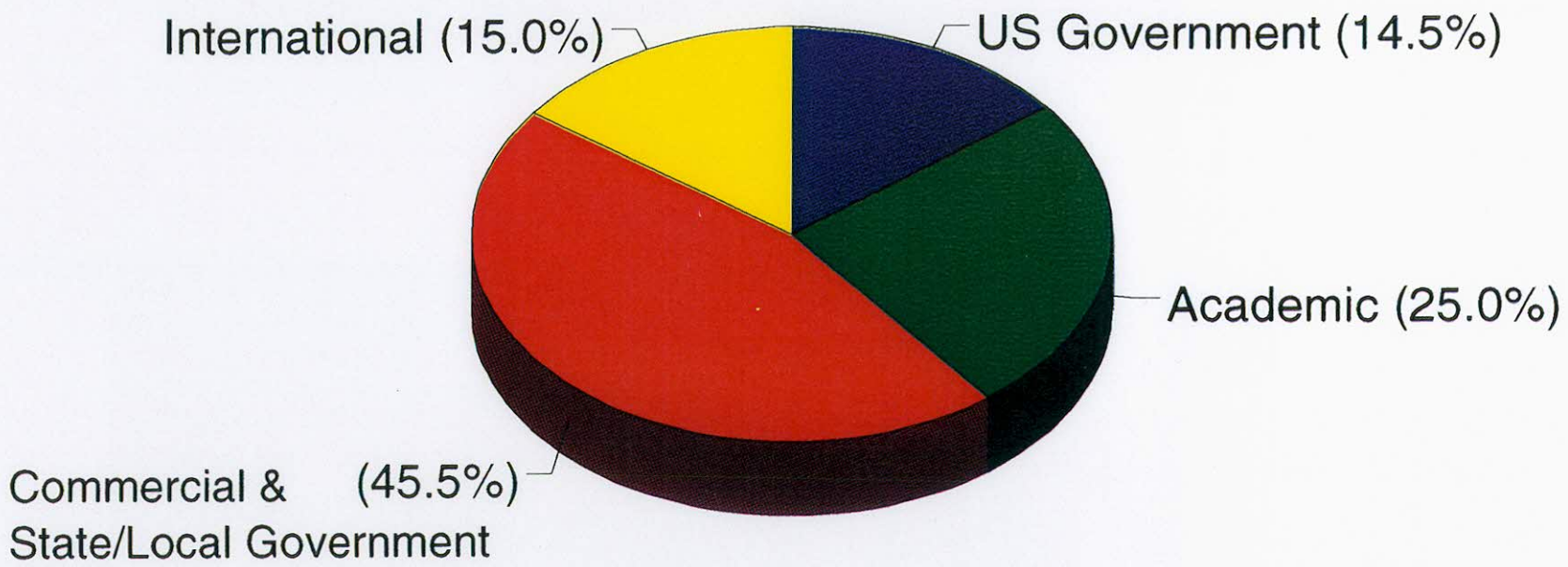


Figure 5. Profile of customers who search for USGS products using the online GLIS system

National Map and Digital Data Production

NAPP Duplication

National Aerial Photography Program (NAPP) film duplication production totaled 258 rolls of color-to-color, 151 rolls of color-to-black and white and 183 rolls of black and white-to-black and white. Color-to-black and white was discontinued in the fourth quarter.

NAPP Contract Support

Significant problems were encountered this year with title transfer on incoming aerial rolls from the flight contractors. To assist in the identification of the problem, EDC provided the NAPP contracting office with an infrared scope and infrared filtered light source to be used during the NAPP original color IR film inspection process. When properly configured into a film viewing table, this equipment will help determine if there is a problem with title-transfer or flaking of the titling ink. This procedure, if implemented, will save the government considerable time and materials if the title-transfer problem is identified before the NAPP film is accepted. Removing titling ink is labor intensive and if it is not removed, it is printed into subsequent photographic working masters which may need to be remade at considerable cost in materials and labor.

Diapositive Production

Support for the Digital Orthophoto Quadrangle (DOQ) program increased significantly though the year. Increasing backlogs pushed due dates for diapositive products to an average of thirty days. Production backlogs during the months of August and September averaged 35,000 - 40,000 frames. Staffing for the year was increased by 2 FTEs to a total of 6 printer operators.

Photographic Laboratory diapositive support for the federal mapping centers during the year included production of 132,903 frames of imagery, consisting of 64,179 diapositives, 51,455 paper prints, 12,336 color film and 4,933 color paper prints. Color production was moved to EDC from the Aerial Photography Field Office (APFO) in Salt Lake which increased that production over last year.

Photo Data Production

The Photographic Laboratory produced a total of 376,502 units; up from the 320,000 produced in FY95. The production for aircraft film and paper included approximately 136,000 frames, 95,000 NAPP duplicates, 133,000 diapositives, along with an additional 6,000 frames of custom and miscellaneous products. Additional equipment was purchased and installed within the Photographic Laboratory. Two Electronic Photo Control (EPC) printers to produce both film and paper standard color customer products have been installed. Both a black-and-white paper processor and a color paper processor have been ordered. A Durst 2501 horizontal digital enlarger was received from the Western Mapping Center. This enlarger will add to the Photographic Laboratory's capability to provide a better product turnaround on large format black & white and color products and more flexibility on custom size enlargements. It will be installed following planned facilities modifications within the lab.

Dissemination was significantly impacted due to increased DAAC CD shipping diapositive production and NLAPS coming on line. Dissemination shipped more

than 3000 DAAC CD's. A contract is now in place to ship DAAC CD's through South Dakota Industries for the Blind. More than 6000 have been shipped through the contract.

Production of Declassified Intelligence Satellite Photography (DISP) increased through the year. Refinements to the production system to provide better quality products continued. Approximate DISP production for the year includes (in frames):

9" Pos Film	420
9" Neg Film	290
9" Std Print	209
9" Custom Print	4
20" Std Print	6
20" Custom Print	14
40" Custom Print	2
Total	**945**

Digital Data Production

Production of systematic products from NLAPS continued throughout the year. The suite of 83 tests required before the release of the full complement of precision products to U.S Government and Affiliated users is nearly complete. The system upgrades and testing should be complete and the full product suite should be released in early October. Total production (in scenes):

	1st Qrtr	2nd Qrtr	3rd Qrtr	4th Qrtr	Total
MSS Systematic	4	0	31	27	**62**
MSS Map-Reg	2	0	1	7	**10**
MSS Terrain Corrected	0	0	0	7	**7**
TM Level 0 Raw	3	0	0	0	**3**
TM Level 1 Radiometric	5	0	0	0	**5**
TM Systematic	188	466	780	883	**2317**
TM Map-Reg	33	24	1	16	**74**
TM Terrain Corrected	0	0	0	10	**10**
Total Production	**235**	**490**	**813**	**950**	**2488**

GLOBE Program

Production in support of the Global Learning to Benefit the Environment (GLOBE) Program, an educational outreach program initiated in 1994 by Vice President Gore, is in full operation. The first set for 2500 schools is complete with 164 additions currently being processed.

The Digital Data Production group is also actively supporting many other Data Center projects including: North American Landscape Characterization, Multi-Resolution Land Characterization (both regional and global), Senegal ecological monitoring, Global Land Cover Test Sites, Humid Tropical Forest Inventory Project, and biodiversity assessment in Madagascar.

Order Inquiry and Processing

Customer-related activities doubled from the previous fiscal year. Total orders were up 15% to 15,413. Total inquiries, not counting contacts through GLIS, were 86,951 which included 44,125 telephone calls, 26,236 pieces of mail, 15,145 facsimiles, and 1,445 emails.

Customer Services continued to test and process orders for Landsat TM data on the National Landsat Archive Production System (NLAPS). The staff received a refresher course on assisting customers with FTP procedures for digital cartographic data products.

Improvements to the on-line tracking system continued throughout the year. This system now includes an on-line telephone memorandum for the staff to use instead of hand writing telephone requests from customers. Customer information from each memorandum is used to update the tracking system. Customer inquires are automatically distributed to a representative for processing, while orders are transmitted directly to an accountant to set-up an account.

Systems Development

NLAPS

The National Landsat Archive Production System (NLAPS) was developed by MacDonald, Dettwiler and Associates under contract to the USGS. The system was delivered to the EROS Data Center and formally accepted in October 1995. This new product generation system provides the EDC with the capability to generate radiometrically and geometrically corrected Thematic Mapper and Multispectral Scanner products, as well as raw full-scene Thematic Mapper products, from the Landsat 1 - 5 data archived at EDC. The NLAPS system has since been upgraded to add similar processing capabilities for data from the French SPOT satellite (Systeme Probatoire de l'Observation de la Terre).

Information Systems

The Global Land Information System (GLIS) is an interactive computer system developed by the USGS for scientists and the general public seeking sources of information about the Earth's land surfaces. Through GLIS, scientist and researchers can evaluate earth science data sets, determine their availability, and place online requests for products. GLIS also offers online digital browse samples of earth science data to allow users to view a data set to evaluate its potential usefulness (figure 6).

Researchers can use GLIS to display outlines of the geographic areas covered by the satellite data sets overlaid on a map background to determine relative locational information. Using digital browse images, users can determine such information as the amount of cloud coverage or the quality of an image prior to ordering the data (see page 5).

The most recent enhancement to the GLIS system is the WebGLIS system. WebGLIS allows the user to interactively search the USGS inventories via the Internet using public domain web browsers. The WebGLIS is unique in that users are able to search the databases using geographic search capabilities and

detailed graphics to view earth science data. The address for WebGLIS is http://edcwww.cr.usgs.gov/webglis.

Cartographic Systems DLG-F Development

Software required to load and provide the National Hydrography Dataset to the Environmental Protection Agency and other data partners was delivered, and EDC staff working with the Rocky Mountain Mapping Center and Mid-Continent Mapping Center tested and prepared to receive data from the EPA. This dataset is a combination of the best aspects of the 1:100,000 scale Digital Line Graph - feature (DLG-F) data and EPA's River Reach. The enhancements include feature specific metadata, 'names' of hydrography features (i.e., Missouri River), as well as up-stream and down-stream flow to support water modeling applications. When loading has been completed there will be approximately 7 million features made available initially in drainage basin units. Staff are in the process of developing and evolving toward a deferred product strategy where these features will be served dynamically out of an on-line seamless database.

Work is proceeding on defining and documenting feature maintenance concepts and strategies. There are steps being taken to support a short term interim approach to enable maintenance of the National Hydrography Dataset, as well as more fully supporting longer term Spatial Data Framework requirements. Staff from EDC, Rocky Mountain Mapping Center, and Mid-Continent Mapping Center are working together to complete the specifications and documentation.

Software required to support conversion of existing and new Digital Line Graph (DLG-3) data to DLG-F is being developed with a planned FY'97 delivery. Staff from EDC, Mapping Application Center, Mid-Continent Mapping Center, and Rocky Mountain Mapping Center are all contributing to the software development and testing effort. This software will enable the USGS to convert existing holdings, as well as new data that are produced during the transition into DLG-F operations.

Research and Applications

Researchers at EDC conduct a variety of projects 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.

Land Cover Characterization

The land cover characterization project has five objectives designed to meet the needs of cooperators who require such data for their environmental assessment and land management programs. These objectives are: (1) develop and validate multi-resolution land cover (MRLC) characteristics data bases for use in a broad range of applications; (2) facilitate the use of land characteristics data in key resource/environmental management, assessment, and research programs; (3) develop and apply data and methods that permit the monitoring

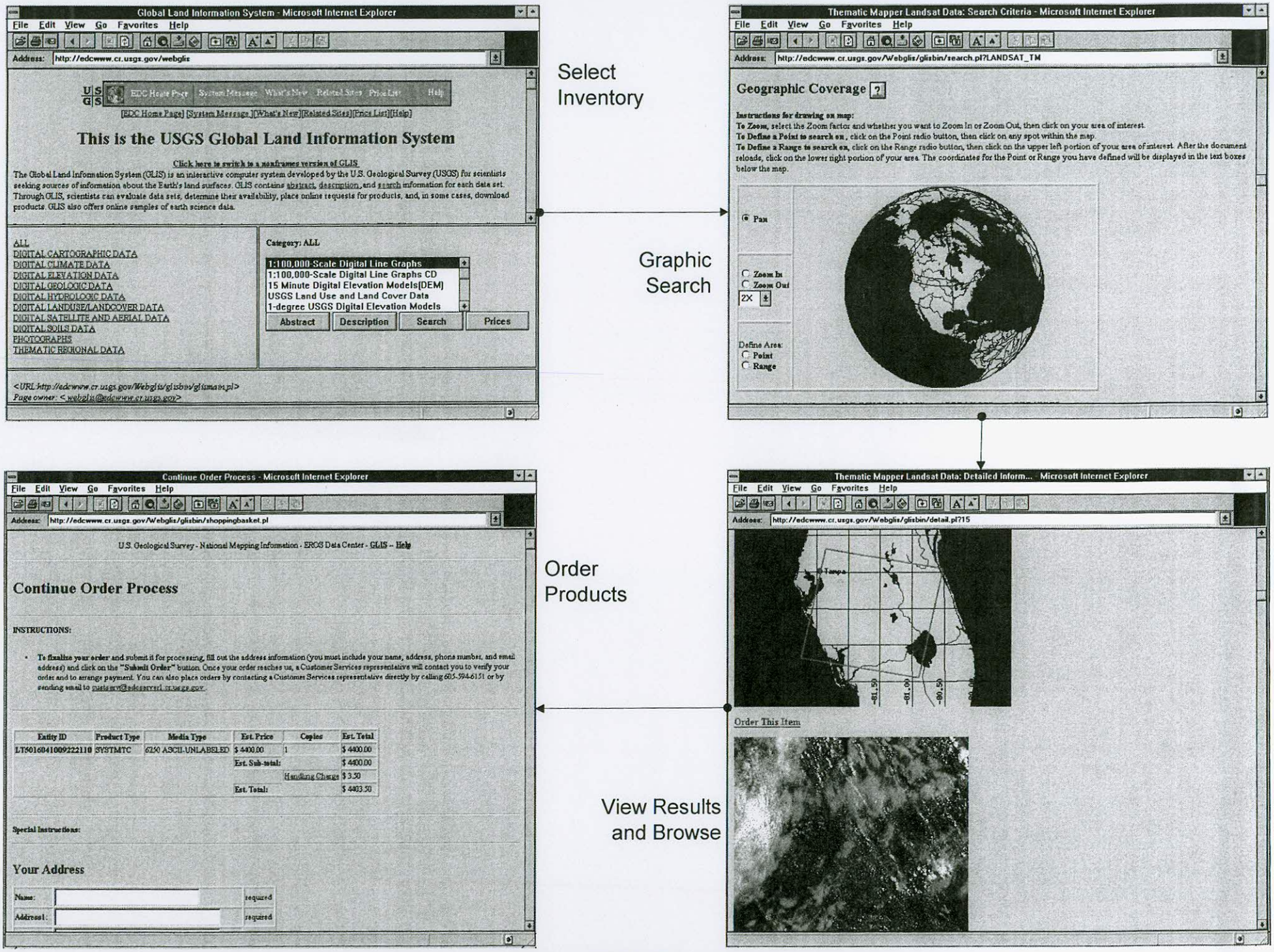


Figure 6. WEBGLIS System

and assessment of landscape changes, including historical changes in land use and cover and near real-time land cover conditions; (4) conduct research on large-area land characterization strategies, landscape monitoring techniques, and change analysis methods; and (5) continually monitor the requirements for historical and contemporary land characteristics data.

The global land cover characterization task team has completed the North American continent data set, and it is available on-line to interested users. Preliminary versions of South America, Africa, and the China-Mongolia portion of Eurasia data sets have been completed. Further refinements were made and the data sets have been made available on a limited basis to interested users. The target date for completion of data bases for all global land masses is July 1997. Plans are currently being developed to carry out a validation of the completed data base, using manual interpretation of TM data as the comparison data set.

Review and revision of the implementation plan for a national 30-meter land cover characteristics data base for the conterminous United States has been completed. The plan calls for the data base to be developed through the combined efforts of the MRLC consortium members and through private sector involvement. The data base is being generated using federal regions as the units for processing. Regions 2 and 3 are complete, and region 4 is in progress. A schedule for completion of the national data base will be developed as collaboration with partners and the private section is defined. A draft work plan and funding from Water Resources Division (WRD) were approved for cooperative land cover mapping of National Water Quality Assessment (NAWQA) Project study units. Because federal regions contain study units within them, part of the strategy is to coordinate regional and NAWQA activities to meet both needs with a single effort. Currently, two study units are being mapped using region 3 land cover data as the starting point.

The North American Landscape Characterization (NALC) project, a cooperative effort between the USGS and EPA, has assembled three decades of georeferenced and terrain-corrected Landsat multispectral scanner (MSS) data for the conterminous United States and Mexico. The data sets, called triplicates, include MSS data for the years 1973, 1986, and 1991, plus or minus 1 year, and also include co-registered DEM data. The data are currently being used by government agencies, educational institutions, and private industry for a variety of applications, including land cover change analysis, biodiversity fluctuations, climatic modeling, deforestation monitoring, and analysis of urban sprawl. Processing has been completed for the 544 triplicates covering the study area, with 174 of the triplicates processed in FY 1996.

The Global Land Information System contains an overview of the NALC project, the processing and product documentation, the production status map, and a list of the Landsat path/rows for which triplicates are available. The same information is accessible on the Internet through the EDC Distributed Active Archive Center home pages on the WWW. These access points were established as part of an active public outreach for the Landsat Pathfinder Program. NALC data are currently available for distribution on 8mm tape, and will be made available on compact disc by mid-1997.

Topographic Studies

In collaboration with the United Nations Environment Programme/Global Resources Information Database (UNEP/GRID) office located at the EDC, hydrologic data bases of flow lines and watershed boundaries were completed for North America and Africa. A watershed-numbering technique was selected and applied to the data bases to facilitate their use in GIS applications.

EDC staff assisted the Director of the USGS, Dr. Eaton, in an analysis of the North American 30 arc-second elevation data set. The work focused on a digital analysis of topographic profiles across the Rocky Mountain front to determine if their respective shapes could be used to infer the relative ages, durations, and rates of uplift in different portions of the Cordillera.

Devil's Lake is a closed drainage basin in the prairie pothole region of northeastern North Dakota. The basin covers about 3,700 square miles. The above-average precipitation which has occurred in the past several years has caused substantial flooding problems, particularly in the lower portions of the basin. The state of North Dakota, the USGS, and several other agencies are in the initial stages of a project to study alternatives for alleviating the current flooding problems and mitigating future flooding. One suggested means of mitigating future flooding is to increase the storage capacity of the upper basin. In order to evaluate the feasibility of this suggestion, highly accurate elevation data are required. A pilot project consisting of 10 quadrangles within the Devil's Lake Basin has been initiated. The National Mapping Division has produced 10 high-resolution DEMs over the pilot study site. Personnel from the WRD and the NMD are working in cooperation with North Dakota state officials to analyze these digital elevation data to determine the accuracy of storage volume estimates and other hydrologic information derived from these high resolution DEMs.

A prototype design and implementation of the elevation data framework was completed and used to assemble a rapid prototype of elevation framework for the Mojave Desert ecosystem area. The resulting data set is a seamless geographic coverage built from multiple sources of elevation information.

USGS Mississippi Basin Carbon Project

A new USGS Global Change project has begun research on the carbon budget in soils and sediments of the Mississippi River basin. The focus is on the effects of land-use change on carbon storage and transport, nutrient cycles, and erosion and sedimentation throughout the Mississippi River Basin. Particular emphasis is placed on understanding the interactions among changes in erosion, sedimentation, and soil dynamics. EDC staff are cooperating with scientists in other USGS divisions to provide spatial analysis of a wide variety of geographic data sets, estimation of whole-basin and sub-basin carbon and sediment budgets, development and implementation of terrestrial carbon-cycle models, and site-specific field studies of relevant processes. The USGS project addresses the importance of the land surface to biogeochemical problems such as the global carbon budget.

Ecological Mapping

In 1996 the USGS became a signatory to a Memorandum of Understanding (MOU) with the U.S. Forest Service (USFS), National Resource Conservation Service (NRCS), Bureau of Land Management (BLM), National Park Service (NPS), National Biological Service (NBS), U.S. Fish and Wildlife Service (USFWS), and the U.S. Environmental Protection Agency (EPA) for the establishment of a Common Spatial Framework of Ecological Units of the United States. The objective is to bring together the Major Land Resource Areas (MLRAs) of the NRCS (formerly Soil Conservation Service), the ECOMAP program of the USFS and the Ecoregion Mapping work of EPA, into a single consistent and hierarchial framework for the entire United States. The USFS, NRCS, BLM, EPA, and USGS have been involved for the past 2 years in reviewing the existing mapping systems and products, discussing methodologies, defining the technical approach, and drafting a work plan for an initial National product at 1:3,500,000 scale. In support of this cooperative activity, EDC hosted an Interagency workshop on "Developing a Spatial Framework of Ecological Units of the United States." The nine participating agencies are: USGS, USFS, NRCS, BLM, USGD, EPA, NPS, USFWS, NBS, and Agricultural Research Services (ARS). This workshop was the first meeting in which representatives of all nine agencies came together to discuss the methods for the actual implementation of the MOU.

Arctic Studies

Clearinghouse Activities

In support of the USGS commitment to the National Spatial Data Infrastructure (NSDI) and to an Alaska Geographic Data Committee (AGDC) defined requirement for an Alaska based data clearinghouse to support Federal, state, local government, and other non-government entities, the AFO established the AGDC Geospatial Data Clearinghouse. Created and managed by the EDC Alaska Field Office (AFO), the AGDC Clearinghouse is now "Federal Geographic Data Committee (FGDC)" endorsed as one of the nine State level clearinghouses established-to-date nationwide. The AGDC clearinghouse was also recognized as one of the top three of those nine at an April 1996 FGDC Clearinghouse meeting in Washington, D.C. The AGDC Clearinghouse will serve as both an on-site repository and distribution center for individual agencies' data, but primarily as a pointing mechanism to agencies that will be serving data from their own systems.

The NBS, USFWS, and AFO have initiated a clearinghouse project that will attempt to bring together and serve all biologic and earth science data gathered over the past 15 years for the Arctic National Wildlife Refuge, with special emphasis on the coastal plain region known as the 1002. The geospatial data will be arranged in a hierarchial framework with small scale, regional type data sets at the higher levels and more detailed, site specific, large scale data sets nested within the different ecological regions. The NBS has funded the activity within its National Biological Information Infrastructure (NBII) program.

Arctic Land Process Studies

Arctic ecosystems are among the most pristine and most fragile ecosystems on earth. The potential for the Arctic to show significant change resulting from changes in the earth's climate is well accepted by the research community. The need to establish a baseline of scientific information is recognized by the USGS Global Change Research program. The AFO Global Change research project continued with cooperative Land Characterization projects with the NPS and NBS. Land cover maps were completed for the Bering Land Bridge and Noatak National Preserves and Izembek National wildlife Refuge. These projects are part of an ongoing effort to build a comprehensive baseline data base of land cover information for Alaska to document long term changes in vegetation community distribution potentially brought on by global climate change. These areas contain many unique habitat conditions which are critical components of the ecology of several rare and endangered wildlife species.

On an international scale, the AFO has taken the lead for North America for the development of a circumpolar vegetation map under the Conservation of Arctic Flora and Fauna (CAFF) initiative involving the eight circumpolar arctic nations. As part of this 4-year international project, AFO scientists, using a vegetation mapping system devised at an international workshop in Arendal, Norway, will integrate vegetation maps produced by a team of United States and Canadian mappers into a single product for North America. The AFO will then work with scientists from Russia and Scandinavian countries to produce a circumpolar composite for the entire arctic region of the globe. Funding for this activity is coming from the USFWS, BLM, and USGS.

Geologic GIS

The USGS Geologic Division and the NMD in Alaska have combined forces to accelerate the rate at which geologic and mineral resource assessment maps produced for Alaska are moved into the digital domain. This activity directly supports the NSDI requirement to create digital geologic spatial data framework layers as well as provide information to the Federal, state, and private user community in support of their GIS applications.

Work initiated in this project includes compilation of the gravity, magnetic, and geologic data for the state of Alaska and the production of a new 1:500,000-scale geologic map of the state. This is a long-term project (7 years) which is divided into three phases. Phase 1 deals with the interior of the state (expected to take 3 years to complete). Phase 2 and Phase 3 deal with the North Slope and South-central/South-east, respectively.

Technique Development Research

Monitoring the Great Plains: Field Study Sites

Field data are necessary to develop and validate new algorithms to map land surface conditions for ecosystems monitoring. Whether mapping a change in land cover resulting from land management practices, or monitoring ecosystems response to climate anomalies, these data provide the means to determine if changes observed by satellites can be linked quantitatively to surface conditions. An example of this is seen when trying to determine how the Normalized Difference Vegetation Index (NDVI) can be used to monitor changes in green

biomass over North American grasslands. For the study illustrated in figure 7, three test sites were chosen to monitor grasslands which vary from cool season to warm season communities. The Nature Conservancy's (TNC's) preserve at Tallgrass, Oklahoma is dominated by warm season species (Southern Flint Hills); TNC's preserve at Niobrara Valley in Nebraska is a mix of warm and cool season grasses (Sand Hills prairie); while the Grasslands National Park in Saskatchewan is dominated by cool season grasses. In collaboration with TNC, Augustana College, North Dakota State University, the University of Nebraska (Lincoln), Oklahoma State University, and the University of Toronto, EDC collected data from these grassland sites, from 1994 to the present. The graph in figure 7 indicates that, for data collected in the summer of 1995, a consistent relationship exists between NDVI and green biomass for data collected at various sites and times. Ultimately, such relationships will be used to map biomass, leaf area index, fractional absorbed photosynthetically active radiation, and green cover fraction over entire the Great Plains using NDVI derived from the Advanced Very High Resolution Radiometer (AVHRR). EDC is partially funded for this study by the Centre National d'Etudes Spatiales (CNES) through the SPOT/4 Vegetation Preparatory Programme.

Change Detection using NALC Image Pairs

More than 20 years of historical Landsat data provide the longest running remotely sensed image archive available for the study of change in land use/management patterns and ecosystem degradation or recovery. A procedure has been developed at EDC to detect and characterize these changes using Landsat MSS or TM data acquired between 10 and 20 years apart. In this procedure, multiple dates of MSS or TM data are co-registered, then transformed to scene-based measures of brightness, greenness, and (in the case of TM) wetness. After transformation, differences in these measures are used to compute vectors for each image pixel, where vectors designate changes in brightness, greenness, and wetness that have occurred between the dates. A signal-to-noise model, developed from scene statistics, is used to isolate areas of significant change. The vector quantities are then encoded using hue, saturation, and value (HSV) for visual interpretation.

This procedure was verified on the ground for scenes acquired over the Modoc National Forest in California. In figure 8, the left two images are false color composites for scenes acquired in 1985 and 1992, while the rightmost image is the HSV-encoded change image. Not only does the change image indicate changes that are easily interpreted from the composites (fires, dry lake beds), it as well indicates a sensitivity to changes that are less easily discerned. In the northern portion of image, purple regions call attention to areas affected by a late spring frost kill which occurred in 1992, while in the south, the effects of an infestation by fir beetles (scolytus ventralis) are suggested in pink tones. Based on this and other test site evaluations, this procedure shows promise for identifying change over other cover types, including urbanization, forest fragmentation, and wetlands transformation.

The Mojave Desert Ecosystem Initiative - a DOI/DOD Partnership

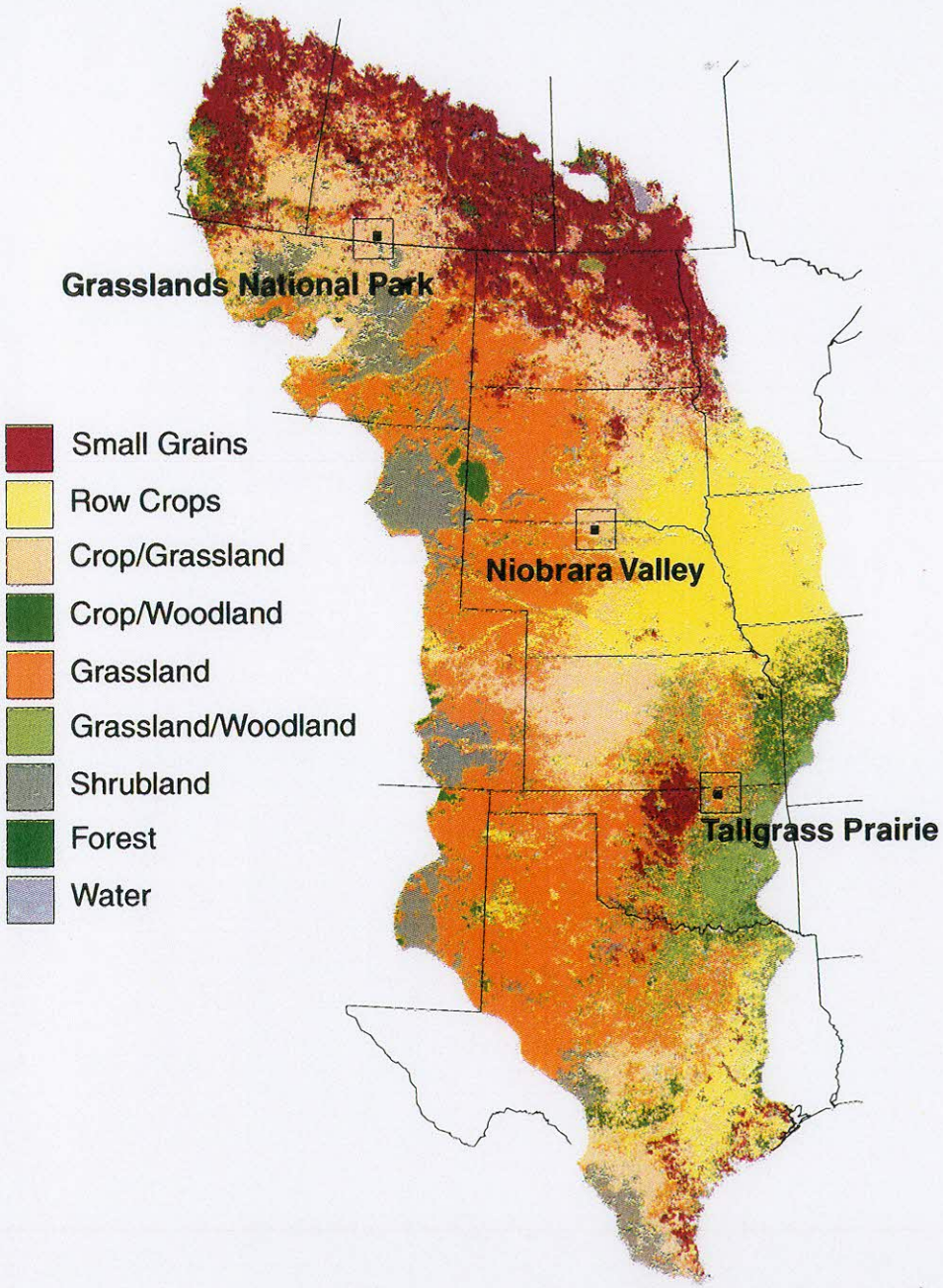
The Mojave Desert Ecosystem Initiative facilitates the sharing of scientifically based data layers in the form of a regional (ecosystem-wide) GIS. To overcome institutional barriers and to ensure the widest access and use of the data, the system makes extensive use of the Internet. Cooperators in the Mojave Desert Ecosystem Initiative are the USGS, BLM, and Utah State University, under the sponsorship of the Department of Defense (DOD) and its Legacy Management Oversight Group. In May 1996, the Mojave Desert Ecosystem Initiative was awarded the National Performance Review's "Hammer Award" for the partnership of DOI and DOD.

Because of the experience with the building of a data base and an Internet server for distributing geospatial data about the Mississippi River flood of 1993 (the Scientific Assessment and Strategy Team (SAST) data base), the EDC staff was asked to participate in the first "jumpstart" phase of the Mojave server. The Mojave server was designed as an NSDI Clearinghouse Node, in compliance with FGDC, and makes use of FGDC's standards and the concepts of framework development. A research project has recently been commissioned for the production of topographic framework data. Topography will be used to calculate various derivatives, such as topographic slope, aspect, basin and drainage delineation, and shaded relief displays.

The USGS National Mapping Division is supplying digital elevation models, digital orthoimages, and satellite imagery (TM), all for distribution via Internet. The Geologic and Water Resources Divisions of the USGS are providing model synthesis and maps depicting soil conditions, erosional and textural change susceptibility, and soil recoverability. Also planned are maps of flow generation/soil-moisture availability under historical precipitation and temperature forcings and changing landscapes. The new Biological Resources Division (formerly the National Biological Service), will be providing a vegetative assessment in 1997.

The first phases of the project have only recently been completed and made available on the web, but public interest in the data holdings and links to other data servers have already made the server quite popular (figure 9). The USGS web development is found at:
http://edcwww2.cr.usgs.gov/homepage/mojave.html. When Internet lines have been established, the permanent URL will be http://mojave.army.mil (figure 10).

Monitoring the Great Plains: Field Study Sites



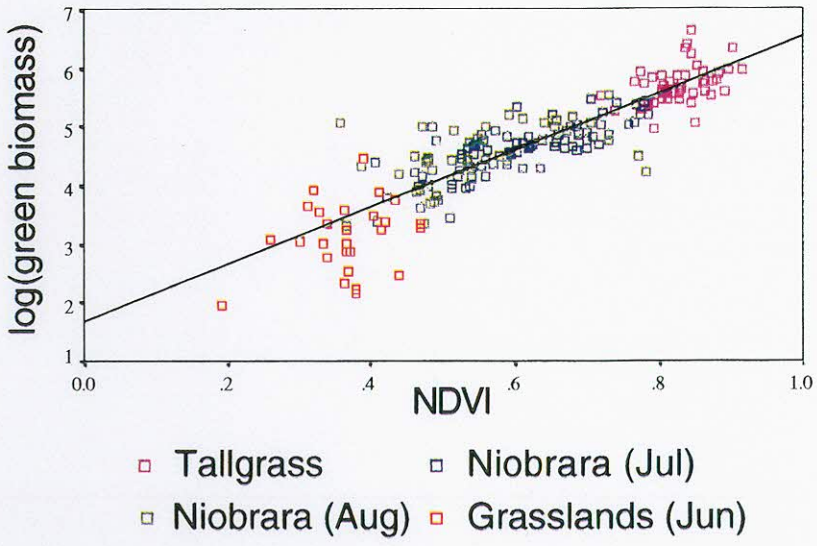


Figure 7. Monitoring the Great Plains: Field Study Sites

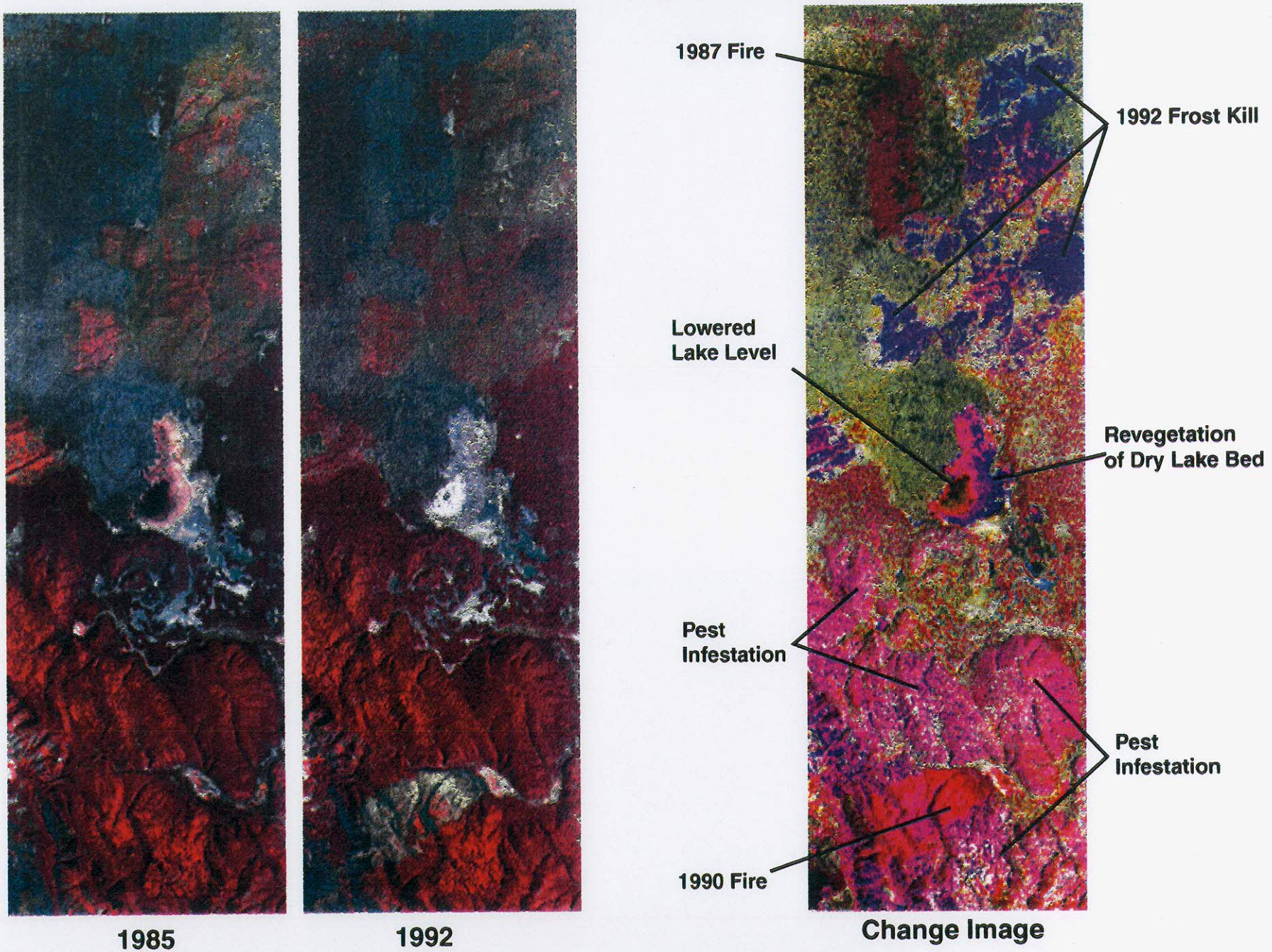


Figure 8. Change Detection using NALC Image Paris

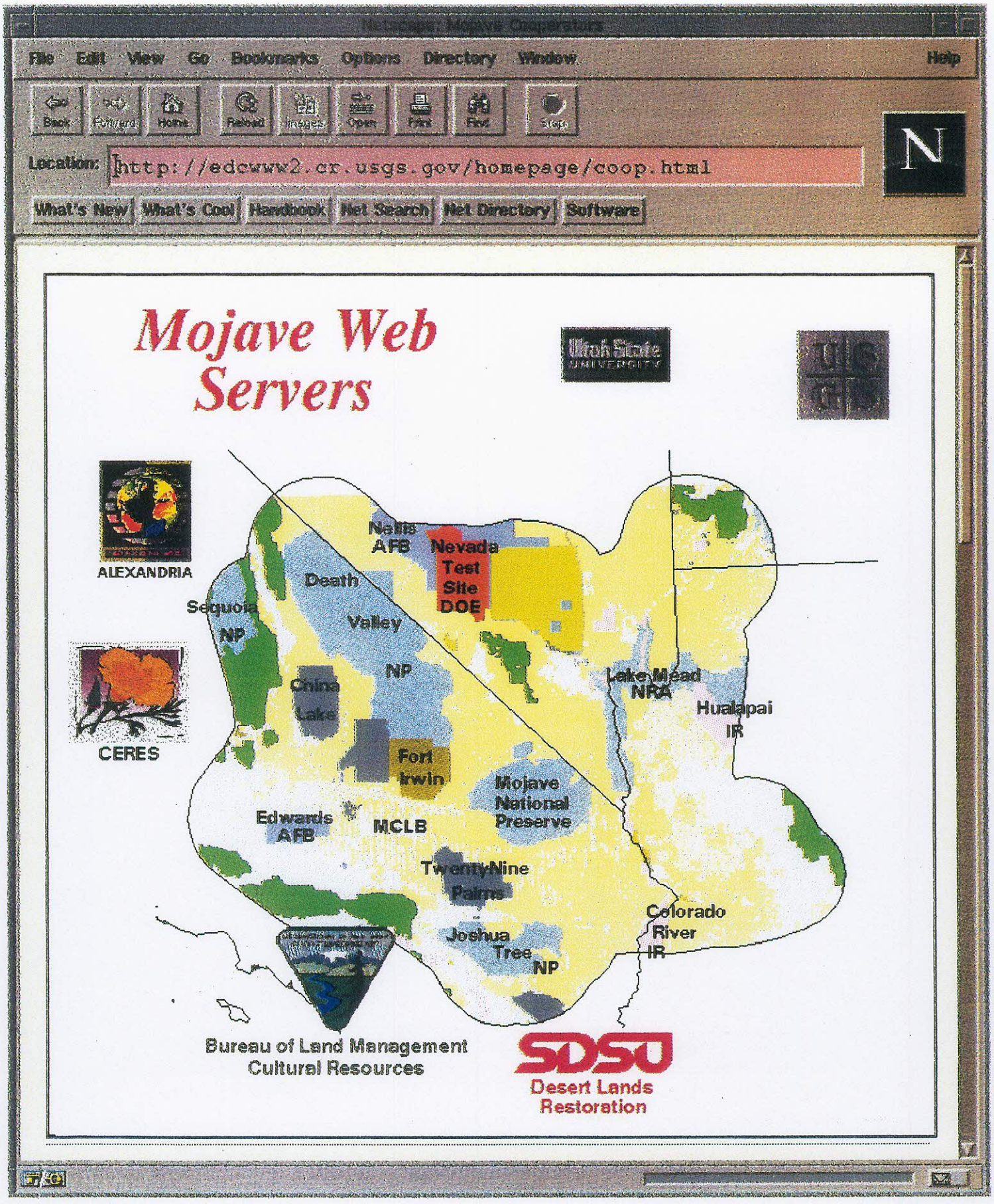


Figure 9. Several Mojave geospatial data servers have been identified, and links are provided from this page.

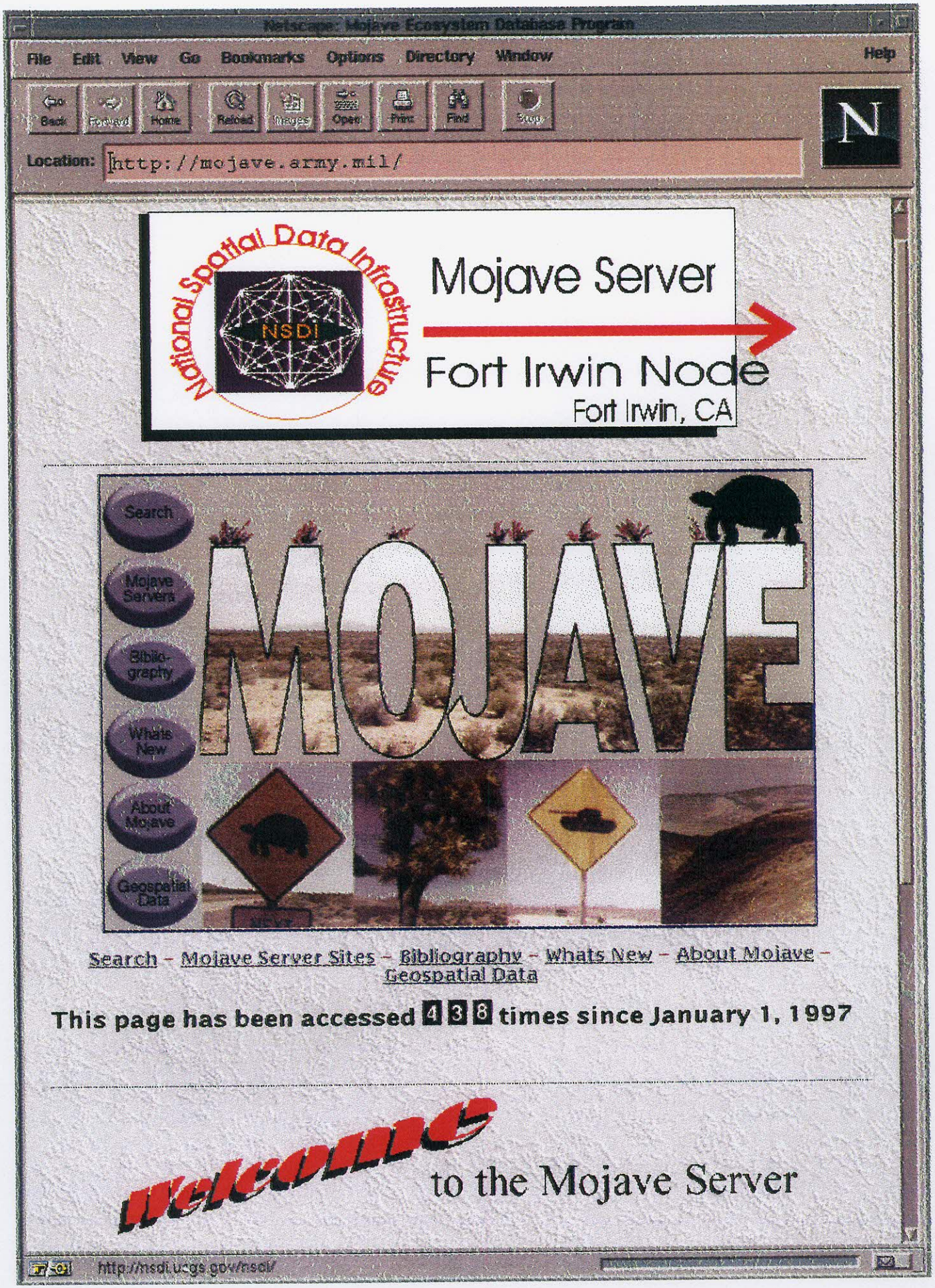


Figure 10. The Mojave homepage will be moved to http://mojave.army.mil.

International Activities

The International Program consists of a variety of projects involving the application of geospatial technology to problems of sustainable development and humanitarian assistance. Most projects are carried out under agreements with missions and offices of the U.S. Agency for International Development (USAID). There is increasing recognition of the value of geospatial information for planning, implementing, and assessing the impact of disaster relief and development assistance, and 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

There is considerable evidence of land degradation throughout Africa, driven by the interplay of changing natural processes and unprecedented human pressures. The present study focuses on 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. In response, the USGS in partnership with the USAID have begun developing a long-term monitoring framework for understanding the rapid changes occurring in Senegal's environment. The monitoring approach integrates the combined strengths of data collection at hundreds of field sites (established in an earlier USAID project in 1982-84, and revisited by EROS Data Center scientists in 1994-96), aerial photography, and satellite remote sensing. Local socioeconomic studies and interviews with rural people add a further dimension, a critical element for better explaining the human dimensions of change.

Close collaboration with EDC's counterpart Senegalese technical institution, the CSE (Ecological Monitoring Center) in Dakar, was a recurring theme throughout the fiscal year. CSE scientists participated in the ongoing effort to revisit field sites, with three campaigns conducted during the course of the year. An aerial video analysis workstation, with frame grabbing capability and custom frame tracking software, was shipped and installed at CSE, following training at EDC of a Senegalese scientist. In December 1995, two EDC scientists conducted a 2-week geographic information system (GIS) training course covering advanced topics in Dakar for CSE staff.

Land use/land cover maps at 1:200,000 scale were completed for a department in Senegal, quantifying changes between 1973 and 1990, based on interpretations and change analyses of Landsat images. The maps and accompanying statistics were presented to the environmental policy group of the Government of Senegal. Advanced spatial modeling efforts were undertaken, based on these land use/land cover change maps. Early results were presented at the Pecora 13 Symposium. Maps of vegetation biodiversity of Senegal were also produced.

A multimedia World Wide Web site was developed for presentation and transfer of the many types of digital geographic data being collected for the project. Bilingual (French and English) text, satellite images, air photos, ground photos, thematic maps, and video loops are featured. The web site has been reviewed by

USAID and Senegalese cooperators, and is planned for opening to the public in FY 1997. It will be accessible through the EDC home page.

Famine Early Warning System

Since 1987, the EDC has provided assistance to the USAID-funded Famine Early Warning System (FEWS) project. EDC provides expert technical assistance in the areas of remote sensing, data management, and GIS technologies. Over the years, the FEWS cooperators (Associates in Rural Development (ARD) of Burlington, Vermont; National Aeronautics and Space Administration (NASA); National Oceanic and Atmospheric Administration (NOAA); and the USGS) have collaborated to generate a great deal of data and information related to famine vulnerability in the Sahelian and southern regions of Africa. These include satellite image products, GIS coverages, and information collected within the FEWS countries including agricultural, rainfall, and commodity price data. In 1996, EDC added a number of data sets to the archive: (1) a Cropland Use Intensity (CUI) map for the entire Sahel region. The CUI map is used in conjunction with the Normalized Difference Vegetation Index (NDVI) data to determine if changes in vegetation vigor are occurring in regions of significant agriculture; (2) a personal computer version of the African digital elevation model (DEM); and (3) a series of 10-day rainfall mean images for the entire continent were generated. FEWS analysts at ARD compare them with rainfall estimates provided every 10-days by NOAA. EDC has the responsibility of long-term archival of all FEWS data and data distribution to cooperators and the public.

To facilitate the distribution of the data, in March 1996, the Africa Data Dissemination Service (ADDS) was released on the Internet, which allows public access to the archived FEWS data. Through October 1, 1996, over 130,000 "hits" were recorded. Internet users may download NDVI images for the entire African continent generated every 10 days by NASA from data collected by NOAA's polar orbiting weather satellites. The ADDS will also compare the current NDVI image with the historical average and display the result. Users may download digital maps, DEMs, and the tabular data related to rainfall, agricultural statistics, and commodity price data collected from various markets in the FEWS countries. Additionally, EDC has developed and makes available (on the ADDS) software designed to analyze and manage these various types of tabular data.The following comment regarding the ADDS was received on August 16, 1996:

> "I work for the International Red Cross and Red Crescent Societies Operations Support Service. For a number of years we have been searching for a useful catalogue of electronic maps, down to the district or provincial level. Thanks to you we now have this resource at our disposal. Thank you very much indeed. You have provided the humanitarian sector with an invaluable tool."
>
> (Christopher Carr: carr@ifrc.org)

Madagascar Protected Area Management Technical Support

The USAID program in Madagascar places an emphasis on the conservation of the many unique species of plants and animals which have evolved on the island. In this context, the USGS provides technical support to Madagascar's National Association for the Management of Protected Areas, ANGAP.

Notable accomplishments during FY 1996 were (1) operational implementation of a fire mapping program to monitor the location and extent of burns with respect to national parks and protected areas; (2) development of a digital, base category, thematic data base for the country from 1:500,000-scale maps provided by Madagascar's national mapping agency (FTM); (3) training of two FTM staff in techniques and tools used by the USGS's National Mapping Division for digital thematic data capture and related map production; (4) completion of a national digital mosaic of Landsat imagery for the entire island (figure 11); and (5) completion of merged Landsat Thematic Mapper (TM) and SPOT panchromatic data image map products for the Isalo Protected Area.

Geographic Information Infrastructure Enhancement in Latin America

The USGS began work under an interagency agreement with USAID's Bureau for Latin America and Caribbean to enhance the geographic information infrastructure of the Western Hemisphere. This support promotes the implementation of Internet capabilities throughout the Western Hemisphere for electronic access to information describing the existence and availability of geospatial data. Concepts and technology of the National Spatial Data Infrastructure have been applied to develop the Inter-American Geospatial Data Network (IGDN) World Wide Web (WWW) site to achieve these objectives.

Western Hemisphere geospatial data producers and users are being brought together by the IGDN. The Internet is used to increase the awareness and accessibility of existing geospatial data for commerce, education, conservation, and government administration. IGDN users are able to search and retrieve metadata to identify data that are suitable for their applications. Public domain software tools enable users to perform queries for data over the Internet using key words and/or geographic coordinates. Figure 12 depicts the IGDN Home Page that can be accessed at the Uniform Resource Locator (URL): http://edcintl.cr.usgs.gov/igdn/igdn.html.

USGS support includes provision of technical assistance to geospatial data organizations interested in participating in the IGDN. Collaboration has been established with partners representing national institutions, local governments, universities, and private enterprises to develop their own servers. These initial collaborators have important collections of geospatial data for sites throughout the Americas, and are located in the United States, Brazil, and Central America. The IGDN server at EDC has been populated with data from the Pan American Institute of Geography and History (PAIGH) Status of Mapping in the Americas and Digital Chart of the World. Internet software was developed to provide the geospatial data search engine, data access and distribution system, and multilingual capabilities for the IGDN.

USAID/Zimbabwe Mission Information System

EDC staff traveled to the Mission of the USAID/Zimbabwe in Harare and installed a digital briefing system and on-line reference library. In addition, EDC staff trained USAID/Zimbabwe personnel in the use and maintenance of the system and how to create and modify hypertext markup language (HTML) documents. The online briefing system and digital reference library can allow the Mission to communicate both within USAID worldwide and to the public regarding the United States development assistance program in Zimbabwe. The digital briefing system and online reference library contains programmatic, budgetary, historical and geographical information about Zimbabwe, the Southern African Region, and the program of United States Government assistance to Zimbabwe. One component of the system is a digital atlas of Zimbabwe and the Southern African region which contains maps for Mission personnel composing digital briefing materials and is accessible through the online reference library.

Final Evaluation of the Sahel Water Data and Management (SWDM) III Project

A five-person team evaluated the effectiveness of the SWDM III Project of the USAID from 1987 to date in supporting the Agronomy-Hydrology-Meteorology (AGRHYMET) Program in the nine countries of the Permanent Interstate Committee against the Drought in the Sahel (CILSS). During the month of September 1996, the team visited USAID officials in Washington, D.C. and World Meteorological Organization officials in Geneva, Switzerland. During 3 weeks in Africa, the evaluation team visited personnel of AGRHYMET, USAID, United States embassies, and other organizations in the nine-country CILSS region. The final report is to be completed in FY 1997.

UNEP/GRID

The North American node of the United Nations Environment Programme/Global Resource Information Database (UNEP/GRID), designated GRID-Sioux Falls, is located at the EDC. The broad objective of GRID-Sioux Falls 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.

Ms. Elizabeth Dowdeswell, Executive Director of UNEP and Under Secretary General; Maurice Strong, Senior Advisor to the President of World Bank, and other representatives from UNEP, the United Nations Development Programme, the USAID, the U.S. Department of State, and the USFS visited GRID-Sioux Falls in March 1996. The meeting provided an opportunity for senior officials from these international agencies to discuss the capabilities, resources, and strengths of a partnership between UNEP and cooperating United States agencies. The meeting also assisted in strengthening United States agencies' relationships with international agencies by addressing environmentally sustainable development issues at the global level. The visit included a breakfast meeting in Sioux Falls, followed by a series of briefings, discussions, and tours at EDC which included a lecture by Ms. Dowdeswell entitled "Information Bridge Between Global Change Research and Sustainable Development."

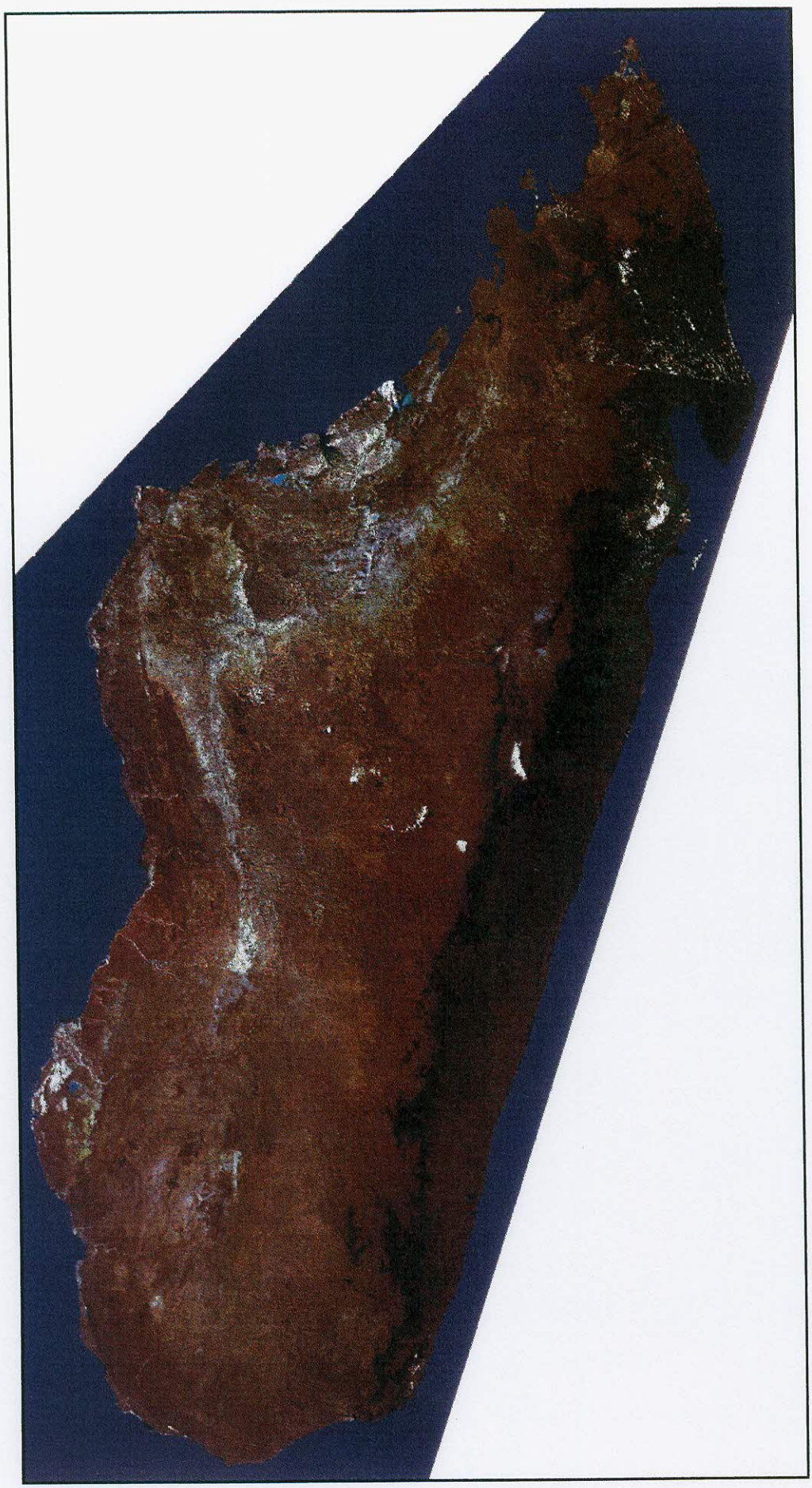


Figure 11. National Landsat Mosaic of Madagascar

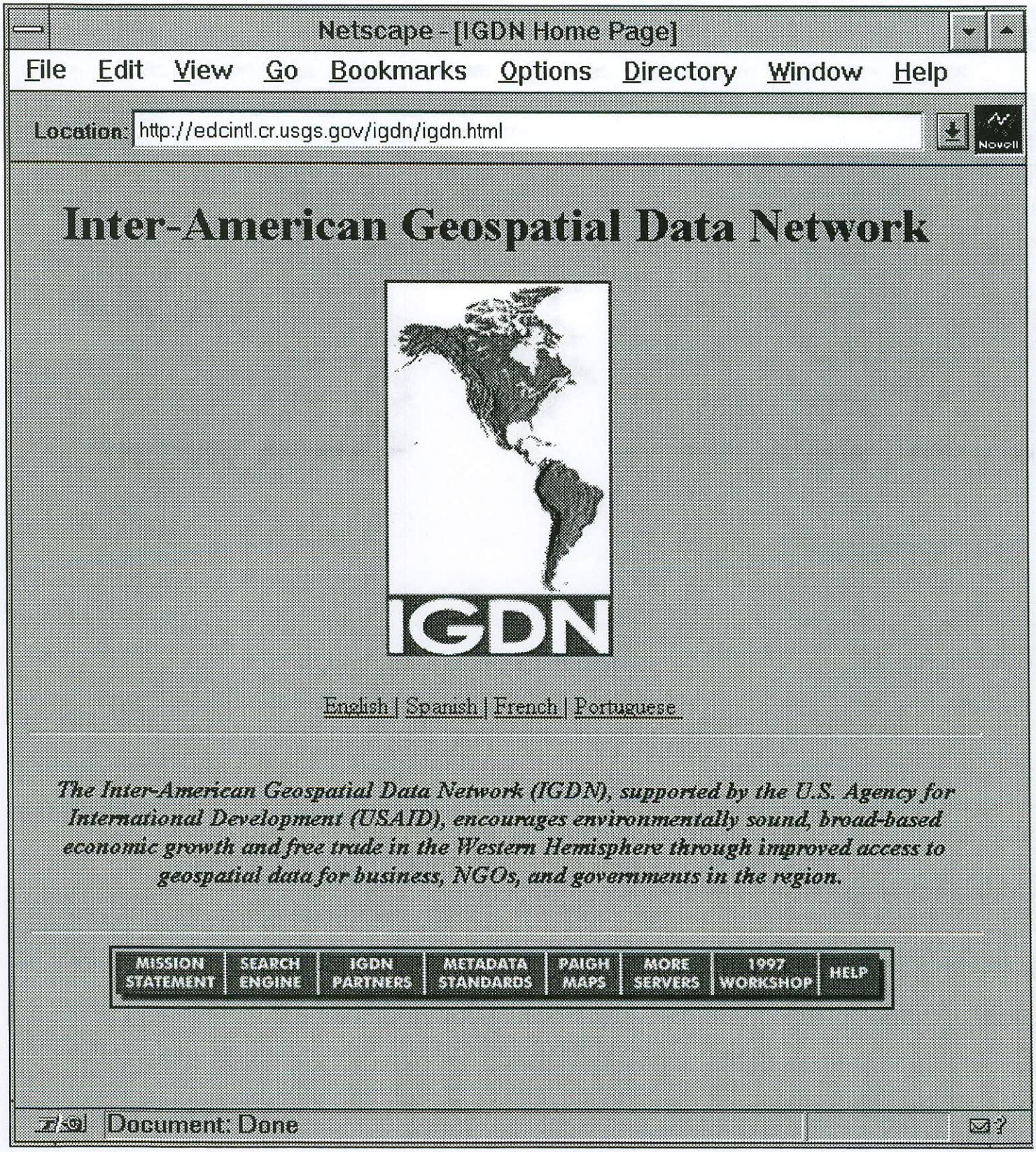


Figure 12. Inter-American Geospatial Data Network.

The Eighth GRID-Sioux Falls Advisory Committee meeting was held in Washington, D.C. on September 17, 1996. Participants included representatives from such agencies as the USFS, USGS, NASA, EPA, and the Department of State. Dr. John Townshend, University of Maryland, has been selected as the new Chairperson of the Advisory Committee. Topics included the current and planned activities of GRID-Sioux Falls and the financial situation of UNEP. One of the recommendations was to distribute more data sets on CD-ROM (Compact Disc-Read Only Memory). The next advisory committee meeting is scheduled for February 1997 in New York City.

The final DEM and drainage basin data sets have been completed for Africa. The DEM for EurAsia is being finalized and work is underway on a drainage basin product. An initial drainage basin product of the Mekong River Basin has been completed.

The GRID-Sioux Falls WWW site has been reorganized. Fact sheets describing major projects have been created for distribution to visitors and to satisfy phone and mail requests. Digital versions of these documents are on the WWW site. The homepage can be reached at http://grid2.cr.usgs.gov. New WWW pages were released linking GRID-Sioux Falls to the 1-km AVHRR and 1-km topographic research and products at EDC. Statistics were created showing the international access to the GRID-Sioux Falls WWW site. The Asian population data sets and documentation compiled by Uwe Deichman at the National Center for Geographic Information and Analysis and Hy Dao at GRID-Geneva were released.

Four visiting scientists from Argentina, India, Uganda, and Kenya worked at the GRID-Sioux Falls this year. Jorge Izaurralde completed his assignment assisting the Land Cover Characterization team in their land cover classification of South America using AVHRR data. The summarized results from this work were presented at the Third International Conference on Integration of Environmental Modeling and GIS.

GRID-Sioux Falls hosted Ms. Gabriela Cuevas-Garcia, a visiting scientist specializing in geographic information systems and digital cartography. Ms. Cuevas-Garcia is from the Geography Institute in Mexico City, Mexico, where she is preparing the digital land use cartography for Mexico. This data set is used in the North American Landscape Characterization project. Her past experience includes updating the cartographic products used in the population census, Mexico City cadastral survey, and the national forest inventory. While at GRID-Sioux Falls, she consolidated the Mexican data and conducted land degradation research incorporating topographic, soils, and population data available through UNEP/GRID.

Outreach Activities

Center staff were involved in major, highly visible outreach events during the year. Logistical, administrative, coordination, and graphic and audio visual support were provided for the April Open House, the 13th Pecora conference, and the formal dedication of the new addition.

With the completion of the addition, the Center again became available for public tours. Over 1200 visitors toured the Center the first three months tours became available. Additionally, the publicity surrounding the larger events created public interest and awareness about Center activities. EDC staff participated in state wide science programs including three Water Festivals (for over 2600 fourth graders), Space Day (for 500 students and teachers), and a series classroom, civic, and service club programs.

The Center's media services group worked on several video projects during the year. A video especially produced for the EDC annual meeting, a 10 minute program about the Center, "EROS: Exploring a Changing Planet", and close captioning of a previously completed video, "Making America's Maps" were all completed during the fiscal year. Production continued on videotapes highlighting the EDC DAAC, the National Satellite Land Remote Sensing Archive, and a project involving monitoring natural resources in Senegal.

The EROS Data Center hosted the thirteenth Pecora conference in August. Over 270 scientists, resource managers, policy planners and educators attended the two and one half day technical meeting. The conference, with the theme "Human Interactions with the Environment: Perspectives from Space", was sponsored by the USGS, NASA, NOAA, EPA, and the U.S. Forest Service, in cooperation with the University of Nebraska, Lincoln, the Consortium for International Earth Science Information Network, the American Society for Photogrammetry and Remote Sensing, and the United Nations Environment Programme, Global Resource Information Database.

Statistical Data

This section summarizes EDC sales and distribution of products and services in fiscal year 1996. It also provides information about customer profiles, historical trends, and the contents of the EDC archives and data bases.

In fiscal year 1996, the EDC produced and distributed more than $8.3 million worth of products and services. Of the total, over $3.9 million were in sales to outside customers and more than $2 million were for products and services provided through EDC cooperative repay projects, for a "reimbursable" total of almost $6 million. The remaining $2.4 million were for products and services distributed to users within the USGS. In addition, more than 1.6 million files of digital cartographic data were distributed at no charge to the customer via the Internet.

The EDC purchased almost $1.3 million worth of satellite data products from commercial satellite operators as a brokerage service for other Federal agencies.

Approximately 125,000 user inquiries were received at EDC during the year (telephone, mail, fax, e-mail, walk-ins, GLIS), and over 20,000 orders were filled.

	Items	Dollars
Photographic products	369,731	$3,868,751
Digital products/processing	177,556	4,345,429
Reference aids	160	14,344
Miscellaneous	16,951	72,503
	564,398	**$8,301,027**

EDC Annual Sales Report
Fiscal Year 1996

	DIRECT REPAY CUSTOMERS	EDC REPAY PROJECTS	USGS CUSTOMERS	TOTAL
PHOTOGRAPHIC DATA				
AERIAL IMAGES				
NAPP	$ 1,613,399	$ 27,781	$ 1,358,120	$ 2,999,299
Other	408,482	607	21,711	430,800
SATELLITE IMAGES				
Landsat MSS	29,477	7,469	4,237	41,183
Landsat TM	150	44,670	691	45,511
Landsat Derivative Products	2,235	13,290	225	15,750
AVHRR	1,637	4,724	11,113	17,474
Declassified Intell. Satellite Photo.	13,978	0	3,505	17,483
Other	2,080	0	0	2,080
Digital Film Recorder Products	440	34,350	100,275	135,065
Other Photographic Data	23,493	41,235	99,377	164,105
TOTAL PHOTOGRAPHIC DATA	**$ 2,095,371**	**$ 174,126**	**$ 1,599,254**	**$ 3,868,750**
DIGITAL DATA PRODUCTS/PROCESSING				
Digital Data Processing	$ 23,111	$ 87,630	$ 3,149	$ 113,889
Custom Processing Charges	156,366	666,444	232,389	1,055,199
Landsat MSS	208,870	505,350	30,030	744,250
Landsat TM	965,759	120,660	95,078	1,181,497
Landsat Derivative Products	9,820	232,920	183,350	426,090
AVHRR Images	64,363	108,751	111,783	284,897
Digital Cartographic Data				
7.5'/15' 30' DEM	217,275	152	55,923	273,350
250k DEM	7,889	0	0	7,889
24k & 15' DLG	18,013	0	12,414	30,427
100k DLG	11,980	0	3,845	15,825
LULC	20	0	0	20
"Large Order" Charges	44,258	90	8,190	52,538
DAAC Products				
SIR-C Educational CD's	210	123,176	4,240	127,626
DAAC Tape Copies	2,210	15,679	210	18,099
Other Digital Data	10,365	3,259	208	13,832
TOTAL DIGITAL DATA PRODUCTS/PROCESSING	**$ 1,740,509**	**$ 1,864,111**	**$ 740,809**	**$ 4,345,429**
MISCELLANEOUS				
Reference Aids	$ 7,094	$ 1,100	$ 6,150	$ 14,344
Other Products and Services	67,682	1,301	3,521	72,503
TOTAL MISCELLANEOUS	**$ 74,776**	**$ 2,401**	**$ 9,671**	**$ 86,847**
GRAND TOTAL	**$ 3,910,656**	**$ 2,040,638**	**$ 2,349,733**	**$ 8,301,027**
Satellite Data Brokerage Fees	**$ 43,120**	**$ 17,569**	**$ 3,382**	**$ 64,070**
Satellite Data Brokerage Sales	**$ 863,019**	**$ 360,772**	**$ 74,641**	**$ 1,298,432**

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

Product Profile
EDC Photographic Products
Fiscal Year 1996

BLACK-AND-WHITE PRODUCTS		
PRODUCT CATEGORY	**ITEMS**	**DOLLARS**
10" Paper	85,705	$ 491,466
10" Film	141,679	964,124
10" Diapositives Paper	16,466	49,398
10" Diapositives Film	16,605	174,545
20" Paper	6,544	137,180
40" Paper	10,256	381,153
Other	2,323	43,656
TOTAL	**279,578**	**$ 2,241,522**

COLOR PRODUCTS		
PRODUCT CATEGORY	**ITEMS**	**DOLLARS**
10" Paper	11,735	$ 208,651
10" Film	52,784	765,471
10" Diapositives Paper	4,931	39,624
10" Diapositives Film	12,336	149,496
20" Paper	2,530	127,993
40" Paper	3,567	270,095
Other	2,283	66,417
TOTAL	**90,166**	**$ 1,627,746**
GRAND TOTAL PRODUCTS	**369,744**	**$ 3,869,268**

Customer Profile
EDC Photographic Products
Fiscal Year 1996

CUSTOMER CATEGORY	ITEMS	DOLLARS
USGS	234,398	$ 1,745,752
OTHER FEDERAL	28,249	379,748
TOTAL FED. GOVERNMENT	**262,647**	**$ 2,125,500**
STATE/LOCAL GOVERNMENT	10,148	155,398
ACADEMIA	13,168	134,796
INDUSTRY	66,984	1,144,212
INDIVIDUALS	13,771	277,014
NON-U.S.	3,013	31,831
TOTAL	**369,731**	**$ 3,868,751**

Customer Profile
EDC Digital Data Products & Processing
Fiscal Year 1996

Digital Data Products *		
CUSTOMER CATEGORY	**ITEMS**	**DOLLARS**
USGS	53,452	$ 1,615,308
OTHER FEDERAL	7,215	312,373
TOTAL FED. GOVERNMENT	**60,667**	**$ 1,927,681**
STATE/LOCAL GOVERNMENT	3,723	34,739
ACADEMIA	6,865	192,005
INDUSTRY	88,765	528,101
INDIVIDUALS	11,742	124,084
NON-U.S.	2,464	369,731
TOTAL	**174,226**	**$ 3,176,340**

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

Digital Data Processing *		
CUSTOMER CATEGORY	**ITEMS**	**DOLLARS**
USGS	773	$ 989,612
OTHER FEDERAL	2,557	179,477
TOTAL FED. GOVERNMENT	**3,330**	**$ 1,169,089**
STATE/LOCAL GOVERNMENT	0	0
ACADEMIA	0	0
INDUSTRY	0	0
INDIVIDUALS	0	0
NON-U.S.	0	0
TOTAL	**3,330**	**$ 1,169,089**

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

Archives and Data Bases

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

As of the end of fiscal year 1996, the Data Center has archived over 11.7 million frames of photographic data and over 156,000 digital tapes. This included more than 2.8 million frames of Landsat photographic data and nearly 86,000 Landsat data tapes. The international Landsat Data Base maintained by EDC referes to nearly 1 million Landsat scenes archived in the United States, and over 2.6 million scenes of Landsat data held by foreign ground stations.

Data Archive Report
As of October 23, 1996

SUMMARY OF DATA ARCHIVED AT EDC

PHOTOGRAPHIC DATA	ROLLS	FRAMES
AERIAL IMAGES	57,143	7,620,426
LANDSAT SATELLITE IMAGES	21,260	2,856,047
OTHER SATELLITE IMAGES	20,998	1,268,903
TOTAL	**99,401**	**11,745,376**

DIGITAL DATA	MAGNETIC TAPES	SCENES/ FILES
AERIAL IMAGE DATA	4,469	10,261
LANDSAT SATELLITE IMAGE DATA	85,548	1,080,828
OTHER SATELLITE IMAGE DATA	62,698	135,322
DIGITAL CARTOGRAPHIC DATA	63,048	169,266
EARTH SCIENCE DATA	978	7,941
TOTAL	**217,741**	**1,403,578**

* Includes approximately 1,080,828 Landsat scenes and 131,779 AVHRR scenes.

Data Archive Report
As of October 23, 1996

PHOTOGRAPHIC DATA ARCHIVED AT EDC

AERIAL PHOTOGRAPHY		
SOURCE	**ROLLS**	**FRAMES**
U.S. Geological Survey	17,351	2,587,425
NAPP	11,123	1,688,973
Bureau of Land Management	625	125,042
Bureau of Reclamation	302	60,397
National Park Service	85	14,551
Bureau of Indian Affairs	49	9,913
TOTAL DEPARTMENT OF THE INTERIOR	**29,535**	**4,486,301**
Army Map Service	1,711	216,622
U.S. Air Force	3,367	333,897
U.S. Navy	6,440	434,375
Corps of Engineers	82	22,924
TOTAL DEPARTMENT OF DEFENSE	**11,600**	**1,007,818**
Ames Research Center	4,838	614,495
Johnson Space Center	7,632	1,012,642
Other	1,407	131,889
TOTAL NASA	**13,877**	**1,759,026**
OTHER SOURCE AGENCIES	**2,131**	**367,281**
TOTAL AERIAL PHOTOGRAPHY	**57,143**	**7,620,426**

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)	2,846	259,616
Declassified Intelligence Satellite Photography	17,391	946,070
TOTAL SATELLITE PHOTOGRAPHY	**42,258**	**4,124,950**

Data Archive Report
As of October 23, 1996

DIGITAL DATA ARCHIVED AT EDC

SOURCE	MAGNETIC TAPES	SCENES/ FILES
AERIAL IMAGE DATA		
NASA Data		
TIMS / NS001	1,732	7,323
M2S 11-Channel Data	76	N/A
AOCl 10-Channel Data	44	N/A
National Park Service	94	N/A
Side-Looking Airborne Radar (SLAR)	2,523	2,938
TOTAL	**4,469**	**10,261**
SATELLITE IMAGE DATA		
Landsat MSS/TM Digital Data	86,548	1,080,828
AVHRR		
EDC-HRPT Data	19,398	34,734
LAC Data Received via DOMSAT	22,521	50,040
LAC Data Received from Other Sources	13,160	47,005
SPOT Data	372	365
Department of Defense MSI Data	7,247	3,178
TOTAL	**149,246**	**1,216,150**
USGS GEO DATA (Digital Cartographic Data)	**QUADS**	**PRODUCTS**
7.5" Digital Elevation Model (DEM)	35,636	38,895
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	21,388
1:2M Digital Line Graph (DLG)	49	323
Land Use Land Cover (LULC)	521	2,749
TOTAL	**63,048**	**169,226**
EARTH SCIENCE DATA		
National Uranium Resource Evaluation (NURELUB)	957	7,941
Geophysical Research Program	21	N/A
TOTAL	**978**	**7,941**
TOTAL DIGITAL HOLDINGS	**217,741**	**1,403,578**

N/A = Information not Available.

Selected Research and Technical Publications

Acevedo, W., Foresman, T, and Buchanan, J., 1996, Origins and philosophy of building a temporal database to examine human transformation processes, in ASPRS/ACSM Annual Convention and Exhibition, Baltimore, Maryland, April 1996, Proceedings: v. I, p. 148-161.

Anthony, M., and Klaver, J., 1996, The inter-american geospatial data network: a multilingual WWW geospatial data distribution system (abs.), in Annual USGS National Computer Technology Meeting, Eighth, Rancho Mirage, California, May 1996: U.S. Geological Survey Open-File Report 96-204 [Internet URL: http://wwwqvarsa.er.usgs.gov/NCTM96/ofr/].

Austad, J., Faundeen, J., Larsen, D., and Madigan, M., 1996, National Satellite Land Remote Sensing Data Archive Landsat Multispectral Scanner Data CD-ROM, at Pecora 13 Symposium, Human Interactions with the Environment: Perspectives From Space, Sioux Falls, South Dakota, August 1996.

Boncyk, W., Markham, B., Barker, J., and Helder, D., 1996, Artifact correction and absolute radiometric calibration techniques employed in the Landsat-7 image assessment system, in International Geoscience and Remote Sensing Symposium, Lincoln, Nebraska, May 1996, Proceedings: Picataway, New Jersey, Institute of Electrical and Electronics Engineers, Inc., v. II, p. 1273-1275.

Clark, S. C., Starr, J., Foresman, T., Acevedo, W., and Solomon, C., 1996, Development of the temporal transportation database for the analysis of urban development in the Baltimore-Washington region, in ASPRS/ACSM Annual Convention and Exhibition, Baltimore, Maryland, April 1996, Proceedings: v. III, p. 77-88.

Clarke, K., Gaydos, L., and Hoppen, S., 1996, Methods and techniques for rigorous calibration of a cellular automation model of urban growth, in National Center for Geographic Information Analysis (NCGIA) International Conference/Workshop on Integrating GIS and Environmental Modeling, Third, Santa Fe, New Mexico, January 1996, Proceedings: CD-ROM, 1 disc [Disc contains a Readme file].

Crawford, J., Acevedo, W., Foresman, T., Buchanan, J., and Prince, W., 1996, Developing a temporal database of urban development for the Baltimore/Washington region, in ASPRS/ACSM Annual Convention and Exhibition, Baltimore, Maryland, April 1996, Proceedings: v. III, p. 101-110.

Dwyer, J., Sayler, K., and Zylstra, G., 1996, Landsat pathfinder data sets for landscape change analysis, in International Geoscience and Remote Sensing Symposium, Lincoln, Nebraska, May 1996, Proceedings: Picataway, New Jersey, Institute of Electrical and Electronics Engineers, Inc., v. 1, p. 547-550.

Dwyer, J. L., Kruse, F. A., and Lefkoff, A. B., 1995, Effects of empirical versus model-based reflectance calibration on automated analysis of imaging spectrometer data: a case study from the Drum Mts., Utah: Photogrammetric Engineering and Remote Sensing, Falls Church, Virginia, American Society for Photogrammetry and Remote Sensing, v. 61, no. 10, October 1995, p. 1247-1254.

Selected Research and Technical Publications

Acevedo, W., Foresman, T, and Buchanan, J., 1996, Origins and philosophy of building a temporal database to examine human transformation processes, in ASPRS/ACSM Annual Convention and Exhibition, Baltimore, Maryland, April 1996, Proceedings: v. I, p. 148-161.

Anthony, M., and Klaver, J., 1996, The inter-american geospatial data network: a multilingual WWW geospatial data distribution system (abs.), in Annual USGS National Computer Technology Meeting, Eighth, Rancho Mirage, California, May 1996: U.S. Geological Survey Open-File Report 96-204 [Internet URL: http://wwwqvarsa.er.usgs.gov/NCTM96/ofr/].

Austad, J., Faundeen, J., Larsen, D., and Madigan, M., 1996, National Satellite Land Remote Sensing Data Archive Landsat Multispectral Scanner Data CD-ROM, at Pecora 13 Symposium, Human Interactions with the Environment: Perspectives From Space, Sioux Falls, South Dakota, August 1996.

Boncyk, W., Markham, B., Barker, J., and Helder, D., 1996, Artifact correction and absolute radiometric calibration techniques employed in the Landsat-7 image assessment system, in International Geoscience and Remote Sensing Symposium, Lincoln, Nebraska, May 1996, Proceedings: Picataway, New Jersey, Institute of Electrical and Electronics Engineers, Inc., v. II, p. 1273-1275.

Clark, S. C., Starr, J., Foresman, T., Acevedo, W., and Solomon, C., 1996, Development of the temporal transportation database for the analysis of urban development in the Baltimore-Washington region, in ASPRS/ACSM Annual Convention and Exhibition, Baltimore, Maryland, April 1996, Proceedings: v. III, p. 77-88.

Clarke, K., Gaydos, L., and Hoppen, S., 1996, Methods and techniques for rigorous calibration of a cellular automation model of urban growth, in National Center for Geographic Information Analysis (NCGIA) International Conference/Workshop on Integrating GIS and Environmental Modeling, Third, Santa Fe, New Mexico, January 1996, Proceedings: CD-ROM, 1 disc [Disc contains a Readme file].

Crawford, J., Acevedo, W., Foresman, T., Buchanan, J., and Prince, W., 1996, Developing a temporal database of urban development for the Baltimore/Washington region, in ASPRS/ACSM Annual Convention and Exhibition, Baltimore, Maryland, April 1996, Proceedings: v. III, p. 101-110.

Dwyer, J., Sayler, K., and Zylstra, G., 1996, Landsat pathfinder data sets for landscape change analysis, in International Geoscience and Remote Sensing Symposium, Lincoln, Nebraska, May 1996, Proceedings: Picataway, New Jersey, Institute of Electrical and Electronics Engineers, Inc., v. 1, p. 547-550.

Dwyer, J. L., Kruse, F. A., and Lefkoff, A. B., 1995, Effects of empirical versus model-based reflectance calibration on automated analysis of imaging spectrometer data: a case study from the Drum Mts., Utah: Photogrammetric Engineering and Remote Sensing, Falls Church, Virginia, American Society for Photogrammetry and Remote Sensing, v. 61, no. 10, October 1995, p. 1247-1254.

Dwyer, J. L., 1995, Mapping tide-water glacier dynamics in East Greenland using Landsat data: Journal of Glaciology, v. 41, no. 139, p. 584-595.

Eidenshink, J. C., Madigan, M. E., and Weinheimer, M. C., 1996, 1989 conterminous U.S. AVHRR biweekly composites, EROS Data Center, U.S. Geological Survey CD-ROM set, 6 discs [Each disc contains a Readme file].

Eidenshink, J., and Oleson, L., 1996, Network Distribution Techniques of the Global 1-km AVHRR Data Set, for XVIII International Congress of Photogrammetry and Remote Sensing, Vienna, Austria, July 9-19, 1996.

Faundeen, J., 1996, NSLRSDA Landsat MSS Disc (CD-ROM), March 1996.

Fick, S., Goodale, K., Park, P., and Wehde, K., 1996, The EOSDIS Information Management System: Access to Data for Global Change Researchers, poster at Pecora 13 Symposium, Human Interactions with the Environment: Perspectives From Space, Sioux Falls, South Dakota, August 1996.

Foresman, T. W., Wiggins, H. V., Porter, D. L., Masuoka, P., and Acevedo, W., 1996, Design and documentation of a Baltimore-Washington regional spatial database testbed for environmental model calibration and verification, in National Center for Geographic Information Analysis (NCGIA) International Conference/Workshop on Integrating GIS and Environmental Modeling, Third, Santa Fe, New Mexico, January 1996, Proceedings: CD-ROM, 1 disc [Disc contains a Readme file].

Fosnight, E., and Fowler, G. W., 1996, Measures of association and agreement for describing land cover characterization classes, in International Symposium on Spatial Accuracy Assessment in Natural Resources and Environmental Modeling, Second, Ft. Collins, Colorado, May 1996, Proceedings: Ft. Collins, Colorado, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-GTR-277, p. 425-433.

Gallant, A., Binnian, E., Omernik, J., and Shasby, M., 1995, Ecoregions of Alaska: U.S. Geological Survey Professional Paper 1567, p. 75, 2 pl. (map folded in pocket), scale 1:5,000,000.

Gaydos, L. J., Acevedo, W., and Bell, C., 1995, Considerations for using animated cartography to illustrate global change (abs.), in International Cartographic Conference, 17th, Barcelona, Spain, September 1995, Proceedings: v. 1, p. 1174-1178.

Gaydos, L., 1995, Using animated cartography to illustrate global change (abs.), in Joint International Cartography Association Seminar on Teaching Animated Cartography, Madrid, Spain, August 1995, Proceedings: p. 85.

Goodchild, M., Steyaert, L, Parks, B., Johnston, C., Maidment, D., Crane, M., and Glendinning, S. (editors), 1996, GIS and environmental modeling: progress and research issues, Fort Collins, Colorado, GIS World Books, p. 486.

Helder, D., Boncyk, W., Barker, J. L. and Markham, B. L., 1996, Short-term calibration of Landsat TM: Recent findings and suggested techniques, in International Geoscience and Remote Sensing Symposium, Lincoln, Nebraska, May 1996,

Proceedings: Picataway, New Jersey, Institute of Electrical and Electronics Engineers, Inc., v. II, p. 1276-1278.

Hewitt, M., Brown, J., Groskinsky, B., Ostlie, W., James, D., and Totman, D., 1995, The Great Plains international data network: supporting science on the Great Plains (abs.), in Planning for a Sustainable Future: The Case of the North American Great Plains Symposium, Lincoln, Nebraska, May 1995, Proceedings: IDIC Technical Report Series 95-1, December 1995, p. 166-167.

Johnson, W. C., Dixon, M. D., Simons, R., Jenson, S., and Larson, K., 1995, Mapping the response of riparian vegetation to possible flow reductions in the Snake River, Idaho: Geomorphology, Amsterdam, The Netherlands, Elsevier Science, v. 13, p. 159-173.

Krell, D., 1996, Landsat MSS Data Catalog (CD-ROM back in-lay), September 1996.

Kess, B. L., Steinwand., D. R., and Reichenbach, S. E., 1996, Compression of the Global Land 1-km AVHRR data set: International Journal of Remote Sensing, London, United Kingdom, Francis & Taylor Ltd., v. 17, no. 15, October 1996, p. 2955-2969.

Kess, B. L., Steinwand, D. R., and Reichenbach, S. E., 1995, Compression of regions in the global Advanced Very High Resolution Radiometer 1-km data set, in Science Information Management and Data Compression Workshop, National Aeronautics and Space Administration/Goddard Space Flight Center, Greenbelt, Maryland, September 1994, Proceedings: NASA Conference Publication 3277, p. 59-64.

Loveland, T. R., Merchant, J. W., Reed, B. C., Brown, J. F., and Ohlen, D. O., Olsen, P., and Hutchinson, J., 1995, Seasonal land cover regions of the United States: Annals of the Association of American Geographers, v. 85, no. 2, p. 339-355.

Loveland, T. R., and Hutcheson, H. L., 1995, Monitoring changes in United States landscapes from satellite imagery: Status and future possibilities, in Our Living Resources, E. T. LaRoe, G. S. Farris, C. E. Puckett, P. D. Doran, and M. J. Mac, editors, Washington, D.C., National Biological Survey, p. 468-473.

Loveland, T., and Van Driel, N., 1996, The U.S. Geological Survey's land cover characterization program, in U.S. Forest Service Biennial Remote Sensing Conference, 6th, Denver, Colorado, June-July 1996, Proceedings: Bethesda, Maryland, American Society for Photogrammetry and Remote Sensing, p. 17-25.

Lugo, R., Zink, L., Smith, R., Gaydos, L., and Sanders, R., 1996, Access USGS regional web server (abs.), in Annual Computer Technology Meeting, Eighth, Rancho Mirage, California, May 1996: U.S. Geological Survey Open-File Report 96-204 [Internet URL: http://wwwqvarsa.er.usgs.gov/NCTM96/ofr].

Lytle, D. J., Bliss, N. B., and Waltman, S. W., 1996, Interpreting the state soil geographic data base, in M. F. Goodchild, L. T. Steyaert, and others, editors, GIS and Environmental Modeling: Progress and Research Issues, Fort Collins, Colorado, GIS World Books, p. 49-52.

Markham, B. L., Barker, J. L., Boncyk, W., C., Kaita, E., and Helder, D. L., 1996, Landsat-7 enhanced thematic mapper plus in-flight radiometric calibration, in International Geoscience and Remote Sensing Symposium, Lincoln, Nebraska, May 1996, Proceedings: Picataway, New Jersey, Institute of Electrical and Electronics Engineers, Inc., v. II, p. 1273-1275.

Markon, C. J., Fleming, M. D., and Binnian, E. F., 1995, Characteristics of vegetation phenology over the Alaskan landscape using AVHRR time-series data: Polar Record, Great Britain, Cambridge University Press, v. 31, no. 177, p. 179-190.

Markon, C. J., 1995, History and use of remote sensing for conservation and management of Federal lands in Alaska, USA: Natural Areas Journal, v. 15, no. 4, October 1995, p. 329-338.

Markon, C. J., and Williams, B. E., 1996, Development of a geographical information system for the Chugach National Forest, in Forest Service Remote Sensing Applications Conference, Sixth, Denver, Colorado, April-May 1996, Proceedings: Greer, J. D., (ed.), Remote Sensing: People in Partnership with Technology, Bethesda, Maryland, American Society for Photogrammetry and Remote Sensing, p. 155-163.

Masuoka, P. M., Acevedo, W., Fifer, S., Foresman, T., and Tuttle, M., 1996, Techniques for visualizing urban growth using a yemporal GIS database, in ASPRS/ACSM Annual Convention and Exhibition, Baltimore, Maryland, April 1996, Proceedings: v. III, p. 89-100.

Masuoka, P. M., Foresman, T., Fifer, S., Acevedo, W., Clark, S. C., Crawford, J., and Buchanan, J., 1995, Visualization techniques for the analysis of Baltimore regional GIS data, in GIS/LIS 1995 Annual Conference and Exposition, Proceedings: p. 704-712.

Meyer, D., 1996, Estimating the effective spatial resolution of an AVHRR time series: International Journal of Remote Sensing, London, United Kingdom, Francis & Taylor Ltd., v. 17, no. 15, October 1996, p. 2971-2980.

Meyer, D., Reed, B., Loveland, T., Eidenshink, J., Tieszen, L., Schiller, S., Merchant, J., and Lewis, J., 1995, Monitoring seasonal dynamics of North America grasslands using VEGETATION: VEGETATION Newsletter, September 1995, Ispra, Italy, European Commission, Joint Research Centre, p. 9-10.

Ohlen, D. O., Reed, B. C., and Loveland, T. R., 1996, Progress in the development of a global land cover characteristics data base, in Applied Geography Conference, 19th, Kansas City, Kansas, October 1996, Proceedings: p. 281-287.

Qui, Z., Yang, L., and Loveland, T., 1996, Recent experiences in mapping land cover from AVHRR data: People's Republic of China test site, in International Geoscience and Remote Sensing Symposium, Lincoln, Nebraska, May 27-31, 1996, Proceedings: Picataway, New Jersey, Institute of Electrical and Electronics Engineers, Inc., v. IV, p. 2318-2320.

Reed, B. C., Loveland, T. R., and Tieszen, L. L., 1996, An approach for using AVHRR data to monitor U.S. Great Plains grasslands: Geocarto International, v. 11, no. 3, September 1996, p. 13-22.

Rowland, J., Brock, J., Nadeau, A., Klaver, R., Moore, D., and Lewis, J., 1996, Vegetative index to characterize drought patterns: Raster Imagery in Geographic Information Systems, S. Morain and S. Lopez Baros (eds.), Santa Fe, New Mexico, Onward Press, p. 247-254.

Steinwand, D. R., Hutchinson, J. A., and Snyder, J. P., 1995, Map projections for global and continental data sets and an analysis of pixel distortion caused by reprojection: Photogrammetric Engineering and Remote Sensing, Falls Church, Virginia, American Society for Photogrammetry and Remote Sensing, v. 61, no. 12, December 1995, p. 1487-1497.

Steyaert, L., 1996, Status of land data for environmental modeling and challenges for geographic information systems in land characterization, in M. F. Goodchild, L. T. Steyaert, and others, editors, GIS and Environmental Modeling: Progress and Research Issues, Fort Collins, Colorado, GIS World Books, p. 17-27.

Steyaert, L., 1995, A perspective on land characterization research within the global change program of the U.S. Geological Survey (abs.), in Annual Applied Geography Conference, 18th, Arlington, Virginia, November 1995, Proceedings: p. 227.

Tappan, G., and Wood, E., 1995, Framework for long-term monitoring of natural resources in Senegal, in ATLAS/USAID National Colloquium on Natural Resource Management in Senegal, Dakar, Senegal, April 1995, Proceedings: New York, New York, U.S. Agency for International Development, African-American Institute, p. 21-27 and 99-105.

Thorne, E., 1996, Mapping historic wetlands change: the San Francisco Bay region (abs.), in Annual GIS Convention, 10th, Vancouver, British Columbia, Canada, March 1996, Proceedings: CD-ROM, 1 disc [Disc contains a Readme file].

Van Driel, N., and Loveland, T., 1996, USGS land cover characterization program, in National Center for Geographic Information Analysis (NCGIA) International Conference/Workshop on Integrating GIS and Environmental Modeling, Third, Santa Fe, New Mexico, January 1996, Proceedings: CD-ROM, 1 disc [Disc contains a Readme file].

VanderZee, D., Fenno, C., and Singh, A., 1995, UNEP's Global Resources Information Database: The GIS World Sourcebook 1996, 7th Edition, October 1995, Fort Collins, Colorado, GIS World, Inc., p. 577-580.

Verdin, J. P., 1996, Remote sensing of ephemeral water bodies in western Niger: International Journal of Remote Sensing, v. 17, no. 4, p. 733-748.

Verdin, K. L., and Jenson, S. K., 1996, Development of continental scale DEMs and extraction of hydrographic features, in National Center for Geographic Information Analysis (NCGIA) International Conference/Workshop on Integrating GIS and Environmental Modeling, Third, Santa Fe, New Mexico, January 1996, Proceedings: CD-ROM, 1 disc [Disc contains a Readme file].

Vogelmann, J., Howard, S., and Sohl, T., 1996, Regional land cover characterization using multiple sources of intermediate-scale data, in International Geoscience and Remote Sensing Symposium, Lincoln, Nebraska, May 1996, Proceedings: Picataway, New Jersey, Institute of Electrical and Electronics Engineers, Inc., v. I, p. 246-247.

Vogelmann, J., and Hegge, K., 1996, MRLC preprocessing of thematic mapper scenes (abs.), in Annual National GAP Analysis Meeting, Agenda and Abstracts, Sixth, Key Largo, Florida, July 1996, Proceedings: Book of Abstracts, pagination not available.

Walker, D. A., and Markon, C. J. (editors), 1996, Circumpolar Arctic Vegetation Workshop (A compilation of workshop abstracts/short papers presented at the Komarove Botanical Institute, St. Petersburg, Russia, March 1994): U.S. Geological Survey Open-File Report 96-251, p. 143.

Watts, R., 1996, Digital analysis of area-distance scaling of river basins using link statistics and Markov matrices (abs.), in American Geophysical Union Spring 1996 Meeting, May 1996, Proceedings: Supplement to EOS, April 23, 1996, p. S137.

Wehde, M. E., 1995, Digital image comparison by subtracting contextual transformations: percentile rank order differentiation: Photogrammetric Engineering and Remote Sensing, Falls Church, Virginia, American Society for Photogrammetry and Remote Sensing, v. 61, no. 10, October 1995, p. 1273-1278.

Wood, E. C., Tappan, G. G., and Jacobs, D. M., 1995, Monitoring Senegal's natural resources using airborne videography, in Biennial Workshop on Color Photography in Resource Assessment, 15th, Terre Haute, Indiana, May 1995, Proceedings: Bethesda, Maryland, American Society for Photogrammetry and Remote Sensing, p. 315-325.

Wylie, B. K., Donovan, D. D., and Tieszen, L. L., 1996, Grassland canopy parameters and their relationships to remotely sensed vegetation indices in the Nebraska sand hills: Geocarto International, v. 11, no. 3, September 1996, p. 39-52.

Yang, L., Zhu, Z., Izaurralde, J. A., and Merchant, J. W., 1996, Evaluation of North and South America AVHRR 1-km data for global environmental modeling, in National Center for Geographic Information Analysis (NCGIA) International Conference/Workshop on Integrating GIS and Environmental Modeling, Third, Santa Fe, New Mexico, January 1996, Proceedings: CD-ROM, 1 disc [Disc contains a Readme file].

Zelt, R. B., Brown, J. F., and Kelley, M. S., 1995, Refinement of national land-cover characteristics data for regional water-quality assessment: Geocarto International, v. 10., no. 4, December 1995, p. 69-80.

Zhu, Z., Ohlen, D. O., Czaplewski, R. L., and Burgan, R. E., 1996, Alternative method to validate the seasonal land cover regions of the conterminous United States, in International Symposium Spatial Accuracy Assessment in Natural Resources and Environmental Science, Second, Fort Collins, Colorado, May 1996: Rocky Mountain Forest and Range Experiment Station General Technical Report RM-GTR-277, p. 409-418.

Zhu, Z-L., and Yang, L., 1996, Characteristics of the 1-km AVHRR data set for North America: International Journal of Remote Sensing, Taylor and Francis, Ltd., v. 17, no. F10, p. 1915-1924.