

U.S. Geological Survey  
**EROS**  
Data Center



YEARS

1973 - 1998

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## PART I

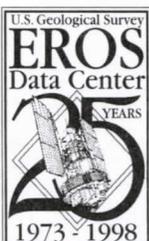
### THE U.S. GEOLOGICAL SURVEY: A TRADITION OF PUBLIC SERVICE 1879-1998

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

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

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

The USGS cooperates with and coordinates its efforts with nearly 2,000 agencies at Federal, State, county, and municipal levels, and with other nations and international organizations. The headquarters of the USGS is located in Reston, Virginia. Three regional centers are located in Denver, Colorado; Menlo Park, California; and Reston, Virginia. Field offices, such as the EROS Data Center, are located throughout the 50 states, the Commonwealth of Puerto Rico, and the Trust Territories of the Pacific. To learn more about the USGS, go to the following Internet address: <http://www.usgs.gov>.



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## THE U.S. GEOLOGICAL SURVEY:

### Vision

*The USGS is a world leader in the natural sciences through our scientific excellence and responsiveness to society's needs.*

### Mission

*The USGS serves the Nation by providing reliable scientific information to*

- *describe and understand the Earth;*
- *minimize loss of life and property from natural disasters;*
- *manage water, biological, energy and mineral resources; and*
- *enhance and protect our quality of life.*



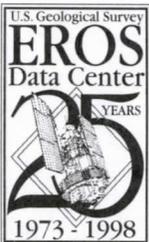
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## THE MISSION OF THE USGS NATIONAL MAPPING DIVISION

*The mission of the USGS's National Mapping Division is to meet the Nation's need for basic geospatial data, ensuring access to and advancing the application of these data and other related earth science information for users worldwide.*

*In support of this mission, we:*

- ensure the production and availability of basic cartographic and geographic spatial data of the country;
- coordinate national geospatial data policy and standards;
- provide leadership for the management of earth science data and for information management;
- acquire, process, archive, manage, and disseminate the land remote sensing data of the Earth; and
- improve the understanding and application of geospatial data and technology.



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## THE USGS EROS DATA CENTER

### Vision

*The USGS Earth Resources Observation Systems (EROS) Data Center's vision is to be the world's leading source of land information for exploring our changing planet.*

### Mission

*To promote new uses, new users, and new understanding of land information, so that others can better understand our planet.*

*To ensure scientists, researchers, businesses, decision makers, and the public have ready access to the land information they need.*

*To safeguard and expand the world's largest archive of remotely sensed land data.*

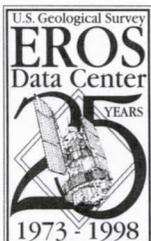


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## PURPOSE OF THIS REPORT

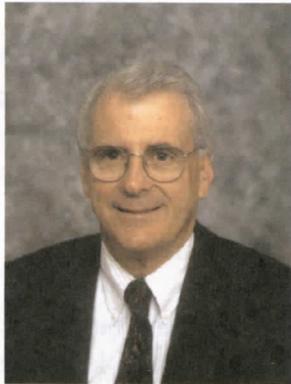
The purpose of this annual report is to inform you, our customers, of the programs, services, and activities of the U.S. Geological Survey (USGS) Earth Resources Observation Systems (EROS) Data Center (EDC), one of five field centers of the USGS's National Mapping Division (NMD). The report summarizes the work we have done in fiscal year 1998 to provide reliable, accurate, and useful land data and information that are relevant to society's needs. Just as important, we try to reflect your ideas and feedback, which have been incorporated into our business of providing you with the best possible service.

The report has three parts. Part I provides information about USGS, NMD, and EDC. Part II summarizes EDC programs and activities in fiscal year 1998. Finally, Part III highlights statistical data, selected technical publications, and provides a word in conclusion.



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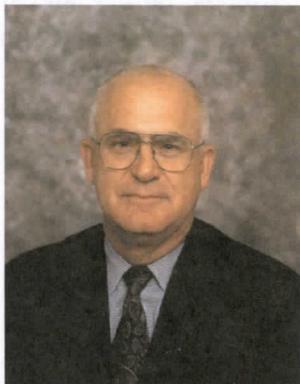
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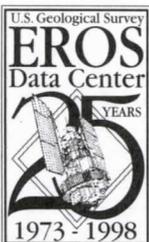
## About the Cover

The U.S. Geological Survey's EROS Data Center (EDC) opened its doors from 9 a.m. to 3 p.m., Saturday, September 19, 1998 to celebrate 25 years of Exploring Our Changing Planet. A record 10,285 people visited EDC to have fun and learn what we do and how we do it through exhibits, hands-on demonstrations, tours, and educational booths. A volunteer force of 350 employees gave tours and answered questions as visitors were given full access to the Center.

The day-long, family-friendly celebration featured many indoor and outdoor activities. The day began with a 5-kilometer competitive run and 2.5-kilometer fun run/walk. A series of four educational activity booths challenged middle school students to learn how EDC staff receive, archive, process, and analyze data. A special guest for the day, former Space Shuttle Astronaut, Mary Cleave, addressed two large groups of visitors at 11 a.m. and 1 p.m. In her two, 45-minute talks, Dr. Cleave described her experiences as a mission specialist aboard the Space Shuttle. In addition to the educational activities, EDC staff arranged to bring in food vendors, clowns, musicians, and Native American dancers to entertain guests aging from 5 to 95. Everything was free of charge, except food and soft drinks at the food court. The only negative on a very positive day were winds gusting from 15-to-25 miles per hour, which canceled tethered hot-air balloon rides and jumps by South Dakota skydivers.

EDC staff also sponsored several kick-off events prior to the 25th Anniversary Open House. For instance, the EROS Data Center Activities Association sponsored a juried art show on the theme Exploring Our Changing Planet. More than 30 entries in photography, painting, and sculpture from across the Nation were received. A volunteer group of EDC staff also visited 6th and 7th grade classrooms in the Sioux Falls area the week before the Open House to present a classroom activity based on aerial photos and satellite images. The lesson provided students and teachers an inside look at work performed at EDC.

The day concluded with a picnic for EDC friends, family, and staff. Messages left by visitors on public comment boards around the Center summed up the day best: It was awesome!!! Wow, great eye-opening experience! Wonderful!



## Part II

### RESEARCH AND APPLICATIONS

EDC staff completed a spatial reconstruction of historical land cover for the Patuxent watershed and surrounding area. The Patuxent watershed is located in the greater Baltimore-Washington, DC area of the Chesapeake Bay. GIS spatial

*Urban Dynamics  
Research*

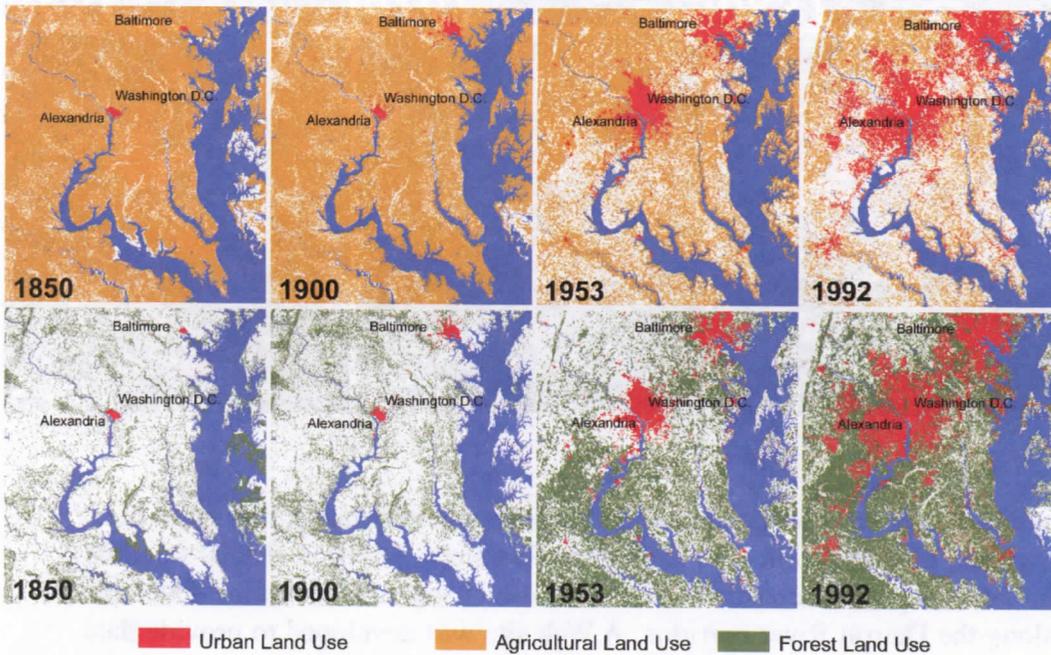
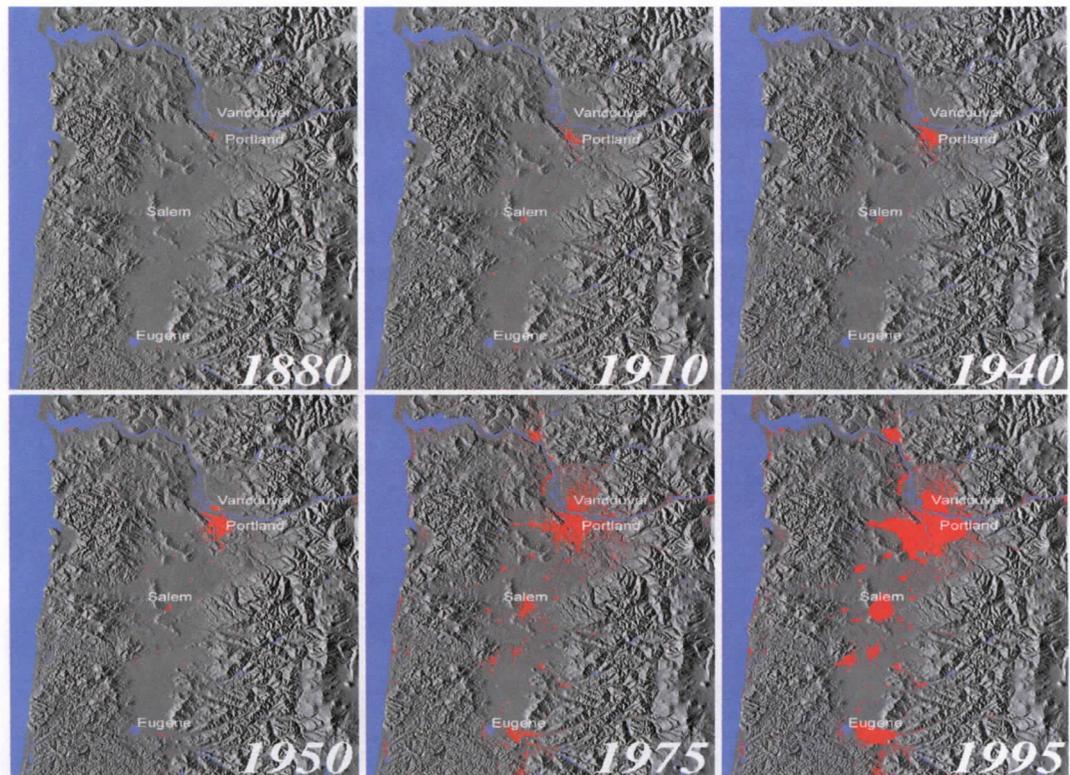


Figure 1

modeling and data integration techniques were used in mapping agricultural, forest, and urban land for six time periods between 1850 and 1992, and are depicted in Figure 1. This research is helping USGS in addressing the land-use changes in the Chesapeake Bay watershed that may have affected the ecosystem over several time periods, including the last several decades and the last several centuries. Preliminary findings from the Patuxent study area indicate that deforestation began near 1650 and hit a peak from about 1850-1900. During this time, agriculture accounted for over 80 percent of the land use in the greater Baltimore-Washington area. Agricultural use has decreased since 1900 and is being replaced by urban land use and forest land. The extensive land clearance in the mid-to-late 1800's is also reflected in ecosystem indicators showing large changes in salinity, dissolved oxygen, and sedimentation rates. This information will be valuable in helping to establish restoration goals that accurately reflect changes in the system due to natural variability and historical land-use changes.

EDC scientists completed the temporal mapping of urban or built-up land for the Portland-Vancouver, shown in figure 2 and Chicago-Milwaukee regional studies. Retrospective geographic information system (GIS) databases were completed

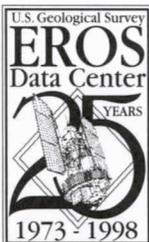
Figure 2



and literature reviews begun on the land use and population history of the regions. Collaboration with Biological Resources Division (BRD) scientists initiated a spatial reconstruction of land use change and shoreline development along the Detroit River corridor. A Web site was developed to provide data access and information on Urban Dynamics regional studies. Application and refinement of the Clarke urban growth model continued through a Cooperative Agreement with the University of California, Santa Barbara. The modeling software was prepared for portability to USGS systems. Web-based documentation was delivered and a system developers workshop was held. EDC established an Interagency Agreement for "Research in Urban Growth and Land-Use Change Modeling" with the U.S. Environmental Protection Agency Office of Research and Development (EPA/ORD). The collaborative land use change modeling project will evaluate the potential degree and configuration of land-use change across the mid-Atlantic region under alternative development scenarios.

### ***USGS Mississippi Basin Carbon***

The USGS Mississippi Basin Carbon Project team is conducting research on the carbon budget in soils and sediments of the Mississippi River Basin. The project is focused on how human-induced changes of land use, erosion, and sedimentation influence the net interchange of carbon (primarily as carbon dioxide and methane) between soils and the atmosphere. Improved estimates of the global carbon budget are needed to support policy decisions related to global change. The activities at EDC were directed toward obtaining preliminary results for the amount of carbon in eroded sediments. Methods were refined for making maps



from the State Soil Geographic (STATSGO) data base, and approximately 160 maps were produced covering the study area. Methods were developed to classify soils according to their erosional and depositional status. The methods were first developed for Iowa, and are being adapted for the remaining states in the Mississippi Basin. This classification is one step toward building a mass balance for the movement of carbon due to erosion. Additional refinements were made in methods to use digital elevation models at 1-kilometer, 100-meter, and 30-meter resolutions to characterize regional terrain patterns. Terrain characteristics derived from digital elevation models are being combined with soil information for erosion modeling. A post-doctoral researcher has joined the staff, with a focus on modeling soil carbon dynamics.

EDC coordinated a USGS integrated natural resources science project focused on vulnerability and recoverability of the Mojave Desert. Scientists from each of the Survey's divisions worked together doing field work on soil compaction at several ghost town sites. This work is yielding valuable information on recovery rates that vary with landscape variables. These variables are being integrated into a GIS. A prototype of the National Elevation Database (NED) was completed for the Mojave Desert and will be used for modeling soil moisture. Perimeters of major fires occurring over the past 10 years were digitized and made available to project modelers. Fire effects on wind erosion and vegetation recovery from stresses are being explored. A web site was established to illustrate the science issues and approach being taken. It is at <http://geology.wr.usgs.gov/MojaveEco>.

Staff at EDC have completed the assembly of the first version of a National Elevation Database (NED). The dataset is designed to comply with the Federal Geographic Data Committee (FGDC) Framework for national digital geospatial data. The NED results from the implementation of the FGDC framework concept in which a seamless, multi-source, elevation database is compiled from the best-available raster elevation data. In addition to assembling the data in a form with consistent units, datum, projection, and cell size, the data are processed to minimize edge mismatches between source files and artifacts within source files. Building Version 1 of the NED involved the conversion and transformation of over 50,000 digital elevation model (DEM) files currently in the USGS sales database. In addition to being logically seamless, the NED is also application-ready, since many of the preparatory steps required before use in applications have already been completed. NED distribution mechanisms are under development. The development of NED Version 2, in which newly produced elevation data are being incorporated, is underway. Version 1 NED data are being tested for their applicability in the areas of drainage basin delineation, flood inundation, digital cartography, and land cover mapping.

*Mojave Desert  
Ecosystem Science*

*National Elevation  
Database*

Figure 3



This graphic represents the National Elevation Dataset - a seamless, best available, GIS-ready dataset of the conterminous United States.



Figure 3



This graphic represents the National Elevation Dataset - a seamless, best available, GIS-ready dataset of the conterminous United States.



Working in collaboration with the U.S. Fish and Wildlife Service, the Institute of Arctic and Alpine Research of the University of Colorado, Boulder, and scientists from eight Arctic nations, the USGS EROS Alaska Field Office continued work on the production of the first comprehensive and consistent vegetation map of the Earth's circumpolar Arctic region. The Circumpolar Arctic Vegetation Mapping (CAVM) project is being conducted in support of the International Conservation of Arctic Flora and Fauna (CAFF) Initiative whose objective is to identify areas of unique and important biodiversity. This information will be used by the U.S. Government and the other Arctic nations in the development of an international conservation strategy for the protection of these unique areas within the context of the Arctic region.

The USGS provided vegetation mapping expertise for Alaska in this multi-year project. The USGS also had the lead in the production of false-color infrared (CIR) and normalized difference vegetation index (NDVI) circumpolar Arctic image map products derived from the 1991 and 1992 global AVHRR biweekly composite data bases assembled at EDC. A circumpolar shaded-relief map was also generated for the circumpolar region from the EDC global DEM data base to support the CAVM effort. These image and map products serve as the base for the interpretation of vegetation by each of the participating nations. The EROS Alaska Field Office hosted a workshop in January at which the mapping methodologies and map unit descriptors were defined, both of which are critical in bringing together the work of each nation into a consistent circumpolar product. The final CAVM product is targeted for publication in the year 2001. The supporting circumpolar CIR, NDVI, and DEM products have been released to the global change community as hard copy products, on CD-ROM, and on USGS Web pages.

The Arctic Environmental Data Directory (AEDD,) an Internet-based clearinghouse, is maintained by the USGS at the EROS Alaska Field Office on behalf of the member agencies of the Interagency Arctic Research Policy Committee (IARPC). The AEDD is designed to be the initial repository for information on the Arctic in support of the Arctic Research and Policy Act of 1984. The AEDD contains descriptions of data and provides Internet links to sites with information on global change studies, environmental interactions, earth sciences, and policy and management. The AEDD is also the U.S. node to the Arctic Data Directory (ADD), which is an international membership organization comprised of countries and organizations with major Arctic environmental data holdings. In facilitating access to Arctic environmental data, the ADD's primary objectives are to preserve and use this information. It does this by encouraging member nations to adopt metadata standards to document their holdings and establishing Internet-accessible data clearinghouses with ADD-defined standards for searching and accessing that information.



***Real Time Hazards -  
Alaska Volcano  
Observatory***

When airplanes meet clouds of volcanic ash thousands of feet above the Earth's surface, the results can be disastrous. Anchorage International Airport is our Nation's largest cargo-handling facility, with heavy passenger traffic, as it serves as the international link to the Orient. That, coupled with the fact that there are over 40 active volcanos in Alaska, makes for a potentially dangerous combination. To provide up-to-the-minute information to the aviation community to ensure public safety, the EROS Alaska Field Office provides remote sensing, computer modeling, and systems support to the USGS Alaska Volcano Observatory (AVO) and its real-time volcanic hazards warning program. The AVO, a joint program which includes partnerships with the University of Alaska-Fairbanks, and the State of Alaska Division of Geological and Geophysical Survey, detects and monitors volcanic events in Alaska and the Russian far east. These activities include tracking ash-cloud movements and providing that information to the Federal Aviation Administration (FAA) and airline industry as a real-time warning system.

In 1998, the EROS Alaska Field Office provided support to the AVO program for the expansion of their Real-Time Ash Cloud Monitoring and Warning System. This included support for the acquisition and integration of a number of different processing systems and software packages to augment the current system. The new capabilities being developed will allow the AVO to retrieve information about ash cloud mass and particle size from Advanced Very High Resolution Radiometer, Geostationary Operational Environmental Satellite, and Geostationary Meteorological Satellite data. This information is then integrated with climate data into volcanic cloud trajectory and fallout models that allow the AVO to advise the Federal Aviation Administration on the potential rate and direction that a particular ash cloud may take as a warning to pilots. This information is also valuable to the communities and citizens of Alaska as active volcanos pose significant risks to people and infrastructure on the ground as well.

***Alaska Geospatial  
Data Clearinghouse***

Since the early 1980's, Federal and State resource and land management agencies in Alaska have been active users of geographic information systems technology to map, monitor, and manage their lands and meet their missions. Tremendous investments are being made in the development of geospatial databases. In 1994, Alaska agencies organized themselves into the Alaska Geographic Data Committee (AGDC) in response to the activities and standards being proposed at the Federal level by the Federal Geographic Data Committee (FGDC). The underlying objective of the FGDC is the creation of the National Spatial Data Infrastructure (NSDI), which encompasses policies, standards, and procedures for all organizations to cooperatively produce and share geospatial data. One of the primary components of the NSDI is establishment of a National Geospatial Data Clearinghouse. The National Clearinghouse is based on Internet Web technology and a distributed network of clearinghouse server nodes in all states and regions of the country. The EROS Alaska Field Office has created, and now manages, the geospatial data Web clearinghouse for the Alaska Geographic Data Committee and its member organizations.



The AGDC Clearinghouse is also a distributed network, as some agencies choose to serve their data from their own server using FGDC standards but link to the network through the USGS established node. As a result, a user can find data through one set of search tools provided within the AGDC site. The data holdings of the AGDC are growing exponentially as new sites link in, and as new USGS Geodata products for Alaska are produced.

Alaska Federal, State, and local government agencies, as well as native corporations and private landowners, have experienced highly significant impacts in recent years due to spruce bark beetle infestations and resultant mortality of several million acres of spruce forests. The exact cause of this epidemic, which is unprecedented in size and severity, is unknown. Many forestry scientists are looking at global warming as a potential contributing factor as warmer weather and less summer rainfall have stressed trees, while providing more favorable breeding conditions for the spruce bark beetle.

In an attempt to get a more complete assessment of the extent of the epidemic, the value of the resource impacted, and to try and predict areas within the state where the epidemic may expand in future years, the U.S. Forest Service and the EROS Alaska Field Office have established a cooperative GIS/Remote Sensing research project. In the first year of the project, the Field Office was successful in meeting the primary objective to establish a Forest Health Monitoring Clearinghouse (FHMC) on the AGDC Clearinghouse site. The FHMC compiles all of the relevant geospatial data from Federal, State and non-government agencies into a single integrated Geographic Information System (GIS) data base. The FHMC serves to not only organize and provide centralized access to information relevant to forest health, but will also provide tools to display and analyze the data to address related land management and planning issues. Significant progress was also achieved on the development of remote sensing and GIS methods to accurately map the extent of the white spruce forest across the state, the preferred species upon which the spruce bark beetle bases its life cycle.

In January 1998, the EDC established a hazard preparedness and disaster response team to improve and broaden the coordination, management, and scope of the Center's response to natural hazards and disasters. Planned activities for the team include: establishing a hazard/disaster response management structure, improving mechanisms for delivery of data for disasters, and developing partnerships with emergency response agencies.

Satellite images, aerial photographs, and digital cartographic data (elevation, digital maps, or digital orthorectified photographs) were provided to various emergency response agencies in response to several tornadoes (Florida, Georgia, Alabama, South Dakota), wildfires (Florida, Yellowstone), hurricanes (North/South Carolina, Puerto Rico), past flooding (North Dakota), current flooding (South Dakota), landslides (California), and potential volcano eruption areas (Mammoth Mountains, California, and Mt. Raider, Washington).

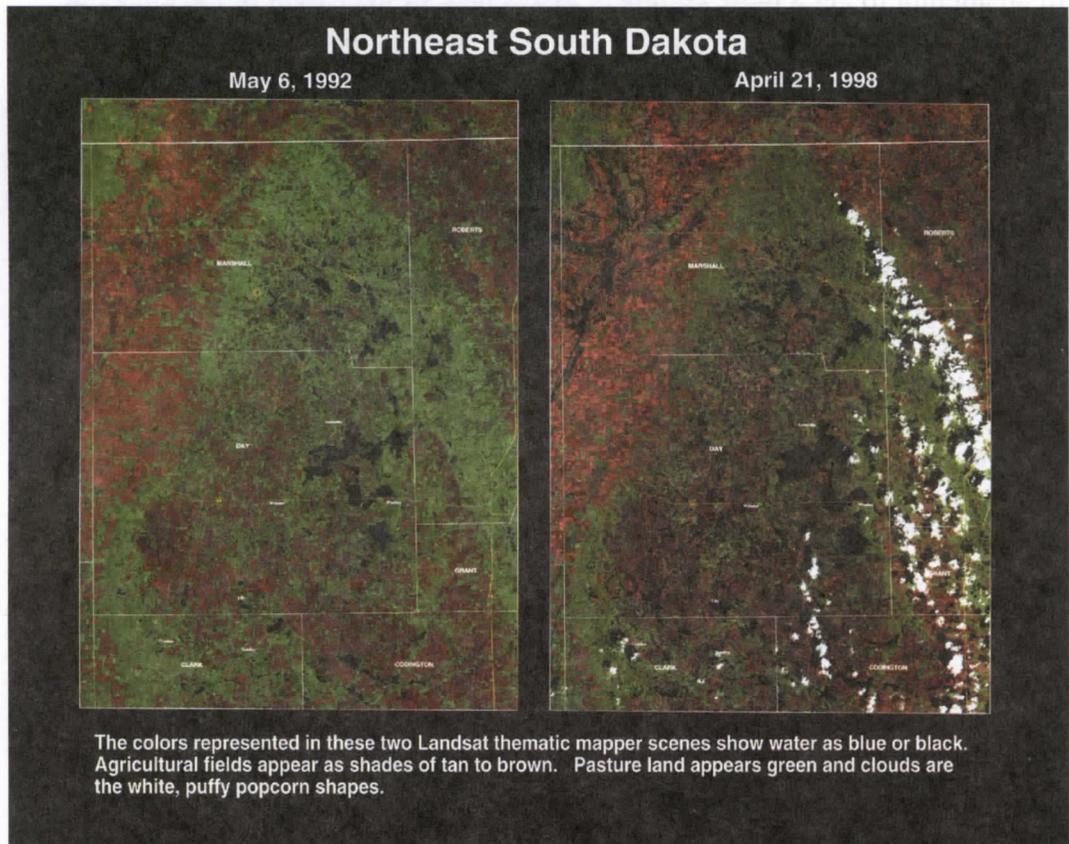
***The Alaska  
Statewide Forest  
Health Monitoring***

***Natural Hazards  
and Disasters***

EDC has made considerable progress in developing emergency response partnerships, particularly with the USGS hazard teams (coastal erosion, landslides), the USGS Center for Integrated Natural Disaster Information (formerly called the Natural Hazard Information Center), and the Federal Emergency Management Agency (FEMA). A Memorandum of Understanding (MOU) between EDC and FEMA Region 8 is nearly complete, which provides for rapid response to disasters in Utah, Colorado, Wyoming, Montana, South Dakota, and North Dakota. A FEMA Remote Sensing Operations Manual, currently in review, identifies the EDC as the point of contact to provide unclassified satellite imagery and aerial photographs in response to disasters within the United States.

EDC is participating, with the USGS Water Resources Division, in a FEMA-sponsored hydrologic study of the Presidentially-declared flooding in Day County, SD. Satellite data, radar data, aerial photographs, and digital terrain data are being used to map water surface area, and determine past, current, and potential water flow and overflow areas in the enclosed watershed. Figure 4 shows

Figure 4



Landsat thematic mapper images of Day County, SD, taken in May 1992 and 1998, under normal and flooding conditions, respectively. These images are but two of many satellite images which are being analyzed to quantify water surface cover during the past 6 years.

High-resolution (10-meter posting interval) Digital Elevation Data have been assembled into a seamless, best-available dataset, using filtering and edge-matching techniques developed at the EDC, to produce the emerging National Elevation Database (NED). The area shown in figure 5 is a portion of a one-

### Day County Digital Elevation Data

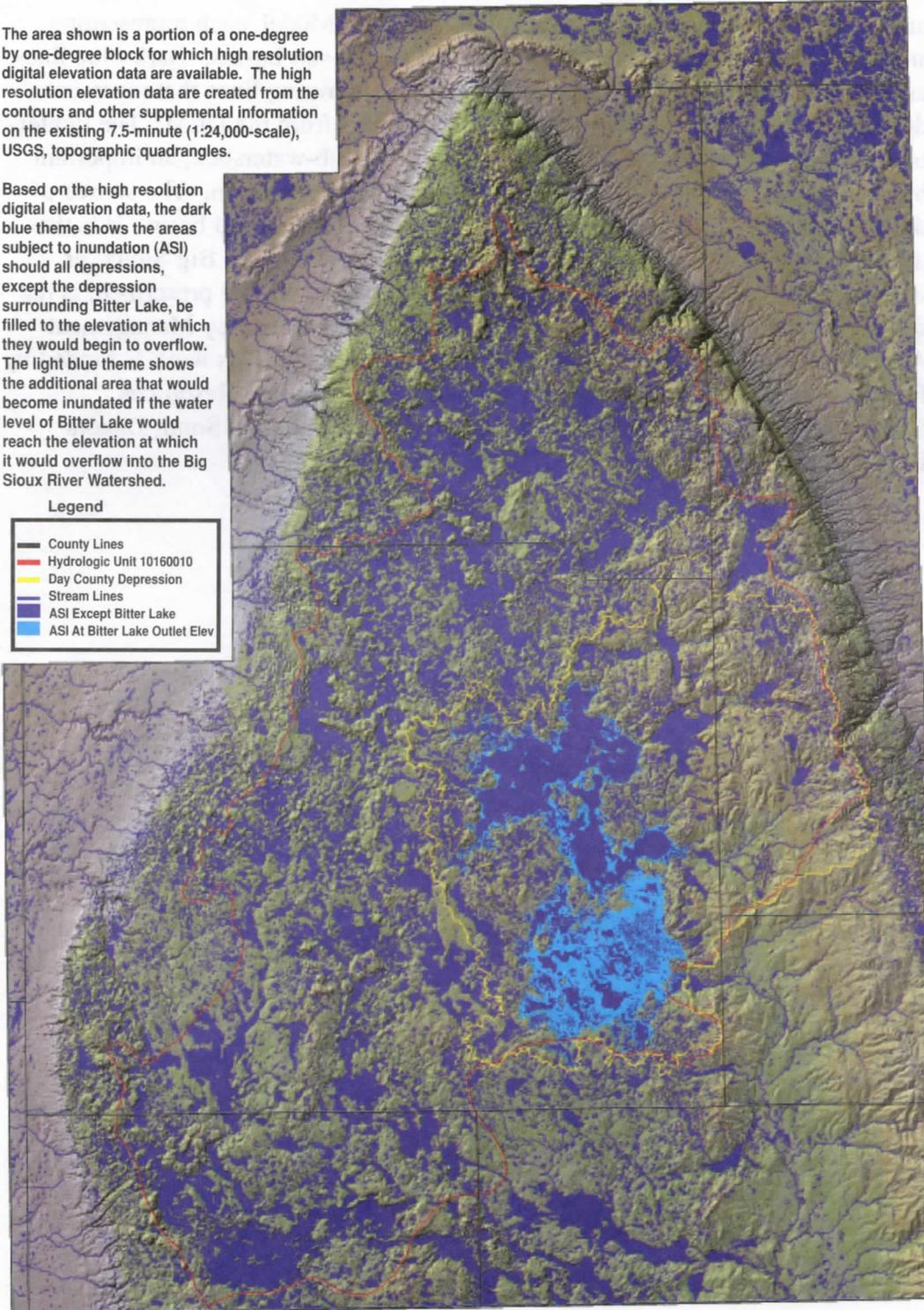
Figure 5

The area shown is a portion of a one-degree by one-degree block for which high resolution digital elevation data are available. The high resolution elevation data are created from the contours and other supplemental information on the existing 7.5-minute (1:24,000-scale), USGS, topographic quadrangles.

Based on the high resolution digital elevation data, the dark blue theme shows the areas subject to inundation (ASI) should all depressions, except the depression surrounding Bitter Lake, be filled to the elevation at which they would begin to overflow. The light blue theme shows the additional area that would become inundated if the water level of Bitter Lake would reach the elevation at which it would overflow into the Big Sioux River Watershed.

Legend

- County Lines
- Hydrologic Unit 10160010
- Day County Depression
- Stream Lines
- ASI Except Bitter Lake
- ASI At Bitter Lake Outlet Elev



degree-by-one-degree block in Northeast South Dakota, for which forty-six, 7.5-minute quadrangles were assembled. In this area of low gradient, glacial processes have left the area with poor drainage and many closed depressions. The large red polygon is Water Resources Division (WRD) hydrologic unit code 10160010, mapped as a closed basin several years ago from small scale maps. The yellow polygon is an updated mapping of the closed basin, and was produced using a digital basin delineation program developed at EDC (Jenson, 1985). The darker blue polygons are Areas Subject to Inundation (ASI) as automatically delineated from the Digital Elevation Model, each representing small non-contributing areas, depressions, or closed sub-basins. Dark-blue lines are thresholded from a flow-accumulation image, forming lines that represent drainage. These were also automatically delineated from the DEM. The lighter-blue area is the basin representing the Bitter Lake sub-watershed, an important hydrologic feature at the bottom of the closed hydrologic basin. The source of the Big Sioux River is just below and to the right of the closed basin. Whether the closed basin will someday naturally begin to flow into the Big Sioux, or whether some human intervention (ditching, pumping) will be prescribed, is the subject of ongoing studies by the WRD and Federal Emergency Management Agency (FEMA) that will use the database built at EDC. This work is funded by FEMA, and is being done cooperatively with WRD, Natural Resources Conservation Service, South Dakota State University, and the South Dakota Department of Environment and Natural Resources.



## LAND COVER CHARACTERIZATION

Land cover mapping was completed for 22 of the conterminous U.S. states in fiscal year 1998, bringing the total number of states completed to 29 from Federal Regions 1, 2, 3, 4, 5, and 7. The remaining 19 states will be completed in fiscal year 1999, as shown in figure 6. This land cover data set, based on 30-meter resolution Landsat thematic mapper (TM) data, provides the most detailed

### *Regional Land Cover Characterization*

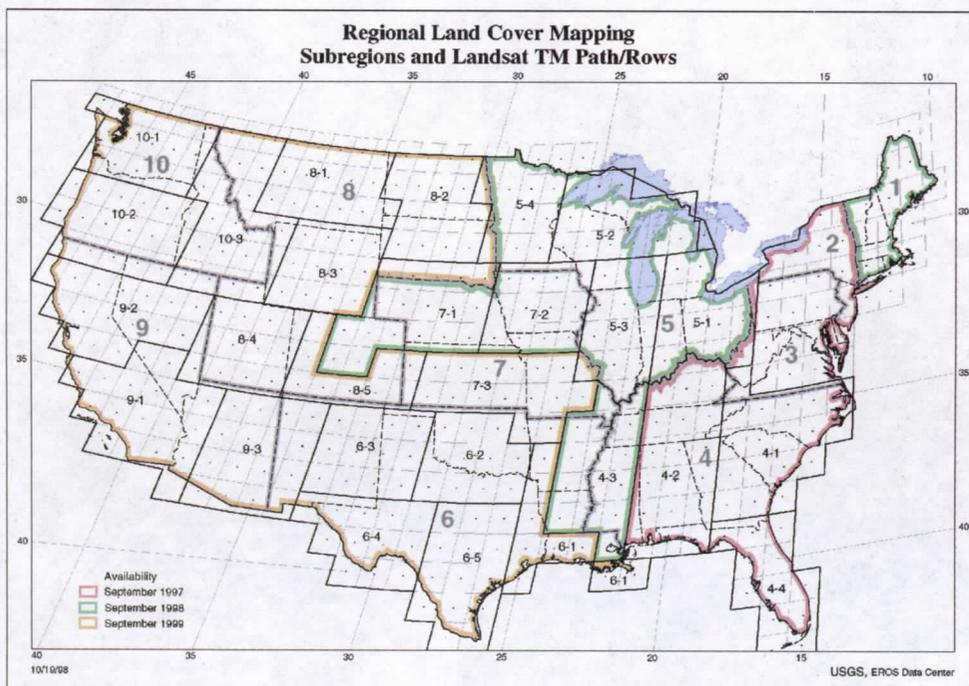


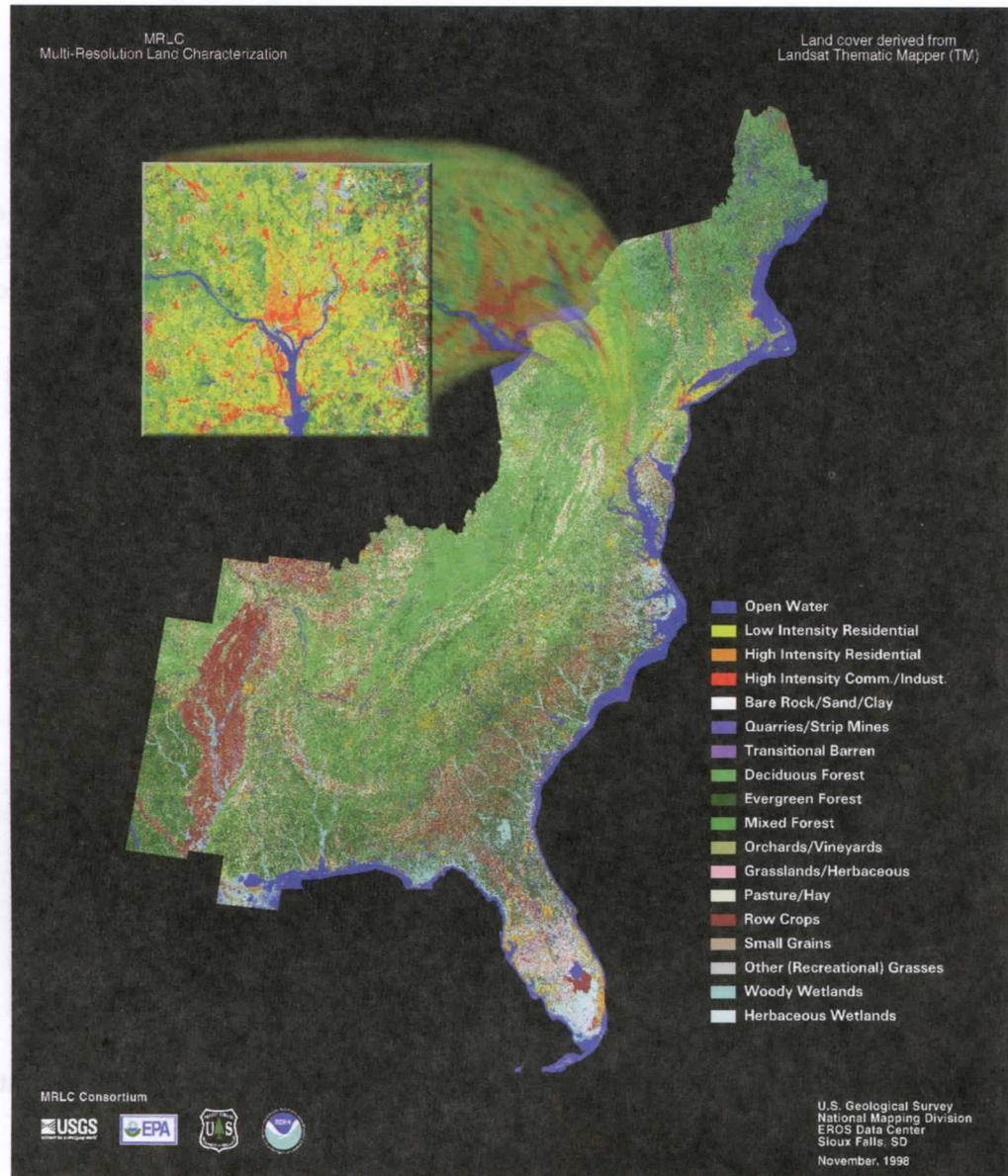
Figure 6

data ever collected for a national land cover program. An accuracy assessment of Federal Region 2 was performed to test a methodology utilizing statistical sampling with aerial photography as ground truth, shown in figure 7. The methodology was shown to be statistically sound, practical in its protocols and implementation, and cost effective. An accuracy assessment will be done for each Federal Region following a revision cycle that incorporates feedback from Multi-Resolution Land Characteristics (MRLC) Consortium partners and other affiliated users. Specialized land cover products are provided to the EPA, NOAA, and National Water Quality Assessment (NAWQA) project study units and other MRLC partners as the regional data sets are completed. A significant portion of this land cover mapping effort, Federal Regions 1, 9, and 10, is being accomplished through private-sector contracting. This private-sector involvement has proven to be very beneficial for meeting both production and budget goals.

The complete Version 1 global land cover characteristics database was released via the EDC DAAC Web site (<http://edcwww.cr.usgs.gov/landdaac/glcc/glcc.html>) early in the fiscal year. The database includes seven land cover data sets, as well as the source data used in the mapping. To date, over 550 users

### *Global Land Cover Characterization*

Figure 7



from over 60 countries have registered their applications of the data with the project team. Approximately 35 percent of the applications involved large-area environmental modeling including climate, carbon budgets, and ecosystem dynamics. Over 30 percent of the applications dealt with conservation assessments and 15 percent were for mapping studies. Prominent applications include:

- World Resources Institute Global Watersheds Vulnerability Assessment
- University of Wyoming global carbon budget modeling
- European Centre for Medium-Range Weather Forecasts numerical weather prediction
- E.O. Wilson Biodiversity CD-ROM
- National Geographic Society Satellite Atlas of the World
- United Nations Food and Agriculture Organization Global Forest Resource Assessment 2000
- NASA Earth Observing System MODIS At-Launch land products generation

The project team also fostered a strong scientific relationship with the International Geosphere-Biosphere Programme (IGBP), and EDC staff played key roles in several international IGBP workshops focused on fostering regional applications of the global land cover characteristics database. Based on user feedback, a complete revision of the Version 1 global database will be completed in fiscal year 1999.



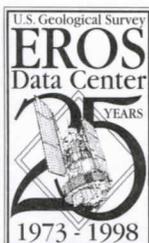
## INTERNATIONAL ACTIVITIES

### *UNEP/GRID Sioux Falls*

The North American node of the United Nations Environment Programmes Global Resources Information Database, UNEP/GRID-Sioux Falls, has been operational since 1991 as a partnership between UNEP, USGS, and NASA. At the beginning of 1998, the EPA and the U.S. Forest Service (USFS) also joined the partnership for the next 5 years. UNEP/GRID-Sioux Falls serves as a window for the United Nations community into the activities of its North American partner organizations particularly related to integration, analysis, and visualization of environmental data sets.

The Democratic Peoples Republic of Korea (DPRK) project, implemented at the request of UNDP, includes maps at 1:1,000,000- and 1:200,000-scales providing a reconnaissance survey of land cover, landforms, and crop-use intensity of the DPRK derived from remotely sensed data. A report titled "Landform, Land Cover, and Crop Use Intensity Mapping for Agriculture Rehabilitation and Food Security in the Democratic Peoples Republic of Korea" describes the mapping activities and highlights areas of cropping intensification using declassified Corona imageries and Landsat satellite images. The report on "Linking Population, Environment and Shared Resources in Africa" was funded by the Japanese Government. The basic objective was to assess regional environmental issues, analyze the spatial relationship between population and protected areas, and provide quantitative information on transboundary protected areas and drainage basins using globally consistent and comprehensive geospatial data sets to catalyze international cooperation. Four analytical studies that were also completed during 1998 were "Biodiversity-Rich Ecoregions in Africa Needs Protection," "Status and Trends in Spatial Data Handling Software 1997," "Methodology for Forest Fire Potential-Global Forest Fires Watch," and "A Database on Environmental Conditions, Resources and Violent Conflicts." UNEP/GRID-Sioux Falls also created the first World Wide Web (WWW) site within UNEP to raise global awareness of Indonesian forest fires. The three major activities in 1998 were the Democratic Peoples Republic of Korea (DPRK) Crop Use Intensity project, and two technical reports titled "Linking Population, Environment and Shared Resources in Africa," and "Forest Fires and the Environment: A Global Synthesis" as a part of UNEP's Global Environment Outlook (GEO 2) report produced in cooperation with a number of partners.

Of special interest is the implementation of the DPRK project database using the Internet Map Server technology developed by the Environmental Systems Research Institute (ESRI), Inc. which allows users to visualize and analyze Geographic Information System (GIS) databases using Netscape Browser. ESRI, Inc. donated the necessary software and provided training to staff. UNEP/GRID-Sioux Falls also received funding from the U.S. Federal Geographic Data Committee (FGDC) for the design and implementation of an International Standards Organization-compliant clearinghouse node for UNEP metadata, including migration of the UNEP metadata standard to the ISO standard.



The EROS Data Center, in partnership with USAID and Senegal's Center for Ecological Monitoring (CSE), has developed a long-term monitoring framework to better understand and document the rapid changes that are occurring in Senegal's natural resources. The monitoring approach has been tested by the project team, and embraced by the CSE. It entails a three-tiered approach using the combined strengths of (a) ground site investigations (biophysical and socio-economic), (b) repetitive airborne videography, and (c) high-resolution satellite remote sensing spanning 35 years. The approach is applicable to other parts of the world.

The efforts of the past year have focused on data analyses and producing image and map products that Senegal's environmental policy makers can use to better understand the rates, magnitudes, and causes of change. The findings are giving cause for concern. The project team has shown evidence of a downward spiral of environmental conditions in the past 35 years leading to deterioration of the country's soil, water, and vegetative resources. The main forces of change are from human pressures. The basic conclusion is that rapid population growth has triggered, and continues to stimulate, environmental degradation. Population pressures, coupled with unsustainable agricultural policies and practices, and declining rainfall, have worked in a synergistic way to erode the diversity and health of Senegal's natural resources.

EDC and CSE scientists have tapped into an extensive archive of Corona photographs that provide an invaluable photographic record of the Earth back to 1960. One example of dramatic change that the team documented is in an ecologically-diverse region in west-central Senegal. Figure 8 provides a photographic

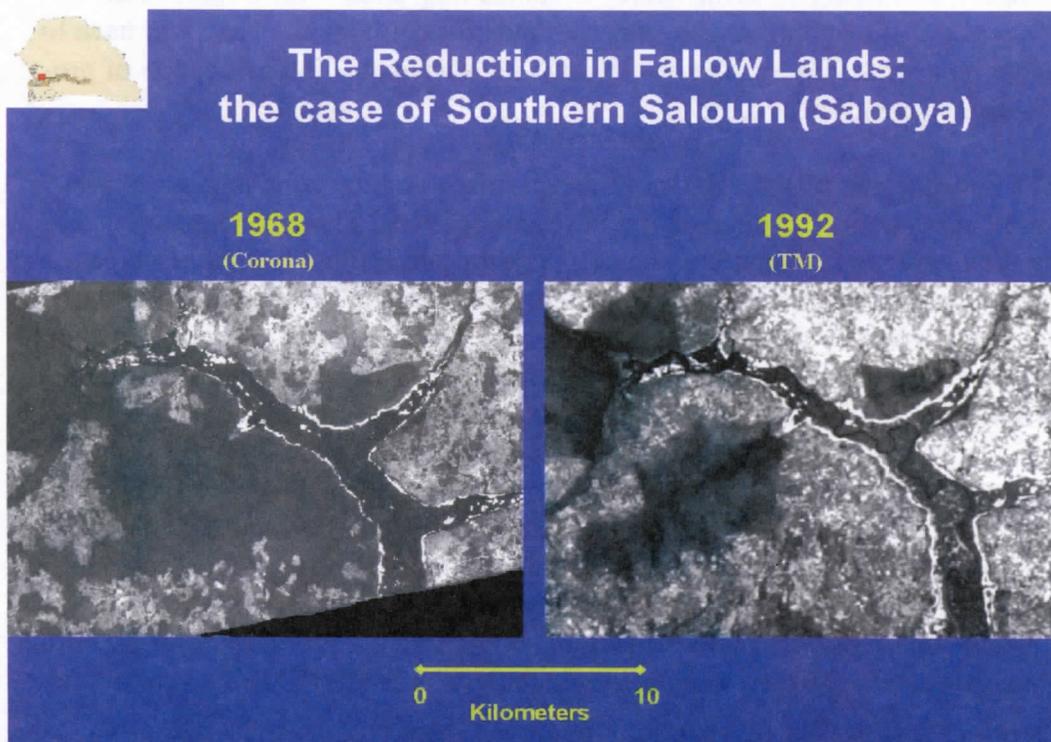
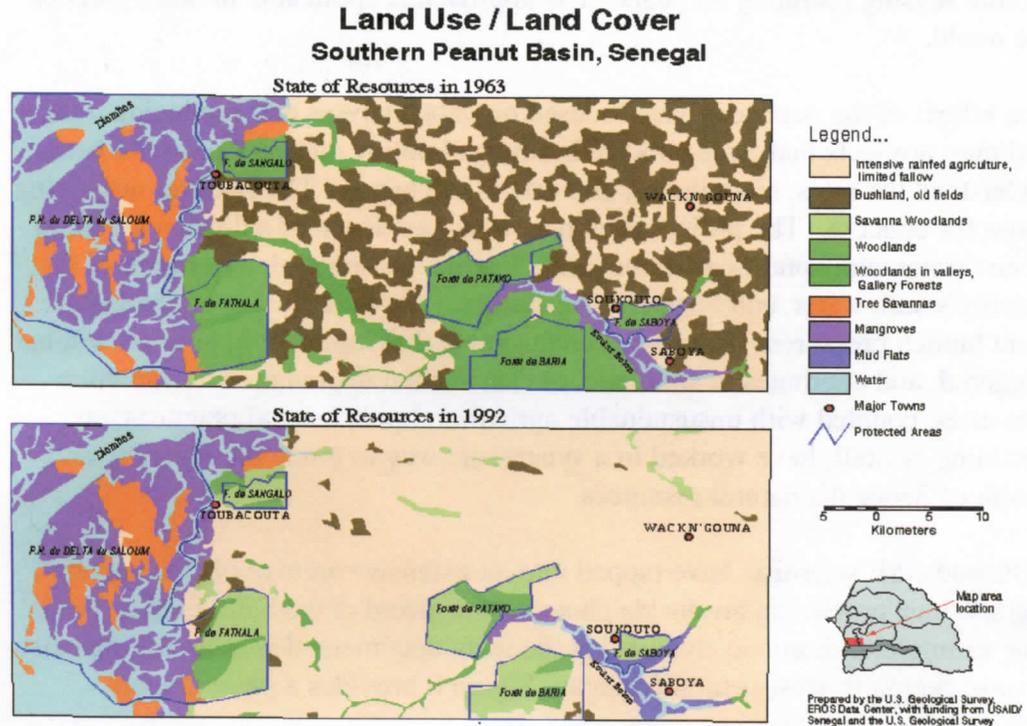


Figure 8

comparison of parts of a Corona photograph, left (January 31, 1968), and a Landsat thematic mapper (TM) band 3 image, right (October 31, 1992). Geographic features include a major estuary bordered by mangrove swamps, and several protected woodlands (dark-toned areas) and bushlands (dark patches among the light-toned agricultural areas). The major decline in woodland and bushland areas can be seen in the 1992 TM image. Figure 9 presents paired land use and land cover maps of the region, prepared from Corona and Landsat TM

Figure 9

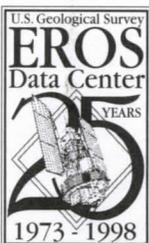


imagery, and field and aerial surveys. As the map shows, local farmers no longer have the option of opening new lands for cultivation. They will have to adopt new strategies for survival through the sustainable intensification of production on existing land.

**Sahel Land Use/Land Cover Mapping**

The Sahel region of West Africa is a semi-arid transition zone that has experienced significant land degradation in recent decades. This phenomenon is driven by the interaction of mounting human pressures on limited natural resources, and climate variability resulting in decreased precipitation. Fundamental questions are being asked by the region's environmentalists and policy makers: How and why does land cover change? How much, and how fast is change occurring? What is the significance of the change that has occurred in recent decades?

The goal of this activity is to collaborate with West Africa's regional environmental monitoring and development agency (CILSS Permanent Interstate Committee for Drought Control in the Sahel) to introduce an improved long-term environmental monitoring capability, and to attempt to answer the fundamental questions about a changing environment. Scientists from the EROS Data Center are working with their counterparts at AGRHYMET (Agriculture-



Meteorology-Hydrology) and Insah (Sahel Institute), two technical agencies of CILSS that monitor environmental, agricultural, and socioeconomic conditions across the region. The joint project is demonstrating and transferring a practical approach to land use and land cover mapping over time, using early Corona satellite photos from the 1960's, and Landsat images from the 1970's through 1990's. The approach is being tested on four case study areas in the countries of Niger, Mali, Burkina, and The Gambia. The resulting maps will be evaluated along with supporting socioeconomic data to better understand the magnitudes, rates, and causes of change over a 30-year period.

EDC processed fire and cloud data for the 1997 burn season (August-December) for Madagascar from Defense Meteorological Satellite Program On Line System images provided by the National Oceanic and Atmospheric Administration/National Geophysical Data Center. The data were made available to the U.S. Agency for International Development/Madagascar in quasi-real time via anonymous file transfer protocol in both image and vector format, and in geographic coordinates and Laborde projection. All fire and cloud data for 1992-1997 were also provided on CD-ROM at the end of the season. A workshop/training session was provided for staff at Madagascar environmental agencies in Antananarivo, Madagascar, in February, 1998. The workshop provided training in the analysis of fire data in Idrisi geographic information systems software, the development of programs to derive fire index for given temporal and spatial intervals, and comparison of fire events with Landsat Thematic Mapper (TM) and ground truth readings. Subsequent analysis of the fire data was undertaken to determine trends in fire events within and between years. A fire index, describing the frequency of fire events related to non-cloud observations, was developed and applied to monthly composites. Preliminary results suggest there was a slight decrease in fire activity in 1994 due to a burn ban (September-December), although the decrease appears significant only during October. It also appears that there are significant fire events within Protected Areas and National Parks.

*Sustainable  
Approaches to Viable  
Environmental  
Management in  
Madagascar*

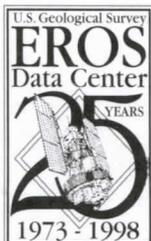
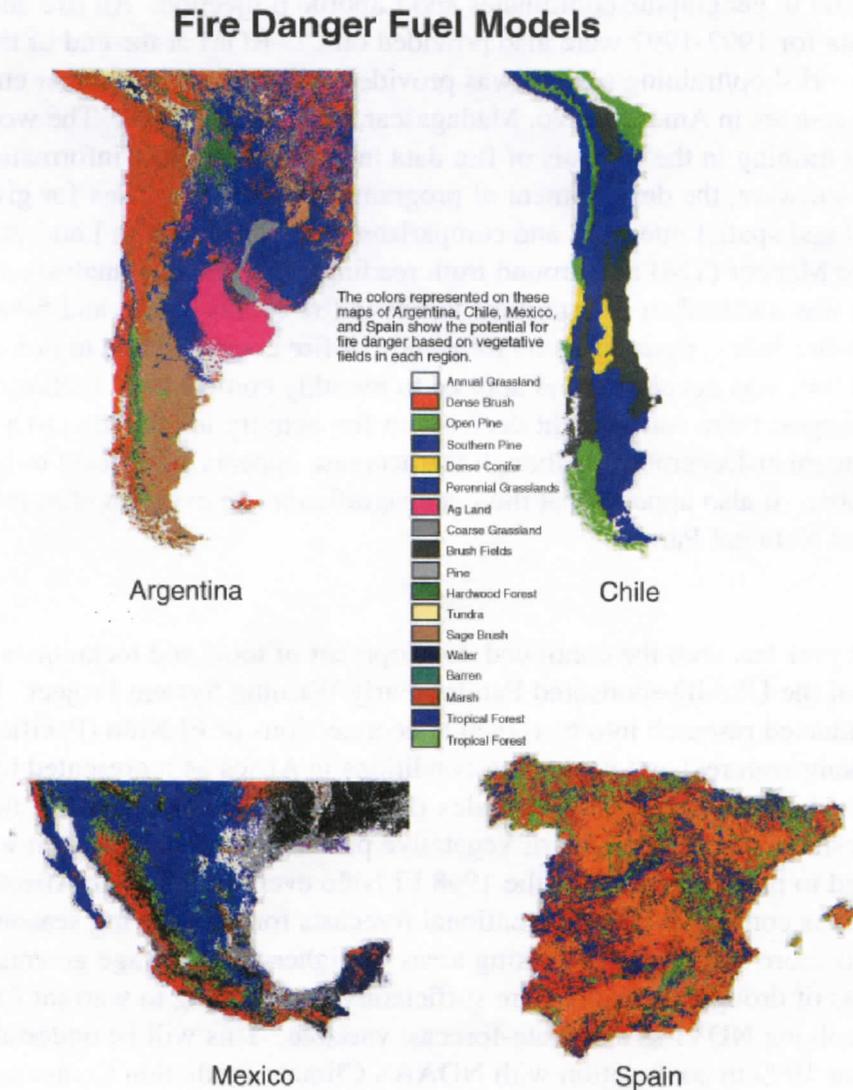
The past year has seen the continued development of tools and techniques in support of the USAID-sponsored Famine Early Warning System Project. EDC staff conducted research into historical teleconnections of El Niño (Pacific sea-surface temperatures) and vegetation conditions in Africa as represented by the Normalized Difference Vegetation Index (NDVI). NDVI is a quantitative measure used to estimate green biomass or vegetative productivity. The research was conducted to project impacts of the 1998 El Niño event in Southern Africa. The forecast was consistent with conventional forecasts for the growing season. The method is more skillful in forecasting areas of higher-than-average greenness than areas of drought. Results were sufficiently encouraging to warrant further work involving NDVI as a climate-forecast variable. This will be undertaken in fiscal year 1999 in cooperation with NOAA's Climate Prediction Center and the University of California at Santa Barbara.

*Famine Early  
Warning System  
(FEWS)*

**Digital Imagery for Forest Fire Hazard Assessment**

In 1997, a Fire Potential Index (FPI) was developed by EDC and the U.S. Forest Service through the Pan-American Institute of Geography and History's (PAIGH) project "Digital Imagery for Forest Fire Hazard Assessment in Mediterranean Ecosystems." The FPI assesses the probability of occurrence of fire, at a 1-kilometer resolution over large areas on a real-time, daily basis. In 1998, the project expanded to calculate and validate the FPI in many other ecosystems within the Americas. A sensitivity analysis was done for the FPI model to determine the model inputs that contributed most to the variability of the model output. The FPI was calculated and validated for the conterminous United States for the period of 1992 through 1997. Near-time daily calculations of the FPI are being completed for the conterminous United States and are available to the public and fire and land managers over the Internet. The FPI was customized and implemented at nine Federal and State land management organizations within the Western United States. Fire fuels were mapped and the FPI is being calculated and validated for the time periods of 1992 and 1993 for the countries of Argentina, Chile, Mexico, and Spain, as seen in figure 10. In 1999,

Figure 10



the project will map the fire fuels and calculate and validate the FPI for 1992 through 1997 for the country of Venezuela. The FPI will also be calculated and validated for 1995 through 1997 for Argentina, Chile, Mexico, and Spain.



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## INFORMATION AND DATA SERVICES

### *Business Partners*

In a significant expansion of the longstanding USGS Business Partner Program, EDC began during 1998 to work with both aerial photographs and digital cartographic data. The intent of the program expansion is to move the USGS toward a wholesale business environment, rather than its traditional direct dealings with end users of its products. The change is encouraged by Congress and the Clinton Administration, both of which urge more engagement with the private sector. Additionally, the expansion is designed to get more data to more users, faster than the USGS can deliver the data directly.

Near the end of 1998, more than 24 companies had executed Business Partner agreements for the data lines held at the EDC. They included some new partners, but also some partners of long standing who do large volumes of business with the NMD.

### *Customer Services*

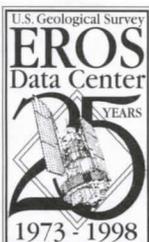
Customer Services handled \$13.99 million in product sales, up from \$10.64 million the previous year. In terms of items delivered, the difference was an increase from 590,432 to 746,420 items. The ability to handle the increase in sales is attributable, in part, to an increasing proportion of customers filing orders electronically, through online systems. With that change, however, comes an increasing demand for assistance in using those systems. An ever more sophisticated suite of technical products also calls for more applications assistance by Customer Services personnel.

### *World Wide Web*

The EDC Web Team, which creates Web pages and ensures compliance with Center, Division, and Bureau guidelines, released a new, streamlined home page in 1998. In addition, the Web Team created two new, easy interfaces for finding and ordering certain products. Called Map Finder and Photo Finder, the interfaces are easier to use than the Global Land Information System (GLIS) and are credited with enhancing the shift of orders to the Internet. Customers can order topographic maps and National Aerial Photography Program (NAPP) products through these interfaces. Map Finder and Photo Finder were written because customers indicated a need for such interfaces on a user feedback mechanism earlier written into GLIS by the Web Team. The EDC is committed to using more feedback buttons to determine customer needs and desires for an increasingly automated, online system.

### *Cartographic Data Sales*

The EDC is home to the National Mapping Division's Sales Data Base, which manages and serves digital cartographic products. These consist of Digital Orthophoto Quadrangles (digitized geo-rectified aerial photos), Digital Line Graphs (layers of map information), Digital Elevation Models (terrain data digitized from topographic maps), and Digital Raster Graphics (whole, scanned topographic maps). The Sales Data Base holdings now total more than 290,000



products and all may be ordered online through GLIS. Figure 11 represents EDC cartographic data sales for fiscal year 1998.

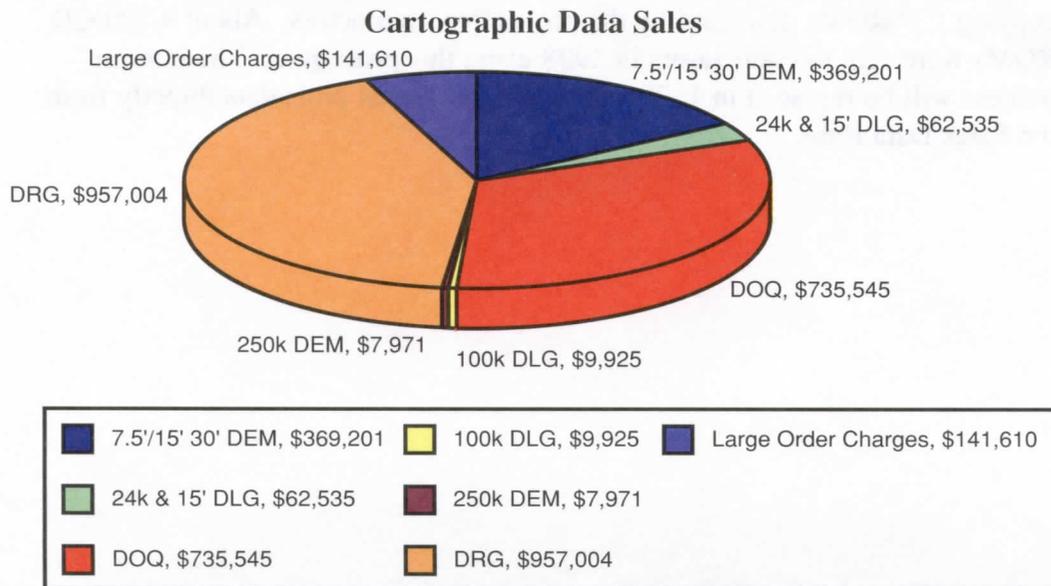


Figure 11

More than 50,000 National Aerial Photography Program (NAPP) products were added to GLIS for public access. The National High Altitude Photography Program (NHAP), the predecessor to NAPP, was released to GLIS, providing an additional 325,000 records of aerial photos for online access to the public.

#### *NAPP Sales*

EDC participation in the Global Learning and Observations to Benefit the Environment (GLOBE) Program included materials for 3,000 participating schools generated by the Data Center's Data Production unit. The Program fully reimburses the Data Center to provide Landsat thematic mapper (TM) data, centered over each school, on floppy disks, as well as color prints of the derived images.

#### *GLOBE Support*

EDC is responsible for diapositive and paper print production associated with the NMD Digital Orthophoto Quadrangle (DOQ) program. These products are generated from the original photos, some of which are held at the EDC and some of which are at the Department of Agriculture's Aerial Photography Field Office (APFO) in Salt Lake City. In 1998, about \$750,000 worth of these products was purchased by NMD from the APFO, in support of DOQ production.

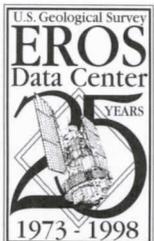
#### *Diapositive Production*

EDC also participates in innovative partnerships arranged by the National Mapping Division's Coordination and Requirements staff. One such agreement, with the State of Louisiana, is of special interest to the EDC as it involves DOQ production without the use of diapositives. The EDC provides original color-infrared photos to Louisiana, where they are scanned and used for aeriotriangulation.

**Cooperator Delivery**

During 1998, the EDC commenced distribution of data to cooperators and Department of the Interior high-priority customers through the Sales Data Base. DOQ distribution to cooperators started mid-year, with an interim process of copying CD-ROMs delivered by the production contractors. About 4,200 CD-ROMs were sent to cooperators in 1998 using this procedure. The interim process will be replaced in 1999 with a procedure that pulls data directly from the Sales Data Base.



## SYSTEMS DEVELOPMENT

EDC participated in a cooperative research and development agreement (CRADA), with Microsoft Corporation, to market Digital Orthophoto Quad (DOQ) data to the public. Microsoft wanted a large data set, a terrabyte worth of data, to demonstrate the ability of Microsoft's structured query language (SQL) server database to handle large amounts of data efficiently through a Web interface. The Digital Orthophoto Quadrangle data set was selected because of the size of the data set (over four terrabytes of data) and the interest the DOQ would have with the general public. EDC's portion of the project was to create a Web site, shown in figure 12, to receive orders from the Microsoft site, take credit

*Information  
Systems*



Figure 12

### Select Payment Method [Help](#)

Your purchase will cost \$123.50. Please decide how you would like to continue processing and press the "Submit Order" button below.

Subtotal: \$120.00

Handling: \$3.50

**TOTAL: \$123.50**

#### Credit Card Via SSL

No additional software is required to pay using this method. Simply enter your information into our secure forms.



Submit Order

#### Microsoft Wallet

Use the Microsoft Wallet to make your purchase. The wallet is compatible with Netscape Navigator 3.0 and Internet Explorer 3.0 or higher. After clicking the link, this plugin will automatically load if you do not have it already.



Submit Order

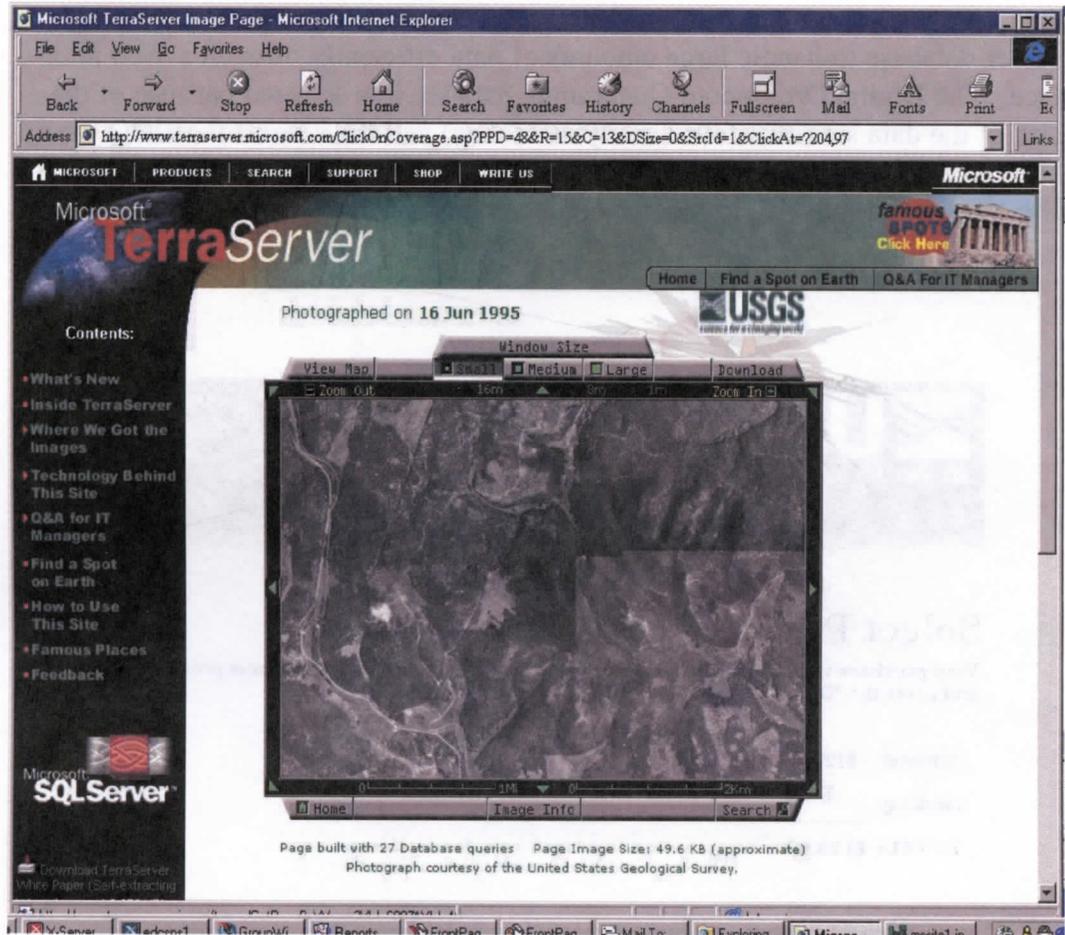
#### Secure Electronic Transaction

**(Coming Soon)**

You will still have a chance to change or cancel your order.

card payments securely through the web, and deliver the product to the customer on CD-ROM. EDC staff developed a secure payment page using Microsoft software and Secure Socket Layer (SSL) technology. EDC has delivered 325 DOQ images in fiscal year 1998 to customers through the Microsoft TerraServer site, as seen in figure 13.

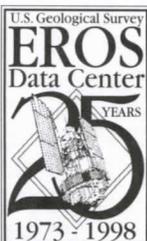
Figure 13



The TerraServer site was released in June, 1998, to the general public. Figure 14 shows the average number of hits per day, for the Microsoft TerraServer site:

Figure 14

Month	Unique Users	Hits	Page Views	DB Queries	Images Displayed
June	59,373	20,122,134	2,302,602	6,514,348	4,504,343
July	52,850	10,204,200	1,985,154	9,598,427	8,040,736
August	47,388	6,798,796	1,092,942	6,253,120	5,397,487
September	47,933	6,176,010	952,599	5,640,884	4,901,582



The new Distributed Ordering, Research, Reporting, and Accounting Network (DORRAN), the accounting program for ordering and tracking products, was implemented in July. The components of the DORRAN system consist of:

**Oracle database residing on a Silicon Graphics server:**

- NT Servers to serve the Oracle forms at each of the main Earth Science Information Center (ESIC) offices around the nation
- Credit Card server at EDC for verification of credit card orders
- NT Server at EDC for X-terminal users and satellite ESIC office connectivity
- PCs to run the Oracle forms and reports
- Web server to store the help documentation and batch print files

EDC staff traveled to NMD ESIC sites to provide training on the new system.

New features in the system include:

- Centralized billing and accounting
- Global accounts between sites
- Secure credit card verification and tracking within the system
- Online order entry
- Centralized database for reporting
- Bar code status of orders

The ESIC sites worked with the EDC Data Services and Software Development team to correct problems when the system was first implemented. Software development staff continue to upgrade and enhance the system with new features.

The Land Analysis System (LAS) was enhanced to include Datum Conversion within the map projection capabilities. LAS is an integrated digital analysis system designed to support remote sensing, image processing, and geographic information systems applications and research. A work-management process that involves the users in determining work plans is now in place. During this fiscal year, 250 software requests for repairs and enhancements to LAS were completed. A modernization project for LAS has been initiated. This project is aimed at longer-term stability, viability, and relevance of LAS. Requirements are being gathered from both the user perspective and the systems-support perspective, while technology exploration has also begun to determine the appropriate role of commercial off-the-shelf (COTS) and government off-the-shelf (GOTS) systems in the future architecture of LAS.

*Scientific Systems*

## *Cartographic Systems*

Software to support loading of the National Hydrography Dataset (NHD) data into the Feature Operational Database (FOD) was completed. Prototypes to support visualization and distribution of the National Hydrography Dataset (NHD) were also completed. These prototypes provide functionality, utilizing Environmental Systems Research Institute (ESRI) software, to:

- facilitate on-line display of data (using Applied Research Corporation Explorer) that is loaded into the Feature Operational Database (FOD);
- demonstrate more clearly the NHD utilizing the Digital Line Graph-Feature (DLG-F) based model using MapObjects Lite; and
- provide an enhanced access gateway to distribute NHD data to cooperators utilizing MapObjects Internet Map Server.

Software maintenance and development activities were improved by establishing a Configuration Management system for all DLG-F components developed at EDC. This system defines a development, system test, and production environment to control all software developed and modified. The DLG-3 to DLG-F batch conversion production system and prototype software was released from this system. All DLG-F system component software, both COTS and custom, were investigated for Year 2000 compliance. All non-compliant software components were identified for fiscal year 1999 work-off and resolution.

Cartographic Systems Development staff continue to participate actively in the activities of the OpenGIS Consortium (OGC) by participating in technical committee meetings and contributing to draft specifications.

## *Process Engineering*

Early in the year, the Process Engineering Team (PET) reviewed and obtained an initial order of process engineering software, conducted user software training, and briefed the EDC Senior Staff on future process engineering solutions and resource requirements. These solutions and resource requirements were refined when the PET conducted a business practice analysis, in conjunction with a consultant, resulting in a series of implementation recommendations. As one result of the analysis, the PET defined a need for several specific near-term projects and goals for the Center. Those project goals included:

- Work Definition and Organization
- Milestone Reviews
- Project Initiation
- Communication
- Deliverables Management



Several process engineering (PE) activities are being coordinated. The Software Engineering Process Improvement Project is well underway. The Budget Development Process has been completed in the Program, Budget and Administration Office, and work started on several additional business processes, including procurement workflow and the agreements and contracting process. The PE training and implementation plan is being further developed. The Project Plan for Process Engineering Activities, a PE briefing for use at Department and Branch meetings, and a proposal, "Structure for Project Management", have been prepared. The first and second issues of The PROCESS, an EDC process engineering/process management newsletter, were distributed Centerwide and placed on the EDC Home Page.

A cross-disciplinary team of engineers, system administrators, and software developers was formed to address Year 2000 issues as they apply to mission-critical and non-mission-critical systems at EDC. This team wrote plans and executed tests and certification procedures to mitigate and, in most cases, eliminate risks from date calculation problems after the year 2000. The mission-critical systems included the Sales Data Base Servers, Global Land Information System (GLIS), Distributed Ordering, Research, Reporting, and Accounting Network (DORRAN), and National Landsat Archive Production System (NLAPS). The certification and test plans were prepared and executed in accordance with the Department of the Interior Year 2000 Certification Policy, the USGS Year 2000 Policy, and the National Mapping Division Year 2000 Project Management Plan. The Y2K team conducted system inventories and identified those software modules and databases containing date fields and subroutines that may be affected by the year 2000. These systems were tested for possible failures in interpreting date information. Subroutines and databases that failed the tests were repaired and tested again. All mission-critical systems have been tested and certified, and contingency plans are in place for the year 2000.

Engineers evaluated the performance of key processing and distribution systems at EDC. This analysis resulted in a migration from magneto-optical technology to real-time application interactive debugger (RAID) technology for Web-based distribution and the addition of a new Custom Image Processing System with eight Silicon Graphics, Inc. (SGI) central processing units. Mass storage engineers wrote benchmark plans to investigate and characterize storage technologies against data set attributes for size and data availability. Technologies of study include new tape storage devices and Hierarchical Storage Management Systems.

A project was initiated to survey the current landscape for industry-best practices in software methods with a goal to achieve Capability Maturity Model (CMM) Level 3. Several major milestones were achieved to improve software processes at EDC. Software engineers analyzed the techniques developed by other CMM Level 3 organizations, selected tools to deploy, and developed a road map and corresponding training agendas for implementation of these tools and practices on high-priority breakthrough projects.

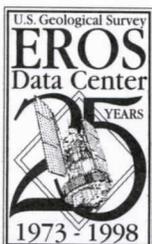
### *Year 2000 (Y2K)*

### *Automated Data Processing (ADP) Transition Strategies*

### *Software Development Methodologies*

**Network  
Engineering**

EDC's LAN (Local Area Network) received network technology upgrades that included switched 100-mega-bytes-per-second (Mbps) Fast Ethernet, switched 100-Mbps FDDI (Fiber Distributed Data Interface), and implementations of selected 155-Mbps ATM (Asynchronous Transfer Mode). Additionally, EDC embarked on the requirement analysis, design, procurement, and implementation of a networking infrastructure to support a high-speed, high-capacity network interchange. This network interchange will be used to transport earth science data to internal and external EDC customers. Planned WAN (Wide Area Network) interfaces received technology hi-grades supporting data bandwidths up to 155-Mbps. Also, several 45-Mbps WAN interfaces were developed, integrated, and deployed for operations during fiscal year 1998. Additionally, EDC network engineering staff continued with phased development, implementations, and augmentations to EDC's network monitoring and reporting systems. Also, in response to EDC mission and programmatic requirements, EDC continued active participation in strategic network planning of the Administration's Large-Scale Networking and Next Generation Internet initiatives.



## SATELLITE SYSTEMS

A major new initiative during the year was the development of a cooperative project with a number of universities in the State of Ohio called the OhioView Consortium. This project was created in response to a Congressional appropriation that called for augmentations to the EDC's infrastructure and for the EDC to initiate a pilot project with this group of universities. OhioView's mission is to promote the distribution and application of U.S. Government data for public use. The consortium will encourage the wide application of the next generation of satellite data and other earth science products in Ohio. Consortium participants are represented in figure 15 and include: Bowling Green University, Kent State University, Miami University, the Ohio State University, Ohio University, and the University of Cincinnati. OhioView researchers will use the satellite data for applications in disciplines such as agriculture, cartography, education, forestry, geology, urban planning, and hydrology.

*OhioView*

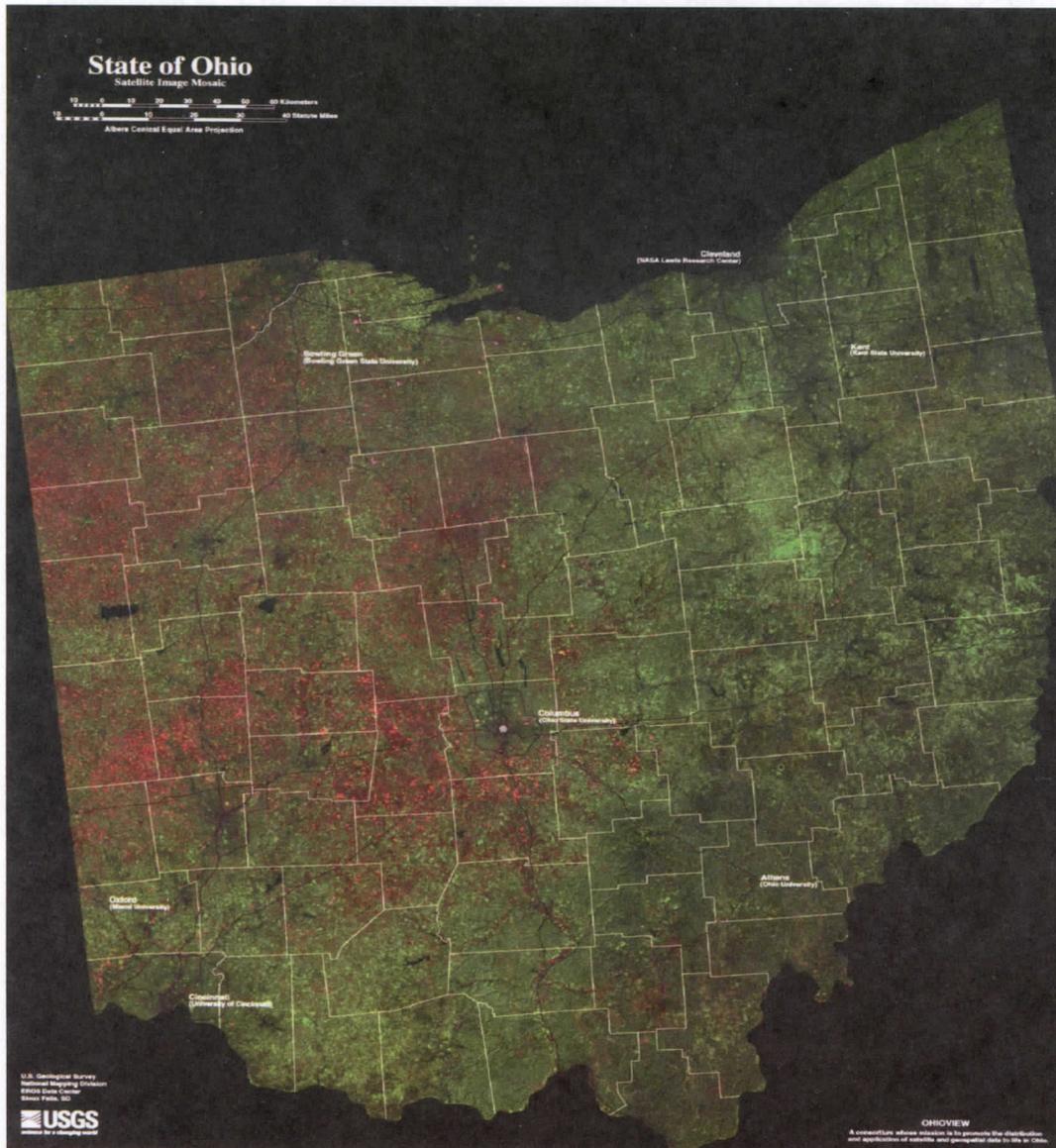


Figure 15

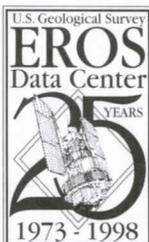
EDC will provide access to high-volume data and products from satellites such as Landsat 7 and EOS AM-1, and other earth science products over high-speed networks between the EDC and consortium members. To provide these capabilities, EDC will enhance its networking, information access and delivery, and product generation infrastructure. The project is developing the requirements specifications, and design and procurement documents for the enhancements to the EDC infrastructure. Procurement is underway for the hardware augmentations to the EDC networks and Landsat 7 production system. A contract for the software to create Landsat 7 products has been signed with MacDonald Dettwiler and Associates. Under this contract, the existing National Landsat Archive Production System (NLAPS) capabilities will be upgraded, new capabilities to process Landsat 7 data will be added, and a series of options have been identified. These options include such items as the capability to generate browse and metadata for SPOT 1-3 data. The high-speed network connection between EDC and Lewis Research Center (LeRC) has been established and testing begun. EDC is also upgrading its internal networking capabilities. EDC is developing a new information access capability that will provide an easy-to-use, tailored-user interface for OhioView Consortium members and others to locate, peruse, and order earth science data.

EDC hosted two visiting scientists from the consortium this summer as part of the Memorandum of Understanding that has been signed between the USGS and OhioView Consortium. Drs. Richard Beck and Larry Mayer worked on developing applications, and understanding the capabilities and data sets available from the USGS. NASA's Lewis Research Center (LeRC) is also participating in the project. LeRC will provide networking, visualization and image processing, and archiving expertise to the consortium. Information on this cooperative project is posted on the WWW at: <http://edcwww.cr.usgs.gov/OhioView/> or on the OhioView Consortium homepage at: <http://www.ohioview.org/>.

### *Landsat Program*

The Landsat 7 team continued preparing the Data Handling Facility (DHF) for full-time operations. The rest of the Landsat 7 Ground Station is nearing operational status, but final check-out and testing continues in preparation for the launch of Landsat 7 scheduled for mid-April 1999. Final updates to the DHF software will be made in December 1998, with a projectwide freeze beginning in January 1999. The DHF has been processing data from the satellite (on the ground at Valley Forge, PA). In addition to testing the Landsat 7 processing system, this serves to test the satellite as well. Three quarterly management meetings were held at EDC and one at the Goddard Space Flight Center, Greenbelt, MD, to ensure operational readiness by launch.

The EDC hosted the 27th Landsat Ground Station Operations Working Group in May. Over 40 individuals, representing 15 countries, the European Space Agency, and three U.S. Federal agencies (NASA, NOAA, USGS), attended. The group is comprised of representatives from international ground receiving



stations responsible for processing, archiving, and distributing Landsat data. The purpose of the three-day meeting was to coordinate global Landsat acquisition, processing, and archiving strategies for product generation of Landsat 7 data worldwide.

The EDC DAAC distributed more than 500 gigabytes of data to users via the Internet and more than 23,200 data products on hard media. Most DAAC products are simple copies of items in the DAAC's data holdings. However, the DAAC does perform production processing for some data products. For example, during the year the DAAC produced more than 6,600 AVHRR Orbital Segments and 2,400 Spaceborne Imaging Radar-C (SIR-C) precision products. The DAAC's data holdings grew significantly in fiscal year 1998. The DAAC ingested more than 900 Landsat scenes into the NASA Landsat Data Collection, and six additional test sites into the Global Land Cover Test Site data set. This brings the DAAC data holdings to more than 47,600 data items totaling approximately 11.3 terabytes. Information about EDC DAAC data and services, is available on the Web at: <http://edcwww.cr.usgs.gov/landdaac/>.

*EDC Distributed  
Active Archive  
Center (DAAC)*

In February, a major milestone was reached when the delivery and installation, of the first set of EOSDIS Core System (ECS) Release 2.0 software was successfully completed. Since then, the DAAC has supported the delivery, installation and initial acceptance testing of many major software deliveries and patch releases. Most recently the DAAC completed initial installation and checkout of the software delivery containing most of the launch critical capabilities required to support initial post-launch checkout and validation of Landsat 7 and EOS satellite data. In the area of scientific algorithm integration and testing, the DAAC received delivery of five Advanced Spaceborne Thermal Emission and Reflectance Radiometer (ASTER) algorithm executables that will be used to generate higher-level ASTER science data products. All have been taken through initial inspection, installation, and checkout on DAAC ECS systems. Due to a variety of spacecraft and instrument problems, as well as a flight operations software problem in the case of EOS, the launches of both the Landsat-7 and EOS AM-1 satellites have been postponed into fiscal year 1999.

*EOSDIS Core  
System Readiness*

**Landsat Data  
Management**

The antenna installed at EDC for acquisition of Landsat 7 data successfully received Landsat 5 thematic mapper (TM) data over the Black Hills of South Dakota on September 17, 1998, as seen in figure 16. This is a historic step

Figure 16



toward fulfilling the vision of the former USGS Director and Undersecretary of the Interior, William Pecora, to acquire Earth observation imagery directly from a satellite at the EROS Data Center. Arrangements have been made with Space Imaging, the private vendor of recent Landsat scenes, to buy data through this new mechanism as needed under an agreement established for U.S. Government and Affiliated Users.

The TM and multispectral scanner (MSS) Archive Conversion System, or TMACS, was successfully tested for year 2000 compliance. Metadata receipts from Space Imaging involved processing weekly data files, resulting in more than 23,000 new scenes for entry into Global Land Information System (GLIS). Interchange tapes from the Japanese foreign ground station were also received and processed for access through GLIS.



**Wide Band  
Videotape  
Conversion**

Work commenced during 1998 to convert Landsat 1, 2, and 3 wide-band videotapes (WBVT) to computer-compatible media for long-term storage. These tapes hold data that had been acquired between 1972 and 1979. Additional NASA funding allowed the work to begin on rebuilding a system to process these 310,000 tapes, many of which are more than two decades old. The WBVT system is expected to be operational in 1999.

**Brokerage Direct  
Support**

EDC serves as a broker for certain other Federal agencies to acquire remotely sensed data that are held by other institutions and are not available directly from EDC. During 1998, brokerage activity included \$800,000 in data purchases from Space Imaging and \$360,000 from SPOT Image Corporation. An additional \$200,000 worth of other data were purchased through individual purchase orders or blanket purchase agreements with various commercial imagery providers.

**SPOT Data  
Management**

EDC reached a Memorandum of Understanding with the Spot Image Corporation, establishing a working relationship for future cooperative ventures. Preliminary engineering discussions and tests have investigated the feasibility of converting some 600,000 scenes from SPOT satellites 1, 2, and 3 from high-density computer tapes to an archival medium. These are scenes over the United States acquired from 1986 to June 1998. EDC staff are investigating several other cooperative activities under this agreement with SPOT which include:

- Preservation of SPOT 1-3 United States data currently on high density data tape;
- Processing SPOT 1-3 United States data to produce and distribute, within the U.S. Government and its Affiliated Users, system-corrected products;
- Promotion of the wider application of historical SPOT data;
- Exploring the possibility of a downlink at EDC of SPOT data for the continental U.S., including consideration of SPOT-4 Vegetation sensor data reception;
- Consultation between EDC and SPOT experts on technical topics about remote sensing, image processing, and data management; and
- Occasional joint use of facilities, hardware, and software.

Fiscal year 1998 marked the 10th consecutive year of greenness mapping of the contiguous United States, an EDC activity developed with data from NOAA weather satellites and their AVHRR sensors. The data are used to determine, through spectral analysis, the relative vigor or greenness of vegetation. The decade of greenness mapping has documented the effects of a wide variety of climatic events, including El Niño, on the forests, crops, and grasslands of the

**Greenness Mapping**

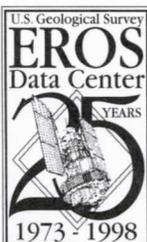
lower 48 United States. The work yields information for fire danger warning, agricultural assessment, land-cover mapping, and many scientific investigations.

***Data Production  
and Distribution  
Infrastructure  
Development***

In the constant effort to keep up with the increasing demand for EDC-held data, major developments improved the Data Center's data production and distribution capacities during 1998. These enhancements included augmenting the digital data production system with a new, high-speed computer and data storage system. Systems providing access to online products also were enhanced, resulting in faster service. The Product Distribution System received additional CD-ROM writers to meet customer demands for satellite and cartographic data products on that medium.

***Advanced Very  
High Resolution  
Radiometer  
(AVHRR) Data  
Reception***

EDC operates an AVHRR direct reception system and receives these AVHRR data through a Domestic Communication Satellite System (COMSAT) data relay. The direct reception capability is used to receive data immediately for the contiguous United States and major portions of the rest of North America. The COMSAT antenna is used to receive data over Alaska and foreign regions that are recorded on the satellite and transmitted to a ground station operated by NCAA. The data are used in national and international programs that require course-resolution satellite data for land-based environmental studies and global climate change research. Almost 200,000 AVHRR scenes are stored at the EDC.



## OUTREACH ACTIVITIES

EDC staff participated in many significant outreach activities during fiscal year 1998. Specifically, EDC Outreach Team members provided coordination, planning, graphic art, publication, and audio visual support for many EDC programs and activities throughout the fiscal year. Staff initiated and signed an educational partnership with the Bureau of Indian Affairs, Flandreau Indian School, which included helping to excess \$148,000 of furniture and equipment to the school as well as providing much needed Internet service and laptop computer equipment. Outreach staff hosted a third Global Learning and Observations to Benefit the Environment (GLOBE) teacher training workshop, and supported the participation of a Sioux Falls middle school in a NASA program called Earthman - an educational partnership offering middle school students the unique opportunity to photograph the Earth using a digital camera mounted aboard the Space Shuttle.

During fiscal year 1998, 290 public tours were given, and 20,061 visitors, including 10,285 for the 25th Anniversary Open House, came to the Center. EDC staff also participated in statewide science programs that included three Water Festivals for over 4,100 fourth grade students, South Dakota Space Day for 654 students and educators, and 27 presentations to classrooms. Additionally, several presentations were given to civic, church, and service clubs in Southeast South Dakota.

EDC Outreach staff produced a 5-minute video for the EDC Annual Meeting. This program highlighted accomplishments and activities of EDC employees throughout the calendar year. EDC video production staff also updated an 11-minute orientation video that is shown to visitors to the Center. In addition to these outreach activities, Outreach Team members supported the planning, graphic art, publication, promotion, and audio visual needs for the Center's 25th Anniversary celebration and open house, September 19, 1998. A long-list of graphic art products were produced by Outreach Team members, including a series of six promotional posters, a commemorative poster, programs, passports, exhibit booths, educational activity booths, banners, an art contest, and collateral materials such as a logo, notepad, and pressure-sensitive labels.

## Part III

## STATISTICAL DATA

*Products and Services*

In fiscal year 1998, EDC produced and distributed nearly \$14 million worth of products and services. Of the total, nearly \$7.6 million was in direct sales to outside customers and more than \$2.7 million was in products and services provided through EDC cooperative repay projects, for a reimbursable total of \$10.3 million. The remaining nearly \$3.7 million was for products and services distributed to users within the U.S. Geological Survey. In addition, nearly 4.5 million files of digital cartographic data were distributed free of charge via the Internet.

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

	Items	Dollars
Photographic Products	399,225	4,595,850
Digital Products/Processing	325,695	9,308,110
Miscellaneous	21,968	92,563
<b>TOTAL</b>	<b>746,888</b>	<b>13,996,523</b>



**EDC Annual Sales Report**  
**Fiscal Year 1998**  
**(Dollars)**

	DIRECT REPAY CUSTOMERS	EDC REPAY PROJECTS	USGS CUSTOMERS	TOTAL
<b>PHOTOGRAPHIC DATA</b>				
<b>AERIAL IMAGES</b>				
NAPP	1,811,291	42,576	1,771,573	3,625,440
Display Images / PAO	15,773	75	21,543	37,391
Other	608,302	461	22,568	631,330
<b>SATELLITE IMAGES</b>				
Landsat MSS / TM	20,198	24,586	14,160	58,944
Landsat Derivative Products	0	19,135	0	19,135
Declassified Intelligence Satellite Photography	72,642	6,060	3,115	81,817
Other	3,973	1,959	3,292	9,224
Photo From Digital Source	0	14,700	5,025	19,725
Other Photographic Data	16,513	55,427	40,905	112,844
<b>TOTAL PHOTOGRAPHIC DATA</b>	<b>2,548,691</b>	<b>164,979</b>	<b>1,882,180</b>	<b>4,595,850</b>
<b>DIGITAL DATA PRODUCTS/PROCESSING</b>				
Digital Data Processing	132,094	609,954	381,455	1,123,503
Landsat MSS	282,064	9,714	30,360	322,138
Landsat TM	2,680,232	560,460	204,988	3,445,680
Landsat Derivative Products	40,975	316,361	3,215	360,551
AVHRR Images	111,872	281,516	539,051	932,440
<b>NDCDB</b>				
7.5'/15' 30' DEM	265,251	189	103,761	369,201
250k DEM	7,455	0	516	7,971
24k & 15' DLG	45,151	168	17,216	62,535
100k DLG	4,797	0	128	4,925
2m DLG	32	0	0	32
LULC	0	0	0	0
DOQ	327,480	17,241	390,825	735,545
DRG	920,701	15,209	21,094	957,004
"Large Order" Charges	100,120	720	40,770	141,610
DAAC Products	6,310	763,149	68	769,527
Other Digital Data	18,813	20,787	35,850	75,449
<b>TOTAL DIGITAL DATA/PRODUCTS/PROCESSING</b>	<b>4,943,345</b>	<b>2,595,467</b>	<b>1,769,297</b>	<b>9,308,110</b>
<b>MISCELLANEOUS</b>				
Other Products and Services	87,129	1,076	4,358	92,563
<b>TOTAL MISCELLANEOUS</b>	<b>87,129</b>	<b>1,076</b>	<b>4,358</b>	<b>92,563</b>
<b>GRAND TOTAL</b>	<b>7,579,166</b>	<b>2,761,522</b>	<b>3,655,835</b>	<b>13,996,523</b>
Satellite Data Brokerage Fees	59,098	4,192	2,769	66,059
Satellite Data Brokerage Sales	1,198,479	87,268	101,247	1,386,993

\* Does not include no-charge electronic distribution of data.

Customer Profile  
EDC Photographic Products  
Fiscal Year 1998

CUSTOMER CATEGORY	ITEMS	DOLLARS
USGS	254,513	2,047,159
OTHER FEDERAL	23,550	376,399
<b>TOTAL FED. GOVERNMENT</b>	<b>278,063</b>	<b>2,423,557</b>
STATE/LOCAL GOVERNMENT	19,652	203,680
ACADEMIA	7,840	110,026
INDUSTRY	64,622	1,260,091
INDIVIDUALS	25,785	541,268
NON-U.S.	3,263	57,230
<b>TOTAL</b>	<b>399,225</b>	<b>4,595,850</b>

Customer Profile  
EDC Digital Data Products & Processing  
Fiscal Year 1998

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Digital Data Products \*

CUSTOMER CATEGORY	ITEMS	DOLLARS
USGS	127,625	3,587,783
OTHER FEDERAL	69,416	1,379,610
<b>TOTAL FED. GOVERNMENT</b>	<b>197,041</b>	<b>4,967,393</b>
STATE/LOCAL GOVERNMENT	12,650	207,803
ACADEMIA	15,093	413,245
INDUSTRY	61,386	1,137,867
INDIVIDUALS	34,985	480,833
NON-U.S.	4,292	1,199,451
<b>TOTAL</b>	<b>325,447</b>	<b>8,406,591</b>

\* Does not include no-charge electronic distribution of data.

Digital Data Processing \*

CUSTOMER CATEGORY	ITEMS	DOLLARS
USGS	234	776,982
OTHER FEDERAL	13	122,924
<b>TOTAL FED. GOVERNMENT</b>	<b>247</b>	<b>899,906</b>
STATE/LOCAL GOVERNMENT	0	-
ACADEMIA	0	-
INDUSTRY	0	-
INDIVIDUALS	1	32
NON-U.S.	2	1,581
<b>TOTAL</b>	<b>250</b>	<b>901,519</b>

\* Image processing or data capture tasks, such as, image registration and mosaicking, vector data capture, data base development, and image manipulation for greenness monitoring.

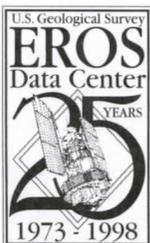
## EDC Archives and Data Bases

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

As of the end of fiscal year 1998, EDC had archived over 12 million frames of photographic data and 158,962 tapes. This includes nearly 2.9 million frames of Landsat photographic data and 54,517 Landsat data tapes. The International Landsat Data Base maintained by EDC refers to more than 1 million Landsat scenes archived in the United States, and more than 2.6 million scenes of Landsat Data held by foreign ground stations.

Category	Frames	Tapes
Photographic Data	12,000,000	158,962
Landsat Photographic Data	2,900,000	54,517
International Landsat Data Base	1,000,000	2,600,000
<b>TOTAL</b>	<b>12,000,000</b>	<b>158,962</b>

Category	Frames	Tapes
Photographic Data	12,000,000	158,962
Landsat Photographic Data	2,900,000	54,517
International Landsat Data Base	1,000,000	2,600,000
<b>TOTAL</b>	<b>12,000,000</b>	<b>158,962</b>



**Data Archive Report  
As Of October 8, 1998**

**SUMMARY OF DATA ARCHIVED AT EDC**

PHOTOGRAPHIC DATA	ROLLS	FRAMES
AERIAL IMAGES	59,055	7,857,948
LANDSAT SATELLITE IMAGES	21,260	2,876,184
OTHER SATELLITE IMAGES	21,507	1,317,007
<b>TOTAL</b>	<b>101,822</b>	<b>12,051,139</b>

DIGITAL DATA	MAGNETIC TAPES / QUADS	SCENES / FILES / PRODUCTS
AERIAL IMAGE DATA	25,109	50,116
LANDSAT SATELLITE IMAGE DATA	54,517	* 1,220,504
OTHER SATELLITE IMAGE DATA	77,042	188,387
DIGITAL CARTOGRAPHIC DATA	** 1,316	341,281
EARTH SCIENCE DATA	978	7,941
<b>TOTAL</b>	<b>158,962</b>	<b>1,808,229</b>

\* Includes approximately 1,220,504 Landsat scenes and 181,953 AVHRR scenes.

\*\* Reduced physical media of outdated DLG's.



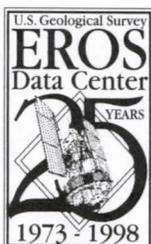
## Data Archive Report As Of October 8, 1998

### PHOTOGRAPHIC DATA ARCHIVED AT EDC

AERIAL PHOTOGRAPHY		
SOURCE	ROLLS	FRAMES
US Geological Survey	17,354	2,587,738
NAPP	12,649	1,916,346
Bureau of Land Management	624	124,834
Bureau of Reclamation	294	58,842
National Park Service	81	13,635
Bureau of Indian Affairs	49	9,913
<b>TOTAL DEPARTMENT OF THE INTERIOR</b>	<b>31,051</b>	<b>4,711,308</b>
Army Map Service	1,741	219,794
US Air Force	3,398	339,602
US Navy	6,462	435,697
Corps of Engineers	98	24,076
<b>TOTAL DEPARTMENT OF DEFENSE</b>	<b>11,699</b>	<b>1,019,169</b>
Ames Research Center	5,078	617,159
Johnson Space Center	7,631	1,012,129
Other	1,401	131,862
<b>TOTAL NASA</b>	<b>14,110</b>	<b>1,761,150</b>
<b>OTHER SOURCE AGENCIES</b>	<b>2,195</b>	<b>366,321</b>
<b>TOTAL AERIAL PHOTOGRAPHY</b>	<b>59,055</b>	<b>7,857,948</b>

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
Color Composites, MSS	N/A	18,271
Color Composites, TM	N/A	1,866
Skylab	634	44,845
Apollo/Gemini/Apollo-Soyuz	127	18,372
Shuttle (Incl. LFC)	3,355	307,893
Declassified Intelligence Satellite Photography	17,391	945,897
<b>TOTAL SATELLITE PHOTOGRAPHY</b>	<b>42,767</b>	<b>4,193,191</b>

N/A = Information not available.



## Data Archive Report As Of October 8, 1998

### DIGITAL DATA ARCHIVED AT EDC

SOURCE	MAGNETIC TAPES	SCENES / FILES
<b>AERIAL IMAGE DATA</b>		
NASA Data		
TIMS / NS001	1,732	7,323
SIR-C	1,187	12,750
ASAS	166	162
NALC	2,531	2,531
NDLC	8,811	5,184
GTOPO 30	1	35
AVHRR 1-KM Orbital Segments	8,064	19,203
National Park Service	94	N/A
Side-Looking Airborne Radar (SLAR)	2,523	2,928
<b>TOTAL</b>	<b>25,109</b>	<b>50,116</b>
<b>SATELLITE IMAGE DATA</b>		
Landsat MSS/TM Digital Data	54,517	1,220,504
AVHRR		
EDC-HRPT Data	23,517	43,346
LAC Data Received via DOMSAT	26,053	59,233
LAC Data Received From Other Sources	17,520	79,374
SPOT Data	308	308
Department of Defense Multispectral Imagery Data	8,350	3,862
Other	1,294	2,264
<b>TOTAL</b>	<b>131,559</b>	<b>1,408,891</b>
<b>USGS GEO DATA (Digital Cartographic Data)</b>		
	QUADS	PRODUCTS
7.5" DIGITAL ELEVATION MODEL (DEM)	50,410	60,470
15" DIGITAL ELEVATION MODEL (DEM)	2,880	3,300
30" DIGITAL ELEVATION MODEL (DEM)	N/A	1,285
250k DIGITAL ELEVATION MODEL (DEM)	N/A	1,384
24k & 15' DIGITAL LINE GRAPH (DLG)	24,459	102,662
100k DIGITAL LINE GRAPH (DLG)	1,842	21,388
1:2 M DIGITAL LINE GRAPH (DLG)	49	323
LAND USE LAND COVER (LULC)	521	2,749
3.75' DIGITAL ORTHOQUAD QUARTER QUAD (DOQ QQ)	N/A	97,272
DIGITAL ORTHOQUAD COUNTY CD'S (DOQ)	N/A	323
DIGITAL RASTER GRAPHICS CD'S (DRG)	N/A	50,125
<b>TOTAL</b>	<b>80,161</b>	<b>341,281</b>
<b>EARTH SCIENCE DATA</b>		
National Uranium Resource Evaluation (NURE/LIL)	957	7,941
Geophysical Research Program	21	N/A
<b>TOTAL</b>	<b>978</b>	<b>7,941</b>
<b>TOTAL DIGITAL HOLDINGS</b>	<b>237,807</b>	<b>1,808,229</b>

N/A = Information not available.

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**SELECTED RESEARCH AND TECHNICAL PUBLICATIONS**

**Binnian, E.F.**, Haga, J.E., **Shasby, M.B.**, Gallant, A.L., and Omernik, J.M., 1998, Alaska ecoregions mapping [abs.], in Pecora Thirteen, Human Interactions with the Environment--Perspectives from Space, 13th, Sioux Falls, South Dakota, August 20-22, 1996, Proceedings: Bethesda, Maryland, American Society of Photogrammetry and Remote Sensing, CD-ROM, 1 disc.

**Bliss, N.B.**, [1998], What do we do if erosion sequesters CO<sub>2</sub>? [abs.], in 1998 Annual Meeting [of the] American Society of Agronomy, Crop Science Society of America, [and] Soil Science Society of America, 90th, Baltimore, Maryland, October 18-22, 1998, Abstracts: Madison, Wisconsin, ASA, CSSA, SSSA, p. 265.

**Brown, J.F.**, 1998, Mapping global grassland ecosystems a comparison of four data sets, in IEEE International Geoscience and Remote Sensing Symposium, Sensing and Managing the Environment, Seattle, Washington, July 6-10, 1998, Proceedings: Monterey, California, Sony Electronic Publishing Services, CD-ROM, 1 disc.

**Brown, J., Reed, B., and Huewe, L.**, 1998, Advanced strategy for multi-source analysis and visualization in land cover characterization: in Proceedings of Pecora 13 Symposium, Sioux Falls, South Dakota, August 20-22, Proceedings: p. 367-382.

**Buehner, D. K.**, Chenoweth, S., **Fosnight, G., Anthony, M., and Singh, A.** A survey of spatial data handling technologies 1997, Environment Information and Assessment Technical Report UNEP/DEIA/TR.97.13: Nairobi, Kenya, DEIA/UNEP, p. 345.

**Buehner, D.K.**, Chenoweth, M.S., and **Singh, A.**, [1998], Status and trends in spatial data handling software results of 1991-1997 surveys, Information for Decision Making Series: [Sioux Falls, South Dakota], UNEP Environmental Information and Assessment Program North America, EROS Data Center, p. 4.

Burgan, R.E., Hartford, R.A., and **Eidenshink, J.C.**, 1998, Using NDVI to assess departure from average greenness and its relation to fire risk, in Pecora Thirteen, Human Interactions with the Environment--Perspectives from Space, 13th, Sioux Falls, South Dakota, August 20-22, 1996, Proceedings: Bethesda, Maryland, American Society of Photogrammetry and Remote Sensing, CD-ROM, 1 disc.

Burgan, R.E., **Klaver, R.W.**, and **Klaver, J.M.**, 1998, Fuel models and fire potential from satellite and surface observations: International Journal of Wildland Fire, v. 8, no. 3, p. 159-170.



**Crawford, T.W., Jr., Dalsted, K.J., Lietzow, R.W., Westin, F.C., and Verdin, J.P.**, 1998, Effects of war and peace on cropland use in Mozambique, in Pecora Thirteen, Human Interactions with the Environment--Perspectives from Space, 13th, Sioux Falls, South Dakota, August 20-22, 1996, Proceedings: Bethesda, Maryland, American Society of Photogrammetry and Remote Sensing, CD-ROM, 1 disc.

**Danielson, J.J.**, 1998, Delineation of drainage basins from 1 km African digital elevation data [abs.], in Pecora Thirteen, Human Interactions with the Environment--Perspectives from Space, 13th, Sioux Falls, South Dakota, August 20-22, 1996, Proceedings: Bethesda, Maryland, American Society of Photogrammetry and Remote Sensing, CD-ROM, 1 disc.

**Danielson, J.J.**, 1997, Verification of drainage basins from 1-km GTOPO30 digital elevation data (abs. for poster), in Environmental Systems Research Institute User Conference, San Diego, California, July 1997, Proceedings: CD-ROM, 1 disc [Disc contains a Readme file]. [URL:<http://www.esri.com/base/common/userconf/archive.html>]

**Danielson, J.J.**, 1998, Using a drainage basin framework with geospatial data sets for environmental assessment in Africa [abs.], in International Geomatics Conference, 10th/Canadian Institute of Geomatics Annual General Meeting, 91st, Geospatial Data on the Information Highway, Ottawa, Canada, June 8-11, 1998, Abstracts: Ottawa, Canada, Natural Resources, p. 32. [Printed in English and French.]

Dufils, J-M., and **Rowland, J.D.**, 1998, GIS and remote sensing for monitoring the impact of conservation-development activities on forest cover in Madagascar, in Pecora Thirteen, Human Interactions with the Environment--Perspectives from Space, 13th, Sioux Falls, South Dakota, August 20-22, 1996, Proceedings: Bethesda, Maryland, American Society of Photogrammetry and Remote Sensing, CD-ROM, 1 disc.

**Evans, G., Feistner, K., and Larson, C.**, 1998, Landsat Pathfinder processing support at the EROS Data Center [abs.], in Pecora Thirteen, Human Interactions with the Environment--Perspectives from Space, 13th, Sioux Falls, South Dakota, August 20-22, 1996, Proceedings: Bethesda, Maryland, American Society of Photogrammetry and Remote Sensing, CD-ROM, 1 disc.

**Feuquay, J.W.**, 1998, Experiences with wide area ATM networks at EROS Data Center, in Pecora Thirteen, Human Interactions with the Environment--Perspectives from Space, 13th, Sioux Falls, South Dakota, August 20-22, 1996, Proceedings: Bethesda, Maryland, American Society of Photogrammetry and Remote Sensing, CD-ROM, 1 disc.

**Fosnight, E.A., and Singh, A.**, 1998, United Nations Environment Programme/Global Resources Information Database--Sioux Falls [abs.], in Pecora Thirteen, Human Interactions with the Environment--Perspectives from Space, 13th, Sioux Falls, South Dakota, August 20-22, 1996, Proceedings: Bethesda, Maryland, American Society of Photogrammetry and Remote Sensing, CD-ROM, 1 disc.

**Fuller, D., Tappan, G., and Wood, E.**, 1998, The changing rangeland and agricultural landscapes of Senegal, West Africa, 1983-1996: The Geographical Review Journal, p. 1-18.

**Gacke, C., Hubbling, B., and Severson, P.**, 1998, EROS Data Center supports the GLOBE (Global Learning and Observations to Benefit the Environment) program [abs.], in Pecora Thirteen, Human Interactions with the Environment--Perspectives from Space, 13th, Sioux Falls, South Dakota, August 20-22, 1996, Proceedings: Bethesda, Maryland, American Society of Photogrammetry and Remote Sensing, CD-ROM, 1 disc.

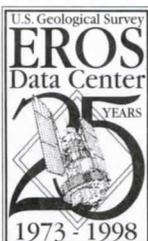
**Gesch, D.B., and Larson, K.S.**, 1998, Techniques for development of global 1-kilometer digital elevation models, in Pecora Thirteen, Human Interactions with the Environment--Perspectives from Space, 13th, Sioux Falls, South Dakota, August 20-22, 1996, Proceedings: Bethesda, Maryland, American Society of Photogrammetry and Remote Sensing, CD-ROM, 1 disc.

**Gaydos, L.**, 1996, Today's land cover mapping, in GAP Analysis: A Landscape Approach to Biodiversity Planning, J.M. Scot, T.H. Tear, and F.W. Davis, Editors, American Society for Photogrammetry and Remote Sensing, Bethesda, Maryland, p. 67-70.

**Gesch, D.B.**, 1998, Accuracy Assessment of a Global Elevation Model Using Shuttle Laser Altimeter Data, in International Geoscience and Remote Sensing Symposium, Seattle, Washington, July 6-10, 1998, Proceedings: CD-ROM, 1 disc.

**Hair, D., Arctur, D., Timson, G., Martin, E.P., and Fegreas, R.**, 1998, Issues and prospects for the next generation of the spatial data transfer standards (sdts): International Journal of Geographical Information Science, v. 12, no. 4, June 1998, p. 403-425.

Hetrick, D.R., **Ehlen, D.E.**, and **Seevers, P.M.**, 1998, An illustration of the use of declassified Corona, Lanyard, and Argon photography in environmental studies [abs.], in Pecora Thirteen, Human Interactions with the Environment--Perspectives from Space, 13th, Sioux Falls, South Dakota, August 20-22, 1996, Proceedings: Bethesda, Maryland, American Society of Photogrammetry and Remote Sensing, CD-ROM, 1 disc.



Higgins, T.Y., Nail, D.S., **Ailts, B., Akkerman, D., and Wright, Jimmie**, 1998, National hydrography dataset pilot projects, enhanced access, and demonstration [abs.], in GIS/LIS 98 Annual Conference and Exposition, Ft. Worth, Texas, November 10-12, 1998, Proceedings: Washington, D.C., Association of American Geographers, CD-ROM, 1 disc. [Published jointly with Bethesda, Maryland, ACSM/ASPRS, Aurora, Colorado, Geospatial Information and Technology Association, and Park Ridge, Illinois, Urban and Regional Information Systems Association.]

**Hutchinson, J.A., and Wittmann, J.H.**, 1997, Map design and production issues for the Utah Gap Analysis Project: Cartography and Geographic Information Systems, Bethesda, Maryland, American Congress on Surveying and Mapping, v. 24, no. 2, April 1997, p. 91-100.

**Kelly, G.G.**, 1998, Estimating water storage potential in the Devils Lake Watershed using high-resolution, 7.5-minute U.S. Geological Survey digital elevation models, in Federal Interagency Hydrologic Modeling Conference, Bridging the Gap Between Technology and Implementation of Surface Water Quantity and Quality Models in the Next Century, 1st, Las Vegas, Nevada, April 19-23, 1998, Proceedings: [Washington, D.C.], U.S. Government Printing Office, v. 2, p. 7-57 - 7-64.

**Klaver, R.W., Klaver, J.M., and Burgan, R.E.**, 1998, The importance of relative greenness in the calculation of a fire potential index [abs.], in Annual Meeting [of the] United States Regional Association - International Association for Landscape Ecology, Applications of Landscape Ecology in Natural Resource Management, 13th, East Lansing, Michigan, March 17-21, 1998, Proceedings: East Lansing, Michigan, Department of Fisheries and Wildlife, Michigan State University, electronic version, <http://www.fs.msu.edu/iale98/>.

**Klaver, J.M., Klaver, R.W., and Burgan, R.E.**, 1997, Using GIS to assess forest fire hazard in the Mediterranean Region of the United States, in Environmental Systems Research Institute User Conference, San Diego, California, July 1997, Proceedings: CD-ROM, 1 disc [Disc contains a Readme file]. [URL: <http://www.esri.com/base/common/userconf/archive.html>]

**Klaver, R.W., Lewis, J.E., Verdin, J.P., and Howard, S.M.**, 1997, Development of a water budget model for monitoring agriculture in Africa (abs.), Environmental Systems Research Institute User Conference, San Diego, California, July 1997, Proceedings: CD-ROM, 1 disc [Disc contains a Readme file]. [URL: <http://www.esri.com/base/common/userconf/archive.html>]

Komar, G.J., Mignogno, M., Sheffner, E., and **Thompson, R.J.**, 1998, The Landsat program--toward Landsat 7 and beyond, in Pecora Thirteen, Human Interactions with the Environment--Perspectives from Space, 13th, Sioux Falls, South Dakota, August 20-22, 1996, Proceedings: Bethesda, Maryland, American Society of Photogrammetry and Remote Sensing, CD-ROM, 1 disc.

**Kost, J.R.**, and **Sprenger, K.K.**, 1998, The U.S. Geological Survey sales data basedigital geospatial data status and trends, in GIS/LIS 98 Annual Conference and Exposition, Ft. Worth, Texas, November 10-12, 1998, Proceedings: Washington, D.C., Association of American Geographers, CD-ROM, 1 disc. [Published jointly with Bethesda, Maryland, ACSM/ASPRS, Aurora, Colorado, Geospatial Information and Technology Association, and Park Ridge, Illinois, Urban and Regional Information Systems Association.]

**Larsen, D.M.**, **Faundeen, J.L.**, **Madigan, M.E.**, and **Austad, J.K.**, 1998, National Satellite Land Remote Sensing Data Archive Landsat multispectral scanner data CD-ROM, in Pecora Thirteen, Human Interactions with the Environment--Perspectives from Space, 13th, Sioux Falls, South Dakota, August 20-22, 1996, Proceedings: Bethesda, Maryland, American Society of Photogrammetry and Remote Sensing, CD-ROM, 1 disc.

**Lethcoe, K.J.**, and **Klaver, R.W.**, 1998, Simulating the interrupted Goode Homolosine projection with Arc/Info, in ESRI Annual User Conference, 18th, [San Diego, California], July 27-31, 1998, Proceedings: [Redlands, California], Environmental Systems Research Institute, Inc., electronic version, <http://www.esri.com/library/userconf/proc98/PROCEED/TO850/PAP844/P844.HTM>.

**Loveland, T.R.**, and **Belward, A.S.**, 1997, The International Geosphere Biosphere Programme Data and Information System global 1-km land cover data set (DISCover): first results: International Journal of Remote Sensing, London, England, Taylor and Francis, Ltd., v. 18, no. 15, p. 3289-3295.

**Loveland, T.R.**, and **Belward, A.S.**, 1998, The International Geosphere Biosphere Programme Data and Information System Global Land Cover Data Set (DISCover): Acta Astronautica v. 41, n. 4 -10, p. 681-689.

**Loveland, T.**, **Ohlen, D.**, **Brown, J.**, **Reed, B.**, **Zhu, Z.**, **Yang, L.**, and **Merchant, J.**, 1998, Western Hemisphere Land Cover: Progress Toward a Global Land Cover Characteristics Data Base, in Proceedings of Pecora 13 Symposium, Sioux Falls, South Dakota, August 20-22, p. 32-41.



**Lu, Z., Freymueller, J.**, 1998, Synthetic Aperture Radar (SAR) Interferometry Coherence Analysis Over Katmai Volcano Group, Alaska: Journal of Geophysical Research, in press, 1998.

**Lu, Z., Mann, D., and Freymueller, J.**, 1998, Satellite Radar Interferometry Measures Deformation at Okmok Volcano, EOS Transactions, Vol. 79, No. 39, 461-466, 1998.

McGwire, K., and **Mah, G.R.**, 1998, The NASA Landsat Pathfinder Global Land Cover Test Sites project, in Pecora Thirteen, Human Interactions with the Environment--Perspectives from Space, 13th, Sioux Falls, South Dakota, August 20-22, 1996, Proceedings: Bethesda, Maryland, American Society of Photogrammetry and Remote Sensing, CD-ROM, 1 disc.

Olson, J.S., and **Zhu, Z-L.**, 1998, Translation strategy to aid forest resource assessment of FAO using the global seasonal land cover regions database [abs.], in Pecora Thirteen, Human Interactions with the Environment--Perspectives from Space, 13th, Sioux Falls, South Dakota, August 20-22, 1996, Proceedings: Bethesda, Maryland, American Society of Photogrammetry and Remote Sensing, CD-ROM, 1 disc.

**Olsen, L.M., and Bliss, N.B.**, 1997, Development of a 30-arc-second digital elevation model of South America, in Environmental Systems Research Institute User Conference, San Diego, California, July 1997, Proceedings: CD-ROM, 1 disc [Disc contains a Readme file].  
[URL:<http://www.esri.com/base/common/userconf/archive.html>]

Outland, J.C., **Tieszen, L.**, DeJong, D., **Reed, B.C.**, 1998, A functional analysis of Ecosystem performance in selected Kuchler types of the Northern Great Plains--NDVI and metrics of land cover classes [abs.], in Pecora Thirteen, Human Interactions with the Environment--Perspectives from Space, 13th, Sioux Falls, South Dakota, August 20-22, 1996, Proceedings: Bethesda, Maryland, American Society of Photogrammetry and Remote Sensing, CD-ROM, 1 disc.

**Pfeifle, L.K., Klaver, R.W.**, Prouty, J.R., **Walkes, J.**, and **Smith, R.**, 1998, Somalia food security information system [abs.], in Pecora Thirteen, Human Interactions with the Environment--Perspectives from Space, 13th, Sioux Falls, South Dakota, August 20-22, 1996, Proceedings: Bethesda, Maryland, American Society of Photogrammetry and Remote Sensing, CD-ROM, 1 disc.

**Quirk, B.K., Thompson, R.J.**, Beck, R.A., Mayer, Larry, and Conley, J.U., 1998, The OhioView project, in GIS/LIS 98 Annual Conference and Exposition, Ft. Worth, Texas, November 10-12, 1998, Proceedings:

Washington, D.C., Association of American Geographers, CD-ROM, 1 disc. [Published jointly with Bethesda, Maryland, ACSM/ASPRS, Aurora, Colorado, Geospatial Information and Technology Association, and Park Ridge, Illinois, Urban and Regional Information Systems Association.]

**Quirk, B. and Beck, R.**, Earth data for the future: GEOTIMES, Alexandria, Virginia, v. 43, no. 3, March 1998, p. 21-23.

**Ramachandran, B.**, 1997, GTOPO30: Global 30 arc-second digital elevation model (poster session), in Environmental Systems Research Institute User Conference, San Diego, California, July 1997, Proceedings: CD-ROM, 1 disc [Disc contains a Readme file]. [URL: <http://www.esri.com/base/common/userconf/archive.html>]

**Reed, B.C.**, 1997, Applications of the U.S. Geological Survey's global land cover product: Acta Astronautica, v. 41, n. 4 -10, p. 671-680.

**Sayler, K.L.**, 1997, Internet image viewer for Landsat Thematic Mapping data: A Mojave Desert prototype, in Environmental Systems Research Institute User Conference, San Diego, California, July 1997, Proceedings: CD-ROM, 1 disc [Disc contains a Readme file]. [URL: <http://www.esri.com/base/common/userconf/archive.html>]

**Sayler, K.L., Zylstra, G.J., and Dwyer, J.L.**, 1998, Landscape change analysis using moderate resolution satellite data, in Pecora Thirteen, Human Interactions with the Environment--Perspectives from Space, 13th, Sioux Falls, South Dakota, August 20-22, 1996, Proceedings: Bethesda, Maryland, American Society of Photogrammetry and Remote Sensing, CD-ROM, 1 disc.

**Schmidtbauer, J., Kringen, K.K., and Kennedy, W.A.**, 1998, Aerial photography and satellite imagery provided by the EROS Data Center for environmental monitoring [abs.], in Pecora Thirteen, Human Interactions with the Environment--Perspectives from Space, 13th, Sioux Falls, South Dakota, August 20-22, 1996, Proceedings: Bethesda, Maryland, American Society of Photogrammetry and Remote Sensing, CD-ROM, 1 disc.

**Singh, A., Ramachandran, B., Fosnight, E., and Crawford, T.**, 1998, Biodiversity-rich ecoregions in Africa lack protection: United Nations Environment Programme, p. 1-10.

**Sohl, T.L., and Dwyer, J.L.**, 1998, North American Landscape Characterization project: the production of continental scale three-decade Landsat data set: Geocarto International.



**Sohl, T.L.**, 1998, North American Landscape Characterization project--the production of a continental scale three-decade Landsat data set

[abs.], in Pecora Thirteen, Human Interactions with the Environment--Perspectives from Space, 13th, Sioux Falls, South Dakota, August 20-22, 1996, Proceedings: Bethesda, Maryland, American Society of Photogrammetry and Remote Sensing, CD-ROM, 1 disc.

**Steyaert, L. T.**, and **Loveland, T. R.**, 1998, Applications of the USGS 1-km AVHRR land cover characteristics data base in land surface process research: lessons learned, in Proceedings of Pecora13 Symposium, Sioux Falls, South Dakota, August 20-22, p. 49-57.

Sundquist, E.T., **Bliss, N.B.**, Stallard, R.F., and Waltman, S.W., [1998], Estimating carbon sequestration due to erosion and sedimentation in the Mississippi Basin [abs.], in 1998 Annual Meeting [of the] American Society of Agronomy, Crop Science Society of America, [and] Soil Science Society of America, 90th, Baltimore, Maryland, October 18-22, 1998, Abstracts: Madison, Wisconsin, ASA, CSSA, SSSA, p. 301.

**Tappan, G.G.**, **Paulson, S.J.**, and **Wood, E.C.**, 1998, Long-term monitoring of changes in Senegal's national resources [abs.], in Pecora Thirteen, Human Interactions with the Environment--Perspectives from Space, 13th, Sioux Falls, South Dakota, August 20-22, 1996, Proceedings: Bethesda, Maryland, American Society of Photogrammetry and Remote Sensing, CD-ROM, 1 disc.

**Tieszen, L.L.**, and Schimel, D., 1998, Great Plains grassland land cover performance--the role C3 and C4 grasses and redistributions based on GCM simulations of 2xCO<sub>2</sub> climate, in Pecora Thirteen, Human Interactions with the Environment--Perspectives from Space, 13th, Sioux Falls, South Dakota, August 20-22, 1996, Proceedings: Bethesda, Maryland, American Society of Photogrammetry and Remote Sensing, CD-ROM, 1 disc.

**Vandersnick, R.**, **Mattson, S.**, and **Embrock, S.**, 1998, Global compositing of 1-km AVHRR data at the EROS Data Center [abs.], in Pecora Thirteen, Human Interactions with the Environment--Perspectives from Space, 13th, Sioux Falls, South Dakota, August 20-22, 1996, Proceedings: Bethesda, Maryland, American Society of Photogrammetry and Remote Sensing, CD-ROM, 1 disc.

**Verdin, K.L.**, 1997, A system for topologically coding global drainage basins and stream networks, in Environmental Systems Research Institute User Conference, San Diego, California, July 1997, Proceedings: CD-ROM, 1 disc [Disc contains a Readme file]. [URL: <http://www.esri.com/base/common/userconf/archive.html>]



**Vogelmann, J.E., Helder, D., Morfitt, R., Choate, M.J., and Merchant, J.W.**, 1998, Characterization of Landsat Thematic Mapper radiometry for land cover analysis, in International Geoscience and Remote Sensing Symposium, Seattle, Washington, July 6-10, 1998, Proceedings: CD-ROM, 1 disc.

**Vogelmann, J. E., Sohl, T., and Howard, S. M.**, 1998, Regional characterization of land cover using multiple sources of data: Photogrammetric Engineering and Remote Sensing, Bethesda, Maryland, v. 64, no. 1, January 1998, p. 45-57.

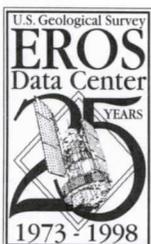
**Vogelmann, J.E., Sohl, T.L.**, Campbell, P.V., and Shaw, D.M., 1998, Regional land cover characterization using Landsat thematic mapper data and ancillary data sources: Environmental Monitoring and Assessment, v. 51, p. 415-428.

**Vogelmann, J.E., SeEVERS, P.M., and Oimoen, M.J.**, 1998, Effects of selected variables for discriminating land cover--multiseasonal data, different clustering algorithms, and varying numbers of clusters, in Pecora Thirteen, Human Interactions with the Environment--Perspectives from Space, 13th, Sioux Falls, South Dakota, August 20-22, 1996, Proceedings: Bethesda, Maryland, American Society of Photogrammetry and Remote Sensing, CD-ROM, 1 disc.

**Vogelmann, J.E., Sohl, T., Howard, S.M., and Brown, J.F.**, 1998, Regional land cover characterization--a prototype case study in the eastern United States [abs.], in Pecora Thirteen, Human Interactions with the Environment--Perspectives from Space, 13th, Sioux Falls, South Dakota, August 20-22, 1996, Proceedings: Bethesda, Maryland, American Society of Photogrammetry and Remote Sensing, CD-ROM, 1 disc.

**Wehde, K.C., Park, P.A., Fick, S.L., and Goodale, K.L.**, 1998, The EOSDIS information management system--access to data for global change researchers, in Pecora Thirteen, Human Interactions with the Environment--Perspectives from Space, 13th, Sioux Falls, South Dakota, August 20-22, 1996, Proceedings: Bethesda, Maryland, American Society of Photogrammetry and Remote Sensing, CD-ROM, 1 disc.

**Wood, E.C., Lewis, J.E., Tappan, G.G., and Lietzow, R.W.**, 1998, The development of a temporal and spatial Markov land use change model for southern Senegal, in Pecora Thirteen, Human Interactions with the Environment--Perspectives from Space, 13th, Sioux Falls, South Dakota, August 20-22, 1996, Proceedings: Bethesda, Maryland, American Society of Photogrammetry and Remote Sensing, CD-ROM, 1 disc.



**Wylie, B.K., Meyer, D.J., Biondini, Mario, and Tieszen, L.L.**, 1998, Using remote sensing to monitor deviations from potential production on Sand Hills range sites [abs.], in Pecora Thirteen, Human Interactions with the Environment--Perspectives from Space, 13th, Sioux Falls, South Dakota, August 20-22, 1996, Proceedings: Bethesda, Maryland, American Society of Photogrammetry and Remote Sensing, CD-ROM, 1 disc.

**Yang, L.**, 1998, Integration of a numerical model and remotely sensed data to study urban/rural land surface climate processes [abs.], in Association of American Geographers Annual Meeting, 94th, Boston, Massachusetts, March 25-29, 1998, Abstracts: [Bellingham, Washington], Promedia, CD-ROM, 1 disc. [Abstracts published as a supplement to the March 1998 AAG Newsletter.]

**Yang, L., and Zhu, Z-L.**, 1998, Large area land cover mapping from remote sensing data 1990's and beyond: Natural Resources, p. 1-15. [Printed in Chinese. Special issue contains papers from the Scientific Forum on Land Cover/Use Dynamics and Ecologic and Natural Resources, held in Beijing, China, August 26-27, 1998.]

**Yang, L., Wylie, B.K., Tieszen, L.L., and Reed, B.C.**, 1998, An Analysis of Relationships among Climate Forcing and Time-Integrated NDVI of Grasslands over the U.S. Northern and Central Great Plains: Remote Sensing of the Environment, v. 65, p. 25-37.

**Zhu, Z-L.**, 1998, Using the USGS global land cover database to support the FAO global forest survey, in Forest Service Remote Sensing Applications Conference, Natural Resources Management Using Remote Sensing and GIS, 7th, Nassau Bay, Texas, April 6-10, 1998, Proceedings: Bethesda, Maryland, American Society for Photogrammetry and Remote Sensing, p. 210-217.

**Zhu, Z-L., and Markon, C.**, 1998, Development of China seasonal land cover regions dataset: NBSM Workshop on Land Cover Characterization, Beijing, China, October 8-10, 1997, p. 1-10.

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### A Word in Conclusion

In closing this report, EDC staff reaffirm their dedication to customer satisfaction. We understand that the value of the data we provide is in its usefulness to our customers. While we remain actively aware of the changing needs of our customers, we encourage our customers to let us know how we are doing and to share with us possible improvements.

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