

"Establishment of a Remote Sensing Service Center
in Support of the LTER Network"

Proposed by:

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to:

Long Term Ecological Research Program Coordinating Committee

April, 1989

Establishment of a Remote Sensing Service Center at the Technology Application Center in Support of the LTER Program Network

Summary

The proposed establishment of a remote sensing service center at the Technology Application Center (TAC), University of New Mexico which would support the LTER Program is a result of TAC's interest in facilitating and centralizing remote sensing acquisition, preprocessing, archival and distribution. A centralized facility is better able to provide consistent protocol in data preprocessing and support to each LTER site. Limited consultation would be available in support of spectral and seasonal data selection as well as potential data applications. A central remote sensing service center, such as we propose, would be responsible to the program coordinating committee and accessible to all LTER scientists. This would facilitate inter-site comparisons through direct interactions at one center, or through regional centers established to support collaborative research. The center approach would also simplify data sharing between sites by facilitating user access to data and standardizing copyright/user agreements.

Justification

1. Remote sensing will play an ever increasing role in the research planned through the LTER program for several reasons. First, we are asking questions at larger scales. Second, detecting global trends in ecosystem properties requires broader scale tools for analysis. And thirdly, there are already strong ties between LTER and ISLSCP/IDS/EOS programs, as well as other DOE and EPA programs, directed to the study of global change. The LTER sites themselves, and the expertise of the LTER teams, complement the needs of each of these global change programs, not to mention the role of LTER sites in "calibrating" remote sensing systems.
2. There are a number of sources of remotely sensed data; Landsat TM and MSS, AVHRR, SPOT, etc. Each of these kinds of data must be properly geometrically corrected and corrected for sensor calibration, etc. This requires experience with these data, as well as appropriate software and hardware facilities. Not all software is capable of geographic correction and calibration. There is a need for a consistent protocol for data processing across the LTER program to facilitate inter-site comparisons. If a standard protocol is not followed, error will be introduced that will be difficult to control.
3. Satellite data acquisition is not always a simple task. Someone must follow overpass dates, order acquisitions in time to make these dates, decide whether the acquired data is of acceptable quality, order the final data, again determine the quality of the digital data across all channels, make appropriate geographic and radiometric corrections, and derive final datasets in an appropriate format. This process can be greatly simplified if performed at a central processing facility with personnel familiar with the subscriber sites, research needs, and analytical capabilities.
4. The utility of systematically acquired, remotely sensed data will be greatly enhanced by a standardized archival system across LTER sites that will permit current comparative studies, as well as future retrospective studies.

Operation

There appear to be three mechanisms for supporting TAC as an LTER center for remote sensing.

1. LTER sites may contract with TAC to acquire and process remote sensing data and write this expense into their individual budgets.
2. NSF provide a base level of funding directly to TAC to provide a certain level of service.
3. The LTER coordinating committee could contract with TAC to provide acquisition, processing, distribution, and archival services to a suite of LTER sites (all or part of the network).

Specifics

- The center which TAC proposes will acquire, preprocess, archive and distribute remotely sensed data for the LTER program.
- Data acquired will include Landsat TM and MSS, SPOT, AVHRR, and other types of data as requested by the LTER Coordinating Committee.
- TAC will perform geometric and radiometric corrections, and archive the original or "raw" data as well as the corrected data.
- All of the data will be inventoried and inventory lists will be provided to each LTER site on a regular basis.
- Distribution of the raw or processed data will be made upon request of an LTER Site Scientist.
- TAC will cooperate with the LTER Coordinating Committee, Regional Centers or individual sites in facilitating comparative/collaborative research.

TECHNOLOGY APPLICATION CENTER
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STATEMENT OF QUALIFICATIONS

1.0 OVERVIEW

Since 1965 the Technology Application Center (TAC) has operated as one of NASA's Industrial Applications Centers (IAC) whose mission is to assist in transferring space technology to user communities. TAC's mission is to retrieve, process, and analyze aerial and satellite data for earth resources, and to transfer the results of these efforts to the public and private sectors in New Mexico, the Nation, and throughout the world. Our specific mission as a NASA contractor and technology transfer agent is to assist in commercializing the national program for space remote sensing. As an applied research laboratory at the University of New Mexico, our mission is to educate future remote sensing and geographic information system specialists and to expand user awareness of the technology through remote sensing projects, in-house workshops, conferences, and visiting scientist research.

TAC began its remote sensing program in 1968 with the dissemination of earth-oriented satellite photography. The launch of Landsat-1 in 1972 initiated a long-term developmental program that has culminated in the array of products, services, and transfer capabilities described in this document. Today we serve not only the domestic user community but the international marketplace as well.

TAC provides applied remote sensing services on a cost-recovery basis. Our client profile has changed from one that was entirely NASA to one which, today, is broadly based on university, industry, government, and individual users. The staff is proud of this because it shows TAC's ability to adapt to changes in markets and technologies. In the last decade, TAC has served the user community with some 140 projects in applied remote sensing using both traditional and digital image processing techniques.

Though TAC specializes in remote sensing services, we support NASA's full line of services including current awareness searches, retrospective searches, and document retrieval. If we cannot respond completely to a client's needs, we refer them to appropriate NASA field centers or sister IACs. We are especially pleased to assist Small Business Innovative Research (SBIR) and state and local governments.

Since TAC is one of the main research and applications arms of the university, we have access to all university facilities, such as printing, computers, photo processing, libraries, as well as the wide range of expertise provided by the university faculty and staff. TAC's facility includes over 6,700 square feet of office and cartographic areas, computer and image display facilities, conference facilities, imagery libraries, and clerical as well as word processing facilities. Appendices I and II list and diagram TAC's current and proposed equipment configuration.

TAC's present expertise is concentrated in four areas: (1) digital image processing of satellite and aerial scanner data, (2) long-term training and workshops, (3) aerial and satellite data retrieval and dissemination, and (4) implementation and design of geographic information systems.

TAC's international experience covers training of scientists from developing countries, the application of remote sensing techniques to natural resources evaluation and utilization, and the application of geographic information systems (GIS) to the spatial relationships between geographic features and non-graphic data. Scientists from about 30 countries around the world have been trained at TAC. Of our 140 completed projects, at least 16 have had an international component. TAC personnel have worked in different projects in Egypt, Italy, Bangladesh, Morocco, Tunisia, Korea, Norway, Peru, India, Haiti, Ecuador, and all the Central American countries.

TAC has an Indefinite Quantity Contract (IQC) with USAID. Under this particular IQC, TAC can provide, upon specific request, USAID/Washington and USAID/Missions or host-country counterpart organizations with short-term, quick response technical services in remote sensing and mapping. Some of the applications that TAC will provide include: agricultural, soil, and vegetation mapping; crop production forecasting; forestry and rangeland assessment; water and marine resources identification, mineral exploration; agroclimatic monitoring using satellite technology; disaster assessments; geographic information system applications; and aerial mapping and geophysical surveys. IQC PDC 0000-I-00-7071-00 is valid through May 29, 1990.

In the last several years, TAC has made an effort to apply remote sensing and geographic information systems in conjunction with ecological measurements to investigate fundamental ecological questions, particularly over extended periods of time. These techniques are essential for studying large-scale ecological patterns and processes. Key to these efforts is TAC's involvement in the study of the Sevilleta National Wildlife Refuge in central New Mexico. The refuge is part of the National Science Foundation's Long-Term Ecological Resource (LTER) program.

2.0 IMAGE PROCESSING

TAC uses the ELAS image processing software package developed by NASA's Space Technology Laboratory (formerly Earth Resources Laboratory) on an in-house Local Area VAX Cluster (LAVC) computer system. ELAS was developed to process remotely-sensed scanner data acquired by the Landsat satellites. In addition, ELAS will process aircraft-acquired scanner data, Thematic Mapper data, and data from the HCMM, SEASAT, CZCS, AVHRR, and SPOT sensors as well as Shuttle Imaging Radar. It can also handle biomedical images such as nuclear magnetic resonance (NMR) data, ancillary data such as digital terrain tapes, and will accept digitized data in a variety of formats.

Some of the current capabilities of ELAS include:

- False color composite display
- Color classification display
- Supervised and unsupervised training data collection
- Maximum likelihood and parallelepiped classifiers

- Satellite and aircraft geometric correction
- Map digitizing
- Image enhancement
 - Contrast stretches
 - Ratioing
 - Principal components
 - Filtering
 - Kauth-Thomas transformation
 - Radiometric correction
 - Atmospheric correction
 - Fourier transformation
 - Texture analysis
 - Edge enhancement
- Data base construction
- Statistical manipulation and analysis
- Distance and area measurement
- Digital terrain modeling
- 3-D perspective
- Printer/plotter map output
- Multiple map output projections

A recent software addition is the LAS (Land Analysis System) image processing package developed by Goddard Space Flight Center and the EROS Data Center. ELAS and LAS will initially run as separate systems but will eventually be combined into a single integrated software system.

TAC performs its image processing services on a cost reimbursable contract basis either at an hourly rate for small projects or for a fixed fee on larger projects. Services are tailored to the client's needs and can include end-to-end processing, project design, interpretation, or the delivery of an enhanced image for client interpretation. Final products can include one or any combination of the following:

- Printer/plotter map to scale
- Transparent overlays
- 35mm color slides
- Enhanced photo print or digital tape
- Methodology and evaluation report

All image processing performed by TAC is done on a confidential basis with the client's identity, interest area, and results kept in the strictest confidence.

3.0 IMAGE DATA RETRIEVAL

TAC has served as a central information and distribution center for all types of aerial and satellite photography since 1968. Our services in this activity greatly expanded when the Governor of New Mexico designated our center as the State's affiliate to the National Cartographic Information Center (NCIC) in 1977. Through this affiliation we are able to provide users with the most complete and up-to-date information on aerial and satellite photography in the U.S. as well as worldwide. Our direct computer links to nationwide data bases and our extensive microfiche and index files provide quick and easy access to information. TAC is equipped to select the type of coverage best suited to

specific needs, locate it, and place the order. Our service is to make all the contacts and do all the work necessary to provide the final product. As an additional service, we are prepared to provide interpretation assistance at any level.

Computer searches are conducted on our in-house terminal to access information stored at the EROS Data Center in Sioux Falls, South Dakota. Through this link, we can locate Landsat MSS and TM imagery for any geographic location worldwide. NASA high altitude photos and lower altitude aerial mapping photos from such agencies as USGS, BLM, BIA, and the Bureau of Reclamation are also located through our computer searches. Users receive a printout containing information on the photograph scale, quality, cloud cover, film type, photo identification number, corner point coordinates, and date for their area of interest.

For manual searches, we utilize microfiche and index files to locate photography over a specific area. After receiving a search request, we check all of these files for relevant data, produce hard copies of search data, contact appropriate holding agencies, and provide a list of data pertinent to the search question. Our microfiche files contain data on Landsat, Skylab, Large Format Camera (LFC), NASA aircraft, USGS, and USDA photography and are updated frequently to provide both historical and current information. For Gemini, Apollo, Skylab, and the Space Shuttle, however, we are a repository for all images and can reproduce them in a variety of sizes. Catalogs of earth-oriented photography from these manned satellite missions are available.

Our index files also contain cartographic information held by such agencies as the Forest Service, Agricultural Stabilization and Conservation Service, National Archives, Soil Conservation Service, and any private firms that have entered their data into the NCIC system.

4.0 GEOGRAPHIC INFORMATION SYSTEM

TAC has been a leader in geographic information system (GIS) development within New Mexico since 1979. TAC possesses an advanced GIS capability which blends digital mapping, image processing, and tabular data with a relational data base management system. The versatility of this GIS capability to respond to resource problems is its ability to capture and integrate any number or type of data sets; combine, analyze, and edit both cartographic and descriptive information; and output final products into map, photographic, and/or report form.

In providing for client needs, TAC will assist in identifying the most proficient method to apply GIS technology. A strategy can be developed which identifies required data sets, processing procedures, analytic scenarios, and product development. The plan will be tailored to the client's particular application and will consider the ideal balance between data needs and cost.

The kinds of problems that can be solved by a GIS range from municipal to natural resource themes and cover almost any desired scale. Application strategies can include land records and property management, urban and regional land use planning, environmental and natural resource management, or simple thematic mapping. In 1984, TAC upgraded its automated GIS capability

by acquiring the ARC/INFO software package developed by the Environmental Systems Research Institute. The software links spatial data to tabular data and can create multiple secondary data bases from the analysis of this information. ARC/INFO also has a strong geographic analysis and modeling capability which is supported by an interactive system for the entry, editing, management, and display of these data.

Selected characteristics of the software include:

- Input and output of USGS Digital Line Graphs
- Two-way conversion of grid and vector based data sets
- Conversion of U. S. Census Bureau GBF/DIME files
- A versatile digitizing system which uses an arc to node structure
- Transformation into and out of most coordinate systems
- Merging of data sets vertically (overlays) and horizontally (appending)
- Interactive extraction and display of any combination of features
- Buffer generation around point, line, and/or polygon features
- Automatic computation of polygonal and linear measurements
- Automatic and interactive editing qualities
- Versatile display and hard copy output characteristics
- Statistical computation of attributes
- Modeling qualities based on weighted variables
- Automated report preparation

Computer Hardware/Software

Major System

Local Area Vax Cluster (LAVC) consisting of:

MicroVax II

MicroVax 3200

Floating Point Processor

24 MB Memory

VMS Operating System

Fujitsu Super Eagle Hard Disk Drive - 689 MB

RD54 Winchester Disk Drive - 159 MB

CDC Sabre Hard Disk Drive - 1230 MB

Cipher Tape Drive - 1600/3200/6250 BPI

GPX Graphics Terminal

Tektronix 4107A and 4205 Color Graphics Terminals

Color Image Display Monitors

3 Mitsubishi and 1 Conrac Monitor - 512 x 512, 19", each monitor
operates from its own Peritek Video Image Display Interface Board

Calcomp 1043GT 8 Color Pen Plotter - 34" wide

Summagraphics 36" x 48" Digitizing Tablet

Printronix Dot Matrix Line Printer

Miscellaneous Terminals

ELAS Image Processing Software Package

LAS Image Processing Software

ARC/INFO Geographic Information System Software Package

PC Workstations

IBM XT - 20 MB Hard Disk, 1 Floppy Drive, Monochrome Display

IBM PC - 2 Floppy Drives, Monochrome Display

Compaq 286 - 60 MB Hard Disk, 1 High Capacity Floppy Drive, Color
Display

Telex 1280 - 20 MB Hard Disk, 2 Floppy Drives, Color Display

Telex 1280 - 20 MB Hard Disk, 1 Floppy Drive, Monochrome Display

Epson FX-286e Printer

Epson LX-800 Printer

Epson LX-86 Printer

NEC 3550 Printer

IBM Quietwriter Model 2 Printer

Software

Lotus 1-2-3

Visicalc

NCSS Statistical Software

WordPerfect 5.0

MS-DOS

Unify DBMS

Miscellaneous Utility Software

