Landsat DATA USERS NOTES

ISSUE NO. 35 MARCH 1986

BRIEF LANDSAT PROGRAM HISTORY

Editor's Note:
Major portions of the introduction to this article were extracted from Chapter 12 of the **Manual of Remote Sensing**, Second Edition, published by the American Society of Photogrammetry and Remote Sensing (ASPRS). The editors recommend the Manual for detailed information about Landsat and other aspects of remote sensing. ASPRS can be contacted at 210 Little Falls Street, Falls Church, VA 22046, (703-534-6617). Special thanks go to Dr. Stanley C. Freden and Dr. Frederick Gordon, Jr.

The series of satellites now known as Landsat evolved in concept from the photographic observations of early Mercury and Gemini orbital flights. The data from those manned flights indicated the practicality of observing from space orbit what is broadly referred to as "earth resources." These observations and the thoughts they generated led to the NASA satellite program that developed the Earth Resources Technology Satellite-1 (ERTS-1), which is now called Landsat 1.[1]

Landsat 1, 2, and 3

The imagery from those Mercury and Gemini flights, being primarily photographic, led the initial thinking about a sensor system for a dedicated "earth resources" satellite to be of a framed nature (in a series of sequentially acquired images). In 1967, a NASA study team looked into the problem of what sensor system should be used on the satellite. Their recommendation for the primary sensor was a television-type system, a return-beam vidicon (RBV), which acquired framed images sequentially that could be telemetered to ground stations. Another government organization interested in the potential use of the satellite data from the satellite was the United States Geogological Survey (USGS), whose interest areas were primarily geology, cartography, and related subjects. The USGS visualized the sensor system as a three-camera

[1] The change in name was anounced on January 13, 1975, shortly before launch of Landsat 2 on January 22, 1975.

(Continued on page 2)

IN MEMORIUM

All of us associated with **The Landsat Data Users NOTES** wish to express our deepest sympathy to the members of the families of the NASA shuttle crew, Challenger, and their co-workers and friends.

EXPECTATIONS OF LANDSAT COMMERCIALIZATION

The contract between the Department of Commerce and the Earth Observation Satellite Company (EOSAT), signed on September 27, 1985, culminated several years of public debate over the future of the U.S. land remote sensing program.

In contrast to meteorological satellites, which primarily support the National Weather Service and other aspects of NOAA's mission, the Landsat system supports a broad spectrum of land applications and users in other Federal agencies, state and local governments, universities, the private sector, and foreign countries. Because the user community and Landsat applications are so broad, the Congress in the Land Remote Sensing Commercialization Act of 1984 found that the national interest of the United States lies in encouraging a competitive, market-driven private sector initiative to fully develop land remote sensing markets, to provide data continuity, and to maintain U. S. world leadership in civil land remote sensing.

NOAA'S tenure as operational "caretaker" for the Landsat program, until it could be transferred to the private sector, resolved many operational problems not addressed when Landsat was an experimental program. However, as operational problems were solved, the fundamental issue that had plagued the program from the beginning became more prominent. How was the Government to balance the benefits of the land remote sensing program against its cost?

(Continued on page 15)

NOAA AND USGS PLAN COOPERATIVE PROGRAMS FOR DATA PRESERVATION AND REMOTE SENSING RESEARCH AND DEVELOPMENT

The Land Remote Sensing Commercialization Act of 1984 (15 U.S.C. 4201) did more than provide authority for the transfer of the Landsat system to the private sector. It also placed responsibility for long-term preservation of land remote sensing data and for support of remote sensing research and development squarely on the shoulders of certain Government organizations.

National Satellite Land Remote Sensing Data Archive

Title VI of 15 U.S.C. 4201 states that it is in the public interest for the United States to maintain an ar-

(Continued on page 17)

FINAL ISSUE OF LANDSAT DATA USERS NOTES

Issue Number 35 formally ends the **Landsat Data Users NOTES** as produced by NOAA, and earlier by the United States Geological Survey's EROS Data Center. EDC produced issues 1 through 24. NOAA produced issues 25 through 35 including a supplemental issue, dated July 1985.

NOAA management wishes to express their thanks to all of the individuals who have assisted in the production of the **NOTES** through the past years.

The Earth Observation Satellite Company (EOSAT) intends to provide the Landsat community with its own newsletter. If you are currently receiving the **NOTES**, you will automatically receive EOSAT's newsletter. If you are having a subscription problem, write or call:

EOSAT Subscription Services
4300 Forbes Blvd.
Lanham, MD 20706
1-800-344-9933 or
1-301-552-0500
Telex: 277685-LSAT UR

LANDSAT PROGRAM HISTORY

(Continued from page 1)

configuration with one TV camera filtered in visible red and a second one in the near (reflective) infrared (IR). Two of the camera systems should have a resolution of about 100 meters. The third camera should have higher resolution (about 25 m) and could be panchromatic. From USGS and staff recommendations, NASA decided on a three-camera, three-spectral band RBV. The bands chosen were green (0.475 to 0.575 μm), red (0.580 to 0.680 μm), and near infrared (0.698 to 0.830 μm) at a resolution of about 80 meters.

NASA also received input from other potential users including the United States Department of Agriculture (USDA). USDA's experience resulting from the use of color and infrared aerophotogrammetry indicated the need for spectral data in agricultural studies. A USDA-university team, headed by Dr. Archibald B. Park, determined that although the RBV could provide adequate spatial resolution, it would not be satisfactory in a spectral sense. The team thought that the spectral requirements would probably be best satisfied by a multispectral scanner (MSS) system. Experience with the Michigan multispectral scanner had shown the practicality of a flight version of such an instrument. The result was the decision to include an MSS system on ERTS to provide the more precise spectral data needed primarily for the anticipated uses of the agricultural community. The spectral bands recommended were the result of the various experiences with color infrared imagery and scanners. The original recommendations were on band centers only and were 550, 650, and 750 nanometers. The exception was the fourth band for which the recommendation was "whatever can be acquired in the 800-nanometer plus region." The actual MSS bandwidths in the visible and reflective infrared regions (0.5 to 0.6, 0.6 to 0.7, 0.7 to 0.8, and 0.8 to 1.1 μm) were the result of instrument decisions with regard to sensitivity and other technological factors. Adding the MSS to the ERTS payload turned out to be an excellent decision because the high quality of the MSS data proved to be the key to Landsat's success.

The orbit chosen for the ERTS (Landsat) was the best compromise in terms of the type of coverage desired, the constraints of the sensor system, and the dictates of the laws of orbital mechanics. The type of orbit desired was circular (for near-constant resolution and scale), cyclically repetitive (for periodic observation of the same sites), and sun-synchronous (for fairly constant illumination).

The result was an 18-day repetitive cycle at a nominal altitude of about 913 km. Associated with the sun-synchronous aspect of the orbit was one selectable parameter, local sun time at a given latitude of overpass of the satellite. The original time considered, primarily on the basis of the requirements of geomorphologists, was an equatorial crossing that was either early morning or late afternoon to provide the long-shadow profiles that would assist in topographic determination. The potential users that preferred maximum illumination, such as agriculturists, protested this choice and opted for a near high-noon overpass. To satisfy a diverse constituency, a compromise was indicated, which meant mid-morning or mid-afternoon. The final choice was mid-morning (about 9:30 a.m. local time). The corresponding mid-afternoon orbit was ruled out because in most terrestrial areas afternoons generally tend to be more cloudy than mornings. These decisions concerning the spacecraft system needs were finalized in about 1968. The result of all these discussions, within the realities of physical and fiscal constraints, was a NASA-planned program for a series of earth resources satellites, the first of which would be launched in early 1972.

From 1972, Landsats 1, 2, and 3 acquired MSS scenes (unique in time but repetitive in area) of several tens of billions of square kilometers of the earth's surface. The RBV system on Landsat 3, which was modified to a two-camera system, produced a scene catalog of all the world's land masses. RBV coverage amounted to about 8 billion square kilometers.

Table 1 presents the contents of the Landsat International Data Base, maintained at the EROS Data Center. This data continues to grow as more data is acquired and additional foreign station holdings are incorporated into the computer database. The Landsat Timeline in the center of this issue indicates the launch and retirement dates for Landsats 1, 2, and 3. It also contains information for Landsats 4, 5, 6, and 7.

Landsat 4 and 5

Landsat 4 and 5 are the bridge

TABLE 1 - Landsat International Data Base as of December 31, 1985[1]

Satellite	SCENES MSS/RBV	SCENES TM[2]	REMARKS
Landsat 1	145,871		Data archived by U.S.A.
Landsat 2	185,114		
Landsat 3	236,642		
Landast 4	38,179	1,185	
Landsat 5	52,291	25,216[3]	
Subtotal	**658,097**	**26,401**	
Brazil	41,309		Data archived at other sites (see Table 2), but referenced in EDC computer database.
Italy	179,690		
Canada	297,365		
South Africa	31,673		
Earthnet	9,184		
Australia	41,452		
Argentina	10,790		
TOTAL	**1,269,560**	**26,401**	

[1] The numbers reflect Landsat data archived by the U.S.A. and other foreign countries referenced in the computer database at EDC. At the time of publishing this issue of the **NOTES**, additional information had been received from Australia, Japan, and South Africa but not incorporated into the database.

[2] Database interchange formats have been established (August 1985), but no foreign TM data had been incorporated as of December 31, 1985.

[3] Includes 11,004 film scenes at EDC and 14,212 scenes on HDT-A or R tapes at Goddard Space Flight Center.

between the old and the new in earth resources satellite systems. Each carries a multispectral scanner and a thematic mapper (TM). The MSS is included in the Landsat 4 and 5 sensor packages to provide continuity of the data type that has been provided since 1972 by the earlier Landsats. The TM is a more advanced scanner, having more spectral, radiometric, and geometric sensitivity than its predecessors. Landsat 4 was launched in 1982. Landsat 5 was to be stored in a launch-ready condition and then used when Landsat 4 failed. Subsystem component failures on Landsat 4 resulted in the decision to launch Landsat 5 on March 1, 1984.

The MSS's on Landsat 4 and 5 are identical in spectral-band location and width with the four reflective bands of Landsats 1, 2, and 3: 0.5 to 0.6 (green) 0.6 to 0.7 (red) and, 0.7 to 0.8, and 0.8 to 1.1 μm (reflective infrared). The TM's have seven bands, three of which are in the spectral range of the MSS (green through reflective infrared). The new spectral coverage regions are the blue (0.45 to 0.52 μm), the higher reflective infrared (1.55 to 1.75 and 2.08 to 2.35 μm) and the thermal infrared (10.40 to 12.50 μm). The three bands that approximate the region of the four MSS bands are 0.52 to 0.60 μm, 0.63 to 0.69 μm, and 0.76 to 0.90 μm. The green and red bands are narrower than their MSS predecessors, primarily to improve the sensitivity to spectral changes that result from agricultural phenomena in this spectral region. The reflective IR band is narrower than the combined bands of the MSS in this region, having its center in a region of maximum sensitivity to plant vigor. The sixth band is thermal infrared which is similar to the band 8 that was on Landsat 3.

The new blue band has been included to expand the use of satellite data in the field of bathymetry and to assist in stress evaluation of agricultural crops. The higher reflective infrared bands will enable agriculturalists to better study water-stress problems in crops and will help geologists to better distinguish between rock classes. The 1.55 to 1.75 μm band will also improve the ability to discriminate between snow and cloud coverage.

The linear geometric resolution of the TM is about 2.6 times that of the MSS. The instantaneous field of view (IFOV) of the TM is a 30m x 30m pixel, as compared with the 79m x 79m pixel of the Landsat 1-3 MSS. (The Landsat 4 and 5 MSS has an IFOV of 82m x 82m). The TM's higher resolution permits observation of smaller areal segments, such as smaller agricultural fields. Table 3 shows the comparative radiometric charactistics of the two Landsat 4 and 5 sensor systems.

The linear radiometric sensitivity of the TM is achieved by utilizing a digitizing scheme with 8-bit quantization in the analog-to-digital conversion process. The MSS uses 6-bit quantization for a sensitivity of one part in 64 versus the TM sensitivity of one part in 256. This finer radiometric detectability in the TM permits observation of smaller changes in radiometric magnitudes in a given spectral band and also pro-

TABLE 2 - International Landsat Data Distribution Centers

1. United States of America:

EOSAT
c/o Landsat Customer Services
EROS Data Center
Sioux Falls, SD 57198
Telephone: (605) 594-2291 or 1-800-367-2801
TWX: 910-668-0310
EDC SFL

2. Brazil:

Instituto de Pesquisas Espaciais (INPE)
Departamento de Producao de Imagens
ATUS-Banco de Imagens Terrestres
Rodovia Presidente Dutra, Km 210
Cachoeira Paulista-CEP 12.630
Sao Paulo, Brazil
Telephone: (0125) 611507
or PBX: (0125) 611377
Telex: (0122) 160 INPE BR

3. Canada:

Canadian Centre for Remote Sensing (CCRS)
User Assistance and Marketing Unit
717 Belfast Road
Ottawa, Ontario K1A 0Y7
Canada
Telephone: 613 995-1210
Telex: 053-3777

4. Europe:

Earthnet User Services
Via Galileo Galilei
I00 44 Frascati, Italy
Telephone: 39-6-9401360 or 39-6-9401216
Telex: 611295 or 610637
(see NOTE below)

5. Japan:

Remote Sensing Technology Center of Japan
Uni-Roppongi Bldg., 7-15-17 Roppongi
Minato-ku, Tokyo 106, Japan
Telephone: Tokyo 3-403-1761
Telex: 02426780 RESTECJ

6. India:

National Remote Sensing Agency
Balanagar, Hyderabad - 500 037
Andhra Pradesh, INDIA
Telephone: 262572/Ext. 67
Telex: 0155-522

7. Australia:

Australian Landsat Station
14-16 Oatley Court
P.O. Box 28
Belconnen, A.C.T. 2616
Australia
Telephone: 062-515411
Telex: 61510

8. Argentina:

Comision Nacional de Investigaciones Espaciales (CNIE)
Centro de Procesamiento
Dorrego 4010
(1425) Buenos Aires, Argentina
Telephone: 772 5108
Telex: 17511 LANBA AR

9. South Africa:

National Institute for Telecommunications Research
ATTN: Satellite Remote Sensing Centre
P.O. Box 3718
Johannesburg 2000, South Africa
Telephone: 27-12-26-5271
Telex: 3-21005 SOUTH AFRICA

10. Thailand:

Remote Sensing Division
National Research Council
196 Phahonyothin Road
Bangkok 10900, Thailand
Telex: 82213 NRCTRSD
Telephone: 579-0117
Cable: NRC Bangkok

11. China:

Academia Sinica
Landsat Ground Station
Beijing, People's Republic of China
Telex: 210222 ASCHI CN
Telephone: 284861 (Beijing, China)

12. Indonesia:

Chairman
Indonesian National Institute of Aeronautica and Space
JLN Pemuda Persil NO. 1
P. O. Box 3048
Djakarta, Indonesia
Telex: 49175

Note: Residents of Italy or Sweden should contact their local centers listed below:

Italy
Telespazio
Corso d'Italia 42-43
Rome, Italy
Telephone: 39-6-8497306
Telex: 610654

Sweden
Swedish Space Corporation (SSC)
Tritonvagen 27
S-171 54 Soina, Sweden

TABLE 3
RADIOMETRIC CHARACTERISTICS

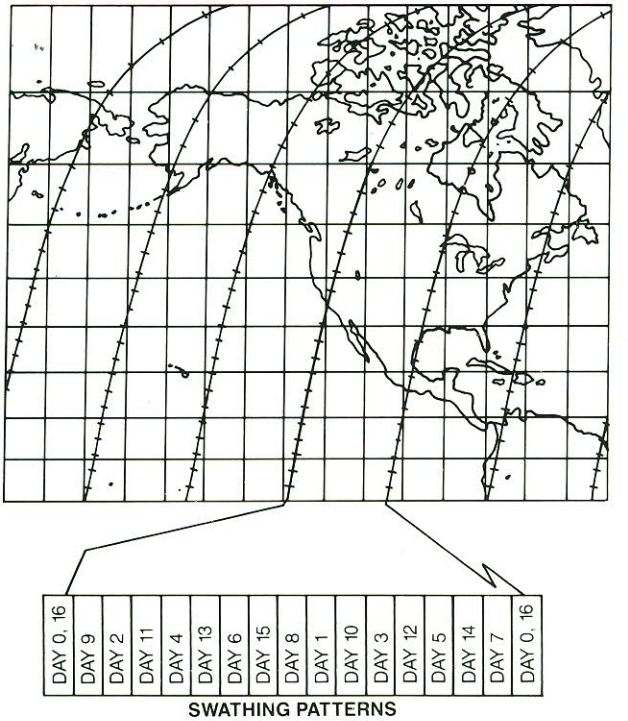
	Thematic Mapper (TM)		Multispectral Scanner Subsystem (MSS)	
	Micrometers	Radiometric Sensitivity (NEΔp)	Micrometers	Radiometric Sensitivity (NEΔp)
Spectral Band 1	0.45- 0.52	0.8%	0.5-0.6	0.57%
Spectral Band 2	0.52- 0.60	0.5%	0.6-0.7	0.57%
Spectral Band 3	0.63- 0.69	0.5%	0.7-0.8	0.65%
Spectral Band 4	0.76- 0.90	0.5%	0.8-1.1	0.70%
Spectral Band 5	1.55- 1.75	1.0%		
Spectral Band 6	10.40-12.50	0.5 K (NEΔT)		
Spectral Band 7	2.08- 2.35	2.4%		
Ground IFOV		30 m (Bands 1-5,7) 120 m (Band 6)	82 m (Bands 1-4)	
Data Rate		85 Mbps	15 Mbps	
Quantization Levels		256	64	
Weight		258 kg	68 kg	
Size		1.1 x 0.7 x 2.0M	0.35 x 0.4 x 0.9 m	
Power		332 watts	50 watts	

vides a greater sensitivity to changes in relationships between bands.

The TM's greater number of spectral bands, higher radiometric sensitivity and increased resolution elements (pixels) per unit ground area all contribute to a much greater data bit rate, resulting in the need for a much higher communication frequency to telemeter the TM data. The TM data rate, after digitizing, is 84.9 Mbps. The S-band microwave carrier used on Landsats 1, 2, and 3 cannot handle this date rate. Therefore, in direct communication to ground stations, X-band (8.025 to 8.4 GHz) is used for transmitting the TM and MSS data, which collectively come to 100 Mbps. The MSS data is also independently transmittable in S-band (2265.5MHz). Thus, the existing ground stations, unless modified, are able to receive MSS, but not TM data.

Landsats 4 and 5 do not have on board wide band data recorders. To achieve worldwide coverage, foreign ground stations and the Tracking and Data Relay Satellite System (TDRSS) used. This planned two-satellite, geo-synchronous system is to receive sensor data from Landsat 4 or 5 and retransmit them to the TDRSS receiving site at White Sands, New Mexico. Then, these data are retransmitted to NASA's Goddard Space Flight Center (GSFC) via a commercial communications satellite for processing in the GSFC Landsat 4-5 ground-processing system. The Ku microwave band (~ 15 GHz) is used for data transmission

FIGURE 1
Landsat 4 and 5 Orbit Ground Trace Pattern



between Landsat and the one TDRSS satellite currently operational. The coverage of Landsat 4-5 for both sensor systems, using the TDRSS, is to be the entire world, except for (1) the zone of exclusion over India and the Indian Ocean, and (2) circumpolar areas having a latitude of greater than 81°. The TDRSS satellites are to be geosynchronously located above the equator at 41°W and 171°W longitudes. Currently, the TDRS at 41°W longitude is operational. The second TDRS was lost in the Space Shuttle Challenger accident.

The nominal 705 km orbit of Landsats 4 and 5 result in the coverage pattern shown in Figure 1. This orbit has a repeat cycle of 16 days. The swath width for both sensors is 185 km. The sun-synchronous,

repetitive orbit crosses the equator on its descending orbit at about 9:45 a.m. local sun time, which is consistent with the local times of the previous Landsats. The orbit is lower than that of Landsats 1, 2, and 3 which were at a nominal altitude of 913 km. This new orbit was dictated primarily by the desire to make Landsat 4 and 5 compatible with the Space Shuttle for retrieval.

An operational status of Landsats 4 and 5 is presented in Table 4.

Ground Processing Systems

During the Landsat program, the U.S.A has used four major ground processing systems. Landsat 1-3 MSS and RBV data were originally processed through the NASA Data Processing Facility (NDPF). The archival output of the NDPF was 70-mm black and white film products created by an electron beam recorder (EBR). In parallel to the film product, an X-format computer compatible tape (CCT) could be generated. These tapes were created only upon user request; tapes were not created for every scene acquired by the MSS or RBV. When a user request for tape was fulfilled, a copy of the tape was archived at EDC along with the 70-mm film. Because only a small amount of the early Landsat MSS data was archived on CCT's (some 6000 scenes) and major problems continued to increase when trying to convert the older wide band video tapes (WBVT) to CCT's, NASA and EDC decided to systematically generate archival CCT data for the years 1972 to 1979. EDC developed the criteria and procedure for selecting scenes to be converted to a digital archive. The selection process resulted in 28,200 scenes for the time period 1972 through 1976. Other agencies agumented this selection process with some 6000 additional scenes. For highlights of this effort, see Table 5. The selection process for 1977 and 1978 was completed by EDC in 1985, with 10,792 additional scenes selected. This brought the total archival CCT data set for 1972 to 1979 to about 45,000 scenes. A brief status of this effort for 1977 and 1978 is presented in Tables 6 and 7. GSFC has been processing about 125 scenes per week and at the end of 1985, had a backlog of approximately 20,000 scenes.

Beginning February 1, 1979, all Landsat MSS data were processed through the new Image Processing Facility (IPF) at GSFC and the EDC Digital Image Processing System (EDIPS).[2] Landsat 3 RBV data processing was converted to the IPF/EDIPS as of September 1980. The High Density Tapes (HDT) created by the IPF were transmitted to EDC via

[2] Subsequent to the acceptance of the IPF and EDIPS, a management decision was made to reprocess all MSS data acquired in January 1979, so that the effective break between the analog and the digital archive was January 1, 1979 for MSS.

TABLE 4 - Landsat 4 and 5 Operational Status
January 31, 1986

ORBITAL CHARACTERISTICS	Landsat 4	Landsat 5
International Designation	1982-072A	1984-021A
Launch Date	16 July 1982	1 March 1984
Date Operations Began:		
MSS	20 July 1982	6 April 1984
TM	17 August 1982	6 April 1984
Orbit Angle	8.15 degrees	98.16 degrees
Average Altitude:		
Kilometers	699.60	699.62
Miles	434.66	434.66
Precession Rate	-0.264 Minutes/Month	-0.324 Minutes/Month
Orbital Nodal Period	98.88 Minutes	98.88 Minutes
Equatorial Crossing Tim		
Descending	9:32 A.M.(local)	9:39 A.M.(local)
Ascending	9:32 P.M.(local)	9:39 P.M.(local)
Hydrazine Remaining	470.82 lbs.	495.74 lbs.
SENSOR STATUS		
MSS	Operational	Operational
TM	Operational[1]	Operational
SPACECRAFT STATUS		
Altitude and Orbit		
Modular Altitude Control System	Operational	Operational
Power Module	Operational	Operational
Communications and Data Handling		
Narrow Band Tape Recorder No. 1	Marginal	Operational
Narrow Band Tape Recorder No. 2	Operational	Marginal
Signal Conditioning and Control Unit A	Failed	Operational
Signal Conditioning and Control Unit B	Operational	Operational
Digital Processing Unit	Operational	Operational
Power and Thermal		
Modular Power System	Operational	Operational
Power Distribution Unit	Operational	Operational
Solar Array Drive	Operational	Operational
Solar Panel 1	Operational	Operational
Solar Panel 2	Operational	Operational
Solar Panel 3	Failed	Operational
Solar Panel 4	Failed	Operational
Operational Solar Array Offset	-32 Degrees	-5 Degrees
Transmitters		
Unified S Band	Operational	Operational
S-Band A	Operational	Failed
S-Band B	Operational	Operational
X-Band A	Failed	Operational
X-Band B	Failed	Operational
Ku-band A	Operational	Operational
Ku-band B	Operational	Operational
Global Positioning System	Off	On (Test)

REMARKS:
LANDSAT 4 continues to support the current MSS mission.
LANDSAT 5 continues to support the current MSS and TM missions.

[1] Landsat 4 TM sensor is not used due to electrical power limitations.

TABLE 5 - Highlights of Landast CCT Historical Selection

- Total path/row points for Landsat 1-3 (land coverage) is 13,893. The initial selection plan preferred 21,000 scenes per year for optimum seasonal coverage. The 1972-1976 project had a success rate of 28% of this plan.
- For selection, the maximum cloud cover allowable was 50%, and scenes could not have missing bands.
- EDC selected over 28,200 scenes for the 1972-1976 project.
- Six thousand additional scenes were requested for historical preservation by other agencies.
- About 1400 scenes (1972-1976) were cancelled by GSFC. EDC selected an additional 1,190 for best possible processing.

1972	124 scenes
1973	744 scenes
1974	407 scenes
1975	78 scenes
1976	29 scenes

- GSFC has supported a historical support production rate of 125 scenes per week.
- All of the seasonal zone overlays and batch search cards are set up on the old Landsat 1, 2, and 3 World Plotting Series (WPS) maps.
- For 1977-1978, of the 51,217 available scenes, 10,792 scenes (21%) were selected for archival to the historical database.

TABLE 7
Total Scenes Acquired 1977-1978 by Cloud Cover Percentage

Cloud Cover %	# Scenes
0%	9,101
10%	17,318
20%	6,868
30%	6,716
40%	6,024
50%	5,190
	51,217[1]
60%	5,045
70%	5,841
80%	6,909
90%	22,666
	40,461
Total	**91,678**

[1] 56% of the data (51,217 scenes) met the 50% or less cloud cover criteria needed for final scene selection.

TABLE 6 - 1977-1978 CCT Selection Information

WPS MAPS & FILE NAME	START PATH	END PATH	START ROW	END ROW	TOTAL SCENES	SCENES SELECTED
NORTH AMERICA						
NORTH1 (ATLANTIC)	245	251	011	049	76	54
NORTH2 (EAST COAST)	001	025	011	049	7,246	1,543
NORTH3 (ALASKA)	052	091	011	033	3,893	698
NORTH4 (WEST COAST)	026	051	011	049	15,061	1,809
					26,276	**4,104**
SOUTH AMERICA						
SOUTH1 (EAST)	229	251	050	099	642	290
SOUTH2 (WEST)	001	032	050	099	366	116
					1,008	**406**
AFRICA	144	226	032	086	**7,227**	**1,157**
EURASIA						
EURAS1 (EAST)	092	143	011	033	2,031	579
EURAS2 (WEST)	144	244	011	031	9,224	2,722
					11,255	**3,301**
OCEANIA						
OCEANA	052	143	034	094	4,961	1,559
ARCTIC OCEAN						
ARCTIC	001	251	001	010	990	254
ANTARCTIC						
ANTARC	001	251	100	119	23	11
					5,974	**1,824**
TOTAL						**10,792**

Some reasons which made selection difficult were due primarily to:

- Excessive cloud cover
- Complete lack of coverage
- Missing bands in data
- Incomplete seasonal coverage

a commercial communications satellite. Final processing to film and computer tape was performed by EDIPS at EDC. The combination of these two new systems changed the MSS and RBV archive for all subsequent acquisitions from 70-mm (analog) to HDT (digital). The new archive medium substantially improved the capability to provide needed data products to Landsat customers.

With the launch of Landsat 4, a fourth ground processing system was implemented at GSFC which included a new Control and Simulation Facility (CSF) and Mission Management Facility (MMF). The CSF is used for command control of the spacecraft. The MMF is responsible for image processing and has two sub-systems; one for MSS, the MMF-M, and one for TM, the MMF-T. These facilities are also referred to as the MSS Image Processing System (MIPS) and TM Image Processing System (TIPS), respectively.

With regard to MSS archive product generation, the MIPS is functionally the same as the IPF. MSS wide band data from Landsat 4 or 5 is radiometrically preprocessed and framed by path and row. The preprocessed data is output to HDT's, which are then transmitted to EDC by communication satellite. The MSS archive for Landsat 4 and 5 remains on HDT and all EDIPS Landsat products

TABLE 8 - Archive Medium By Satellite, Date, and Sensor

Satellite	Date	Sensor	Medium and Location
Landsat 1	Jul 72-Jan 78	MSS	70-mm Film with Selected X-format CCT's at EDC
		RBV	70-mm Film at EDC
Landsat 2	Jan 75-Dec 78	MSS	70-mm Film with Selected X-format CCT's at EDC
		RBV	70-mm Film at EDC
Landsat 2	Jan 79-Jul 83	MSS	HDT-P or A at EDC[1]
Landsat 3	Mar 78-Dec 78	MSS	70-mm Film with Selected X-format CCT's at EDC
Landsat 3	Mar 78-Aug 80	RBV	70-mm Film at EDC
Landsat 3	Jan 79-Sep 83	MSS	HDT-P or A at EDC[1]
Landsat 3	Sep 80-Sep 83	RBV	HDT-P or A at EDC[1]
Landsat 4	Jul 82-Present	MSS	HDT-A at EDC
Landsat 4	Jul 82-Feb 83[2]	TM	HDT-R at GSFC with Selected 241-mm Film and Customer Requested CCT's at EDC
Landsat 5	Mar 84-Present	MSS	HDT-A at EDC
Landsat 5	Mar 84-Present	TM	HDT-R or A at GSFC with[3] Selected 241-mm Film and Customer Requested CCT's at EDC

[1] HDT-P stands for fully "processed" data. HDT-A stands for partially processed data, without geometric resampling applied. HDT-R stands for 'raw" data.

[2] The combination of the X-Band transmitter failures and the subsequent solar array power cable failures effectively ended the acquisition of Landsat 4 TM data on February 15, 1983.

[3] Landsat 5 HDT-R tapes were reused from May 6 to July 27, 1985.

TABLE 9 - Worldwide Landsat Volume[1] and Revenue[2] Trends for Calendar Years 1979-1984

	Argentina		Australia		Brazil		Canada		ESA(Earthnet)		India	
FY	Items	$	Items	$	Items	$	Items	$	Items	$	Items	$
79	—	—	—	—	19,197	272,220	10,898	316,875	2,864	155,359	—	—
80	—	—	464	24,496	11,576	377,901	10,073	389,654	5,677	335,192	512	18,529
81	1,506	150,983	6,244	347,312	8,499	353,513	18,315	358,715	3,587	676,143	2,312	38,523
82	3,429	76,851	6,304	382,770	6,507	585,823	9,126	290,637	3,970	742,152	4,852	103,839
83	828	69,747	4,190	339,400	4,249	340,953	9,665	274,758	2,904	760,800	3,803	103,959
84	466	54,982	3,593	479,100	3,902	233,486	10,570	364,890	3,400	1,040,271	3,154	86,507
	6,229	**352,563**	**20,795**	**1,573,078**	**53,930**	**2,163,896**	**68,647**	**1,995,529**	**22,402**	**3,709,917**	**14,633**	**351,357**

	Japan		South Africa		Thailand		U.S.A. (EDC)[3]		TOTAL	
FY	Items	$	Items	$	Items	$	Items	$	Items	$
79	6,469	27,838	—	—	3,709	23,059	143,988	2,242,473	**187,125**	**3,037,824**
80	8,635	114,451	577	22,800	4,688	24,353	136,435	2,493,639	**178,637**	**3,801,015**
81	8,488	128,021	3,196	98,000	6,016	26,330	130,621	2,663,326	**188,784**	**4,840,866**
82	8,132	145,552	3,078	107,937	4,305	66,662	120,458	3,422,753	**170,161**	**5,924,976**
83	5,394	135,529	1,633	128,634	272	43,090	56,007	3,850,557	**88,945**	**6,047,427**
84	5,048	221,543	1,818	67,752	1,827	124,391	38,337	3,964,186	**72,115**	**6,637,108**
	42,166	**772,934**	**10,302**	**425,123**	**20,817**	**307,885**	**625,846**	**18,636,934**	**885,767**	**30,289,216**

[1]Number of photographic frames and digital scenes, subscenes and quadrants.

[2]Converted to United States dollars.

[3]Goddard Space Flight Center estimated sales for CY 1979 through 1981 are not included. The extimated sales are: CY1979, 28,758 items and $400,000; CY 1980, 22,770 items and $400,00; CY 1981, 13,768 items and dollars are not available.

continue to be available to customers.

For TM, the functional relationship to the archive is similar to the older NDPF system. Black and white positive 241-mm film is generated and processed at GSFC. The film roll is then express shipped to EDC for archiving and product generation. TIPS has the capability to process up to 50 scenes per day to film and 10 scenes to CCT. TM-CCT's are created only upon customer request. Some digital customer convenience is lost as any non-standard resampling technique, projection, etc., must be retrospectively ordered through TIPS.

Table 8, Archive Medium by Satellite, Date, and Sensor attempts to graphically present the status of the current U.S.A. Landsat data archive.

International Landsat Data Sales

Presently, some dozen foreign countries or international organizations receive and process Landsat data. Several other countries are currently installing receiving stations; and additional nations are evaluating the need for Landsat reception capability.

Worldwide Landsat sales for calendar years 1979 through 1984 are presented in Table 9. U.S. sales and distribution of photographic products and computer tapes, through the EROS Data Center are presented in Tables 10 and 11, by fiscal year as noted in the remarks.

TABLE 10 - U.S. Imagery Data Sales, Fiscal Years 1973 through 1985 by Customer Category

FY	Federal Government Items	Federal Government $	NASA[1] Investigator Items	NASA[1] Investigator $	State/Local Government Items	State/Local Government $	Academia Items	Academia $	Industrial Items	Industrial $
73	21,780	62,756	—	—	2,995	10,639	13,071	28,679	24,430	67,360
74	28,493	87,156	—	—	2,534	10,920	18,611	63,964	35,890	114,140
75	34,184	136,883	5,437	12,192	1,921	7,388	27,545	106,374	45,476	180,824
76[2]	38,639	249,429	68,448	266,967	1,359	8,559	34,235	152,089	54,198	292,324
77	20,691	199,216	9,650	60,632	1,331	14,368	13,881	104,677	36,368	289,983
78	26,995	428,269	512	5,431	1,465	21,557	9,966	108,179	20,495	304,624
79	31,973	383,964	—	—	943	15,381	14,336	159,431	25,151	366,192
80	25,297	277,631	—	—	4,134	59,877	12,702	149,501	23,467	365,230
81	28,355	334,367	—	—	3,177	49,067	11,123	144,361	28,219	439,545
82	22,741	277,297	—	—	4,923	75,297	7,460	124,827	21,308	472,840
83	16,907	887,784	—	—	3,415	95,163	4,987	123,375	14,620	510,532
84	14,543	1,143,470	—	—	1,149	71,213	2,287	101,308	7,612	492,287
85	20,844	1,185,757	—	—	1,105	104,312	2,336	112,252	6,924	478,393
	331,442	**5,653,979**	**84,047**	**345,222**	**30,451**	**543,741**	**172,540**	**1,479,017**	**344,158**	**4,374,274**

FY	Individual Items	Individual $	Non-U.S. Items	Non-U.S. $	Unidentified[3] Items	Unidentified[3] $	TOTAL Items	TOTAL $
73	5,109	17,143	8,497	28,154	5,189	13,311	**81,071**	**228,042**
74	17,266	67,127	37,038	120,499	17,346	64,708	**157,178**	**528,514**
75	18,632	98,753	47,066	153,899	17,393	68,576	**197,654**	**764,889**
76[2]	21,760	160,839	78,036	377,105	578	4,779	**297,253**	**1,512,091**
77	7,987	68,929	40,143	344,279	49	344	**130,100**	**1,082,428**
78	5,524	71,208	45,766	502,100	—	—	**110,723**	**1,441,368**
79	9,198	93,654	52,881	569,491	—	—	**134,482**	**1,588,113**
80	8,121	91,932	54,712	635,166	—	—	**128,433**	**1,579,337**
81	9,273	113,842	48,628	567,986	—	—	**128,775**	**1,649,168**
82	5,900	111,765	52,693	629,093	—	—	**115,025**	**1,691,119**
83	3,562	99,230	27,746	530,510	—	—	**71,237**	**2,246,594**
84	1,820	69,318	7,553	343,657	—	—	**34,964**	**2,221,253**
85	1,200	53,032	6,670	326,979	—	—	**39,079**	**2,260,725**
	115,352	**1,116,772**	**507,429**	**5,128,918**	**40,555**	**151,718**	**1,625,974**	**18,793,641**

[1]NASA Investigator program ended in Fiscal Year 1978.

[2]United States changed Fiscal Year system; Fiscal Year 1976 data covers 15 month period.

[2]Accounting system modified in Fiscal Year 1978.

TABLE 11 - U.S. Digital Data Sales, Fiscal Years 1973 through 1985 by Customer Category

FY[1]	Federal Government Items	Federal Government $	NASA[2] Investigator Items	NASA[2] Investigator $	State/Local Government Items	State/Local Government $	Academia Items	Academia $	Industrial Items	Industrial $
75	162	32,400	19	3,800	48	9,600	182	35,680	195	38,880
76[3]	777	77,173	611	122,200	4	800	331	66,200	757	151,400
77	383	70,609	177	35,400	29	5,800	182	36,400	611	122,200
78	1,025	169,000	40	8,000	50	10,000	256	51,200	826	165,300
79	719	117,250	—	—	25	3,900	406	75,800	752	142,600
80	622	114,960	—	—	91	18,450	275	52,900	1,256	249,170
81	822	146,700	—	—	293	58,600	278	54,250	1,602	318,700
82	1,259	294,510	—	—	328	71,600	293	76,750	1,770	451,700
83	995	375,265	—	—	154	61,510	286	108,020	952	407,810
84	1,474	553,240	—	—	73	50,950	291	80,125	601	493,075
85	4,135	1,300,390	—	—	120	105,560	209	142,085	1,484	1,227,680
	12,373	**3,251,497**	**847**	**169,400**	**1,215**	**396,770**	**2,989**	**779,410**	**10,806**	**3,768,515**

FY[1]	Individual Items	Individual $	Non-U.S. Items	Non-U.S. $	Unidentified[4] Items	Unidentified[4] $	TOTAL Items	TOTAL $
75	11	2,200	108	20,760	4	800	**729**	**144,120**
76[3]	47	9,400	766	153,200	6	1,200	**3,299**	**581,573**
77	16	3,200	489	97,800	—	—	**1,887**	**371,409**
78	13	2,600	643	128,600	—	—	**2,853**	**534,700**
79	49	9,200	1,031	194,950	—	—	**2,982**	**543,700**
80	26	5,050	1,869	368,700	—	—	**4,139**	**809,230**
81	19	3,800	1,337	264,050	—	—	**4,351**	**846,100**
82	53	14,800	1,271	340,800	—	—	**4,974**	**1,250,160**
83	9	6,230	883	400,350	—	—	**3,279**	**1,359,185**
84	28	15,180	575	398,305	—	—	**3,042**	**1,590,875**
85	22	16,960	734	579,760	—	—	**6,704**	**3,372,435**
	293	**88,620**	**9,706**	**2,947,275**	**10**	**2,000**	**38,239**	**11,403,487**

[1]Customer Profiles for Fiscal year 1973 and 1974 are not available. FY 1973 sales were 10 items; $1600 and FY 1974 sales were 228 items; $36,480.
[2]NASA Investigator Program ended in Fiscal Year 1978.
[3]United States changed Fiscal Year system; Fiscal Year 1976 data covers 15 month period.
[4]Accounting system was modified in Fiscal Year 1977.

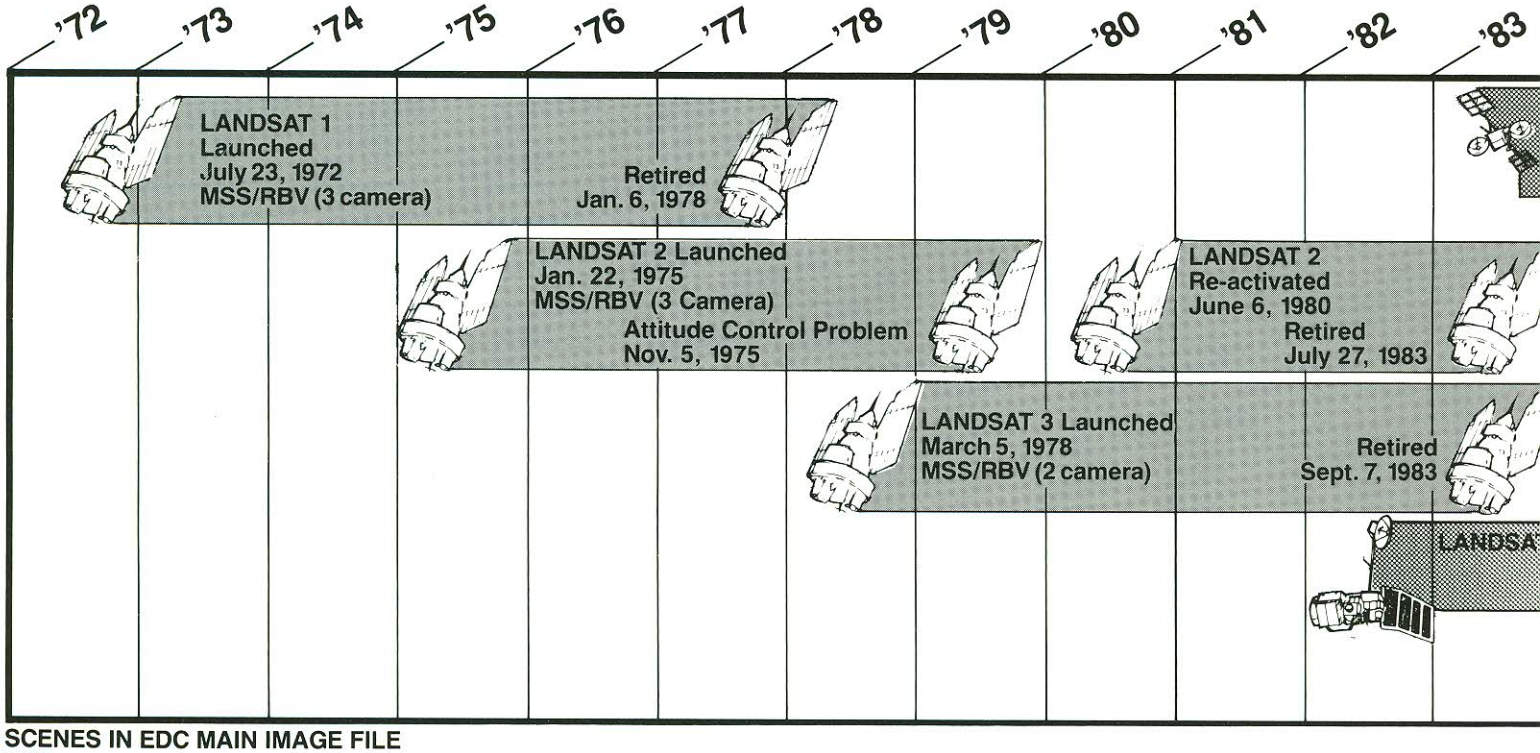
INDEX TO ARTICLES FROM THE LANDSAT DATA USERS NOTES

This index is organized by keyword. Under each, the titles of related articles that have appeared in the **Landsat Data Users NOTES** from Issue No. 18 to and including the present issue, are listed along with the appropriate issue and page number. A similar list is published in Issue No. 18, May 1981, for the first 17 Issues. The issue numbers correspond to the following dates of publication:

No. 18 May 1981
No. 19 July 1981
No. 20 September 1981
No. 21 January 1982
No. 22 March 1982
No. 23 July 1982
No. 24 September 1982
No. 25 December 1982
No. 26 March 1983
No. 27 June 1983
No. 28 September 1983
No. 29 December 1983
No. 30 March 1984
No. 31 June 1984
No. 32 December 1984
No. 33 April 1985
Supplemental - July 1985
No. 34 November 1985
No. 35 March 1986

(Continued on page 12)

LANDSAT TIM



SCENES IN EDC MAIN IMAGE FILE

	'72	'73	'74	'75	'76	'77	'78	'79	'80	'81	'82	'83
MSS	17,678	56,219	93,117	151,802	192,212	263,469	302,654	329,510	351,829	382,158	407,051	437,770
RBV	1,231	1,231	1,273	1,792	2,311	3,238	8,644	11,390	101,953	131,643	153,808	153,897
TM	—	—	—	—	—	—	—	—	—	—	—	322

JULY 1972
70mm MSS Film
Browse Roll Microfilm
CCT-"X" Format (Uncorrected)
System Corrected Image Products

NOVEMBER 1976
NASA NDPF Product Generation

JANUARY 1979
IPF/EDIPS Product Generation
9" MSS Film Products
HDT-"P" (Resampled) MSS Data Available
Initiated GCP Correction to HOM Projection
CCT-"P" Fully Corrected Data
Microcatalog Listings By WRS Path and Row
70mm RBV Film
L/S 3 Line Start Anomaly

MARCH 1979
L/S 3 Thermal Band Failure

NOVEMBER 1979
Presidential Directive 54

SEPTEMBER 1980
9" RBV Film Products for L/S 3
RBV Digital Products Available for L/S 3

JUNE 1981
Unsampled or Resampled MSS and RBV Digital Products
Image and Digital Products Corrected to HOM Projection

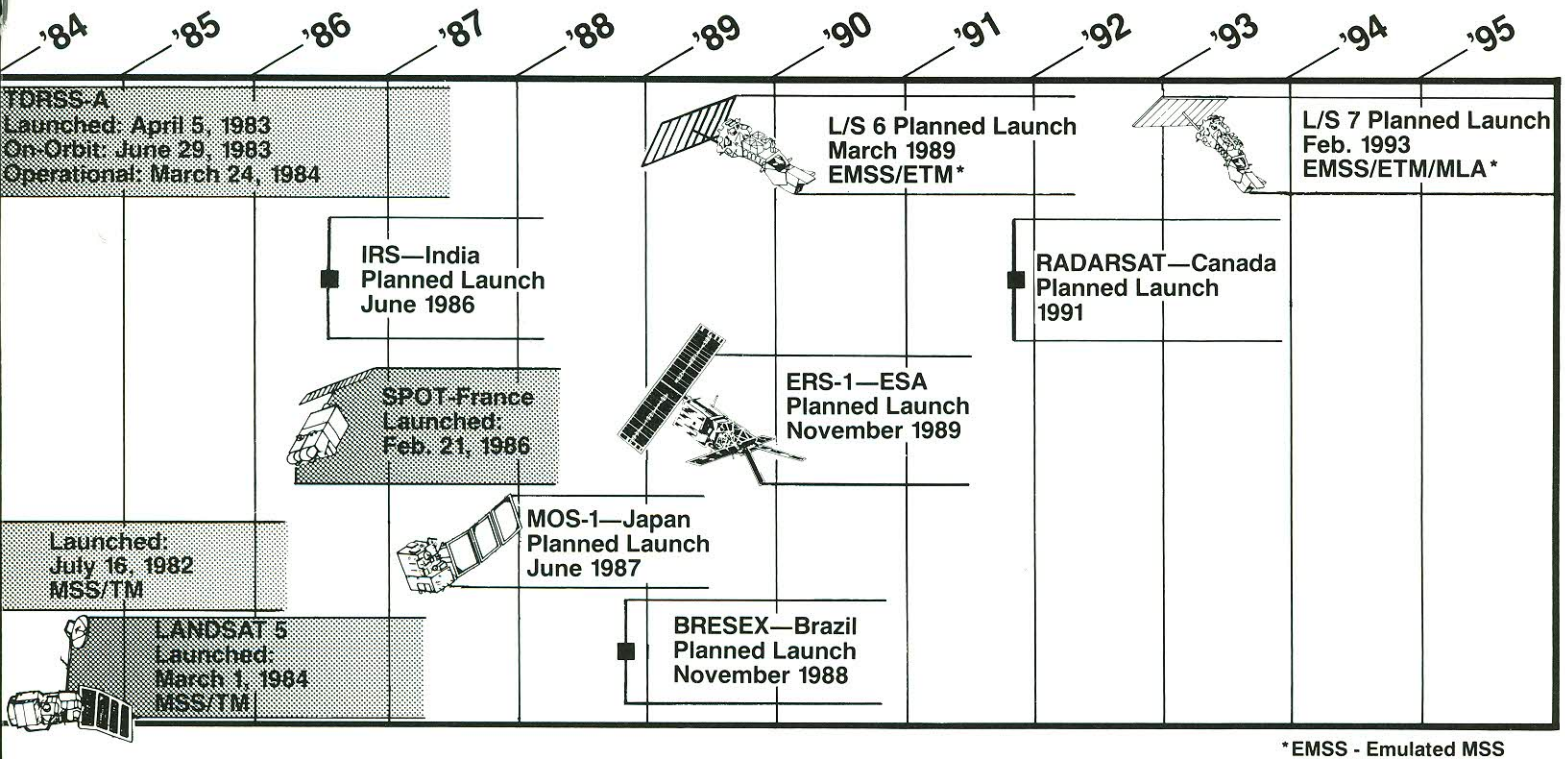
JULY
L/S 4

AUG
L/S 4

SEP
L/S 4
NOA

OCT
L/S 4

MELINE



*EMSS - Emulated MSS
ETM - Enhanced TM
MLA - Multiple Linear Array

	469,071	503,125
	153,897	153,897
	5,455	11,004
84	85	86

982
ctivation of TM Bands 1-4, and MSS

ST 1982
tivation of TM Bands 5-7

MBER 1982
Band Transmitter A Failure
ssumes Operational Responsibility for MSS

BER 1982
entral Unit B Failure

MAY 1983
L/S 4 Solar Panel 4 Cable Failure

JULY 1983
L/S 4 Solar Panel 3 Cable Failure

FEBRUARY 1983
L/S 4 X-Band Transmitter B Failure

JANUARY 1984
Department of Commerce Releases RFP for Landsat Commercialization

JUNE 1984
Land Remote Sensing Commercialization Act of 1984 passed by Congress

SEPTEMBER 1984
NOAA Assumes Operational Responsibility for TM

SEPTEMBER 1985
EOSAT Contract Signed

DECEMBER 1985
EOSAT Headquarters Grand Opening in Lanham, Maryland

(Continued from page 9)

29/p.5; "IX" No. 29/p.5; No. 30/p.25; No. 31/p.14; No. 32/p.8; "X" No. 32/p.10; No. 33/p.12; Supp'l/p.12; No. 34/p.6; "Wyn Pecora Letter" No. 35/p. 19.

Photographic Products: "Landsat Photographic Products to Have Black Borders" No. 18/p.1; "Landsat Products to Include Latitude/Longitude Tick Marks" No. 18/p.1; "TM Photographic Products" No. 28/p.8.

Policies: "Late Payment Policies" No. 21/p.4, No. 22/p.6; "Notice to Customers" No. 29/p.5.

Pricing: "Price Increase" No. 19/p.4; "Summary of Landsat Product Processing" No. 19/p.4; "Landsat Price List" No. 21/p.2; "Prices for TM Products" No. 26/p.8; "NOAA Prices" No. 32/p.20, No. 32/p.8.

Production Statistics: "Landsat Production Statistics" No. 18/p.8, No. 19/p.8, No. 20/p.9, No. 21/p.11; "EDC Historical Landsat Statistics" No. 21/p.12, No. 22/p.8, No. 23/p.15, No. 24/p.12, No. 25/p.12.

Product Lines: "EDC Product Lines Rescheduled" No. 18/p.2; "Standard Product Lines Curtailed" No. 19/p.4.

Publications: "New Publication Series" No. 19/p.6; "Publications on Space Oblique Mercator Available" No. 21/p.10; "Publications" No. 23/p13, No. 24/p.10, No. 26/p.10, No. 28/p.11, No. 29/p.7, No. 30/p.12, No. 31/p.11, No. 32/p.9, No. 33/p.8, No. 34/p.7; "New Publications" No. 35/p. 19.

Quality Indicators: "Historical MSS CCT's: Quality Indicator" No. 32/p6.

RBV: "Masking Techniques Reduces RBV Training" No. 20/p.6; "RBV Worldwide Coverage Project Constrained" No. 21/p.7; "RBV Dodged Prints" No. 22/p.4.

Remote Sensing: "Remote Sensing Experiments Aboard Shuttle" No. 21/p.4; "Remote Sensing in East Africa" No. 25/p.9; "Remote Sensing Videotapes Available" No. 26/p10; "Dictionary of Remote Sensing" No. 27/p.8; "Remote Sensing at the Economic Summit" No. 30/p.12; "Civil Operational Remote Sensing Satellite Committee Members" No. 30/p.14.

River Tributaries: "Columbia River Tributaries Project" No. 22/p.2.

Russia: "The Russian Earth Resources Satellite" No. 21/p.5; "EARSeL/ESA" No. 27/p.8.

Sir-A & B Data: "Sir-A Data Available" No. 26/p.9; "Sir-B" No. 32/p.1, No. 33/p.6.

SLAR: "Available: Radar Images of New Jersey" No. 25/p.8.

SPOT: "International Land Satellite Programs" No. 24/p.4; "SPOT Image Opens U. S. Office" No. 26/p.10.

Surface Mining: "Streamflow Estimation in Surface-Mined Areas" No. 29/p.4.

Symposia: "Workshops Listed" No. 19/p.6, No. 20/p.11, No. 21/p.10, No. 23/p.13, No. 24/p.10, No. 26/p.10, No. 27/p.9; No. 15/p.9, No. 25/p.11, No. 26/p.4, No. 29/p.13, No. 30/p.12/ No. 31/p.12, No. 33/p.8/ Supp'l/p.8; "International Workshop on Hydrological Application of Space Technology" No. 35/p. 20.; "Training & Symposia" No. 35/p. 20.

TDRSS: "TDRS East to be Launched" No. 27/p.3; "TDRS-A in Wrong Orbit" No. 27/p.1; "TDRS Now in Proper Orbit" No. 28/p.2; "TDRS-1 Experiencing Problems' No. 29/p.2; "TDRSS Status" No. 31/p.4, No. 32/p.6; "Loss of TDRS-B" No. 35/p. 19.

Thematic Mapper: "TM Preview Scenes Available" No. 24/p.1; "TM Accession Aids" No. 25/p.3; "TM CCT's" No. 25/p.3; "TM Image Comparisons" No. 25/p.6;"TM Ground Segment Status" No. 26/p.4; "TM Acquisitions in 1983" No. 26/p.4; "No. 27/p.2, No. 28/p.3; "TM Research & Development Period" No. 28/p.4; "TM Photographic Products" No. 28/p.4; "TM Research Program to be Announced" No. 29/p.4; "Changes in Radiometric Calibration of Landsat TM Data" No. 29/p.4; "TM Scene Identification Discrepancy" No. 30/p.3; "Visual Interpretation of TM Band Combinations Being Studied" No. 30/p.7; "Status of Landsat 4 TM Data Set" No. 31/p.7; "TM Operations Under NOAA" No. 31/p.4; "Color Balance for Thematic Mapper: an Improved Image Archive" Supp'l/p.1.

Training/Assistance: "EDC Training Schedule" No. 18/p.7, No. 19/p.7, No. 20/p.11; "Remote Sensing Training Films" No. 21/p.10; "Remote Sensing Program In India" No. 21/p.10; "Digital Analysis Course" No. 22/p.7; "EDC Training Schedule" No. 22/p.7; No. 23/p.15; "Videocassette Series Offered by Purdue" No. 24/p.10; "EDC Training Schedule" No. 25/p.11; "GOES-F Pre-Launch Workshops" No. 26/p.10; "Training in Remote Sensing" No. 26/p.12; "Short Course in Landsat Sensors" No. 27/p.9, No. 29/p.15, No. 30/p.14, No. 31/p.13, No. 32/p.11, No. 33/p.10; "Training & Symposia" No. 35/p. 20.

Unispace: "Unispace '82" No. 25/p.9.

Worldbook: "Worldbook Offering Landsat Maps" No. 25/p.8.

WRS: "Landsat 4 WRS Index Maps Expected Soon" No. 24/p.2; "Landsat 4 WRS Index of U. S. Now Available" No. 25/p.12, No. 26/p.9; "WRS Maps of Europe Available" No. 27/p.2; "Landsat 4 WRS Indexes Complete" No. 29/p.8; "Pre-WRS Landsat 5 TM Data Available" No. 31/p.5.

MAJOR ARTICLE LIST

Each issue of the NOTES was reviewed and the titles of the two major articles were selected. The list of article titles is as follows:

Issue #	Date	Topic
1	January 1978	1) Announcement of **NOTES** 2) **Users Handbook** Revised
2	May 1978	1) Landsat 3 Launched 2) Landsat Micrographic Accession Aids System
3	November 1978	1) Beginning of EDIPS 2) Earth Station Established at EDC
4	January 1979	1) Terminals for Commercial Users at EDC 2) Availability of CCT's
5	March 1979	1) Precision Corrections Applied to Data 2) EDC Source of Landsat Data
6	May 1979	1) DOMSAT in Place 2) Japan Receiving Station Complete
7	July 1979	1) Alaska Field Office Augmented 2) Landsat D Design Outlined

MAJOR ARTICLE LIST (Continued)

Issue #	Date	Topic
8	September 1979	1) Change of EDIPS Processing Procedures 2) SPOT Satellite Proposed
9	November 1979	1) Agristars to begin in 1980 2) Selection Strategy for Preserving Historical Digital Data
10	January 1980	1) Landsat D to be Retrievable 2) MAGSAT Launching
11	March 1980	1) High-Altitude Photography Program 2) Landsat Turnaround Times Outlined
12	May 1980	1) EDC Database Access 2) Landsat Statistics
13	July 1980	1) Mapsat 2) NHAP Received at EDC
14	September 1980	1) Transition to Operational Landsat System Being Planned 2) The AVRI Project: Arizona Vegetation Resources Inventory
15	November 1980	1) EDIPS Upgrade in Progress 2) MicroIMAGE System Discontinued
16	January 1981	1) RBV Image Defects 2) Landsat 3 MSS Problem
17	March 1981	1) Landsat D Simulation Data Available 2) RBV/MSS Composite Available
18	May 1981	1) Landsat Products to Include Latitude/Longitude Tick Marks 2) Index to Articles from the Landsat Notes
19	July 1981	1) International Landsat Sales 2) Aerial Photography - Acquisitions
20	September 1981	1) International Landsat Data Distribution Centers 2) Landsat 2 & 3 Operational Status
21	January 1982	1) International CCT Standard 2) Remote Sensing Experiments Aboard Shuttle
22	March 1982	1) Columbia River Tributaries Project 2) NCIC Sites
23	July 1982	1) Landsat 4 Launch 2) TM Radiometric Sensitivity Table
24	September 1982	1) TM Preview Scenes Available 2) MSS Acquisition Requests at EDC
25	December 1982	1) NOAA - New NOTES Sponsor 2) Landsat Data Available on Floppy Disk
26	March 1983	1) Transfer of NOAA's Land & Weather Satellite Program to Private Sector 2) TDRS-East to be Launched
27	June 1983	1) Landsats 2 & 3 - Standby Mode 2) Landsat 4 WRS Index Maps Released by NOAA & USGS
28	September 1983	1) Launch of D-Prime 2) Earthnet Announcements
29	December 1983	1) Landsat 5 to be Launched 2) Changes in Radiometric Calibration of Landsat TM Data
30	March 1984	1) Landsat 5 Launch 2) Applications of Real-Time Landsat Images in Alaska
31	June 1984	1) Commercialization Legislation Passes in Congress 2) Pre-WRS Landsat 5 TM Data Available
32	December 1984	1) Imaging Radar: Comparison for Landsat 2) Commercialization Process Update
33	April 1985	1) Availability of Large Format Camera Images 2) NOAA's 25 Year Commemoration
Supplemental Issue	July 1985	1) TM Look-up Tables 2) North America Landsat TM Acquisition Map
34	November 1985	1) Commerce Transfers Landsat to Private Sector 2) Synoptic Preview of Landsat Data for Cloud Cover
35	March 1986	1) Expections of Landsat Commercialization 2) NOAA and USGS Plan Cooperative Programs for Data Preservation and Remote Sensing Research and Development

EXPECTATIONS OF LANDSAT COMMERCIALIZATION

(Continued from page 1)

Today, we know that it was unrealistic to expect Landsat technology to mature within a decade and develop a self-sustaining market base. Its potential was then, and is now, dependent on the maturity of other technology, such as high-data rate computer processing technologies and computer-based geographic information systems; experienced, sophisticated users; and a marketing infrastructure that only the private sector can provide.

The Land Remote Sensing Commercialization Act of 1984 (15 U.S.C. 4201, et. seq.) established the framework whereby the United States would:

- Continue its civil land remote sensing program in partnership with the private sector, and
- Provide for a comprehensive U.S. research and development program in remote sensing (space) technology and data applications.

With contract signing on September 27, 1985, NOAA assigned operational control of the Landsat 4 and 5 system to the Earth Observation Stellite Company (EOSAT) under a cost-reimbursable contract. This action is the first phase of commercialization of the Landsat program under Title II of the 1984 law. The contract provides that EOSAT will:

— Continue services to foreign ground stations having formal agreements with the United States.
— Satisfy customer orders for photographic and digital Landsat products using existing Government facilities until commercial facilities become operational.
— Develop market requirements and opportunities at its own expense.
— Begin funding all operations from revenues earned from its marketing efforts with the launch of Landsat 6.
— Build two spacecraft (Landsats 6 and 7) and a new commercial ground processing system (with Government financial assistance) to assure six years of data continuity under Title III.

NOAA is drafting regulations under Title IV to license all U.S. commercial operators of remote sensing space systems, including EOSAT. The regulations will be issued for public review in 1986.

NOAA will establish the U.S. archive of land remote sensing data through an agreement with the U.S. Geological Survey (USGS). The agreement will designate the EROS Data Center (EDC) as the permanent site of the archive and transfer primary responsibility for the archive to EDC by 1990. NOAA and the USGS are establishing a research program colocated with the archive. The program will assure that the basic data set accumulated from Landsat, other U.S., and foreign space systems becomes an accessible data collection to serve global science needs. Other Federal agencies, universities, and private research organizations will be invited to participate.

History of the Contract Process

The Department of Commerce issued the Request for Proposals (RFP) on January 3, 1984. It was not until August 1985 that all major issues surrounding this contract were settled to the satisfaction of both the Congess and the Administration. Following is a brief chronology of events:

1/84- Final RFP issued.
3/84- Seven proposals received; Government review begins.
5/84- Secretarial decision to negotiate with two companies (KODAK and EOSAT).
7/84- Land Remote Sensing Commercialization Act signed.
7/84- New budget authority for implementing Title III limited to $250 million (only EOSAT continued negotiations).
9/84- Initial agreement with EOSAT; Report to the Congress.
1/85- New budget authority sought in NOAA's FY 86 budget request.
8/85- $125 million of new budget authority approved in FY 85 Supplemental Appropriation and FY 86 Appropriation.
9/85- Contract with EOSAT signed.

Contract Overview

The Department of Commerce retains the responsibility for Landsat 4 and 5 operations under Title II of the commercialization act. EOSAT provides Landsat 4 and 5 system operational support at Goddard Space Flight Center at a cost of 20 million dollars. This amount is planned to support the program during the estimated design life of Landsat 5 (through February 1987). If the spacecraft functions beyond that date, NOAA would continue this part of the EOSAT contract under the same terms until the practical demise of Landsat 5, or until six months prior to launch of Landsat 6. This cost-plus-fixed-fee section of the contract comes from existing budget authority for Landsat operations. Previously, NOAA had contracted for operational support with Computer Sciences Corporation at the Goddard Space Flight Center.

Through NOAA agreements reached with EDC, EOSAT will have the support of the EROS Data Center for the operational lifetime of Landsat 4 and 5 in responding to customer orders for Landsat data products, and will market Landsat data during this period at no cost to the Government. All revenues received for Landsat products go to EOSAT until the contract ends or EOSAT relinquishes their rights to the data. All operations and data marketing for Landsat 6 and beyond will be funded by EOSAT and carried out in non-Government facilities.

The contract provides for EOSAT to receive a fixed price of 250 million dollars from new budget authority to provide reasonable assurance of six years of data continuity as required by Title III of the Act. The 250 million dollars is to be applied to the capital costs for Landsat 6 and 7, and a new commercial ground processing system. Any capital costs over 250 million dollars will be paid by EOSAT.

Under terms of the contract, NOAA will provide for the launch of Landsat 6 and 7 on the Space Shuttle. Negotiations with NASA estimate the cost for both launches will total about 38 million dollars.

Landsat 6 and 7 System Overview

Landsat 6 is planned to be available for launch in early 1989. The spacecraft is expected to carry the Enhanced Thematic Mapper (ETM) with a 15-meter panchromatic (PAN) band and a Multi-Spectral Scanner Emulator (EMSS) to process on-board TM data into the functional equivalent of MSS data.

The TM data will have effective ground resolution of 30 meters in six channels (bands 1-5, and 7) and 120 meters in the emissive or thermal infrared channel (band 6). The EMSS will provide ground resolution of 60 meters in four channels that will coincide with TM bands 1-4. Although not covering quite as broad a spectral range as panchromatic film used in aerial photography, the panchromatic band will overlap the spectral range of TM bands 1-4.

Landsat 7, planned for launch in 1993, will carry the ETM, as con-

figured on Landsat 6, with one change. Instead of a single thermal infrared band with 120-meter ground resolution, plans call for a multichannel thermal infrared capability of up to 4 bands in the 8-11.6 micron range with 60-meter ground resolution. In early February 1986, EOSAT convened a working group of scientists for advice on the optimum selection of thermal infrared channels for various applications. The system design decisions must be made early in 1986.

To ensure global data coverage, Landsats 6 and 7 will operate with high-volume, on-board tape recorders and will not use the Tracking and Data Relay Satellite System (TDRSS) for data collection over foreign areas. Panchromatic data rates will be extremely high and can only be acquired using on-board tape recorders. Therefore, direct transmissions from Landsat 6 and 7 to U.S. and foreign ground stations will occur through the X-Band transponder for all data except the 15-meter PAN band.

Among the "challenges" that EOSAT must meet during this phase will be the scheduling of data collection. As more high-data rate channels are added to the ETM, the capability to transmit or capture all data becomes increasingly difficult. EOSAT advises that users will be asked to choose among options when ordering data products. For example, on Landsat 6, options could include: (1) the PAN band plus some, but not all, ETM channels available or (2) the original 7 ETM bands. On Landsat 7, users may be able to choose up to 7 bands out of the 10 (6 visible and reflective infrared, and 4 thermal infrared), or the PAN band plus 3 or 4 ETM bands.

EOSAT recently announced plans for substituting a new "bus" for Landsat 6 and 7. EOSAT proposes to use a modular, reusable platform named "Omnistar" instead of the expendible bus used on the Advanced TIROS-N spacecraft. The Omnistar platform, also designed by RCA Astro-Electronics, will be fully serviceable from the Space Shuttle and will permit in-orbit modifications. EOSAT expects to reduce costs significantly because sensors can be replaced and new payloads added in-orbit. The Omnistar platform is expected to have a 20-year life span.

The Potential Data Gap

A period when no Landsat data can be collected is expected between the failure of Landsat 5 and the launch and operation of Landsat 6. The length of this data gap will have considerable impact on the viability of EOSAT's commercial venture.

In planning for such a gap, EOSAT and NOAA believe the earliest date for Landsat 5 failure is after February 1987, the end of the 3-year design life span of Landsat 5. Such a failure would produce the longest potential data gap of 22 months. The shortest data gap would occur if Landsat 5 continued to function into 1988. In order to complete its commercial ground station facilities in time for the launch of Landsat 6, EOSAT must shut down Landsat 5 command and control operations at Goddard Space Flight Center six months before launch.

Because the current TM ground processing system does not process as much Landsat data as received, EOSAT expects to use the time in the data gap to work off the backlog of Landsat TM data accumulating at the Goddard Space Flight Center. This will give users some newly available data after the satellite is no longer in operation.

A Data Gap of Another Kind

One of the key elements designed into the Landsat 4 and 5 system was the potential of relaying coverage of all the Earth's land areas via the Tracking and Data Relay Satellite System (TDRSS). Because TDRSS would have provided innovative communications, tape recorders were not included on Landsat 4 and 5. However, due to problems with the first TDRSS-East satellite, schedule conflicts during Shuttle missions, and other delays, the system has not achieved full operational status.

If the TDRSS implementation had gone according to plan, the Space Shuttle would have launched two additional TDRSS satellites in 1986. Unfortunately, TDRSS-West was part of the Space Shuttle payload destroyed during launch on January 28, 1986. The launch of the third TDRSS satellite, originally scheduled for July 1986, is expected to be delayed pending NASA's investigation of the accident and reassignment of future Shuttle mission payloads.

An operational TDRSS-West would have enabled Landsat to acquire data over the western Pacific region that includes most of Asia, Australia Hawaii, and western Alaska. Presently, TDRSS-East permits coverage over North and South America, Europe, and Africa on a non-interference basis with Space Shuttle operations.

The most severe consequence of this disaster is the loss of opportunity to acquire a global data set of Thematic Mapper data. Currently, only certain foreign ground stations besides the United States routinely acquire these data (Canada, Brazil, Sweden, Italy, India, Thailand, and Japan). Other nations have plans to upgrade their stations to receive TM data and several new stations plan to begin TM operations within the next two years. However, during the lifetime of Landsats 4 and 5, there will not be enough coverage provided by the increased number of foreign ground stations to acquire one complete global TM data set.

Marketing

An important objective of the contract is for EOSAT to develop a commercial market for unenhanced Landsat data and become a self-sustaining enterprise. The 1984 law and the 1985 contract set several conditions on EOSAT's ability to market these data.

First, EOSAT must provide data products and services to all customers, including the Government, on a

INTERIM OPERATIONS

Prior to the completion of the new EOSAT production facilities in Lanham, Maryland, the EROS Data Center will continue to process and fill customer orders for Landsat products ordered through EOSAT. During this period, customers are encouraged to deal directly with EDC Customer Service Represetatives for routine inquiries and orders. For special requests or technical inquiries, users are urged to contact an EOSAT representative at EDC. All such contacts can be made via:

Telephone: (U.S.) 1-800-367-2801
(International) 605-594-2291
Telex: 910-668-0310
Mail: EOSAT
EROS Data Center
Sioux Falls, SD 57198
USA

Questions on EOSAT policy or marketing inquiries can be directed to EOSAT headquarters:

Telephone: 1-800-344-9933 or
1-301-552-0500
Telex: 277685-LSAT UR
Mail: EOSAT
4300 Forbes Boulevard
Lanham, MD 20706 USA

nondiscriminatory basis. Although other countries endorse this principle, presently only the U.S. private operators of remote sensing space systems are required by law to comply with "open skies" as they conduct their international marketing operations.

Second, the contract grants EOSAT the exclusive right to sell all data from Landsats 1 through 7. This exclusive right applies to Landsat data in the Government's archive acquired prior to the effective date of the contract and to all Landsat data acquired during the contract term. Data acquired by purely commercial satellites will be owned by commercial operators.

Third, EOSAT may set commercial prices but must offer the same terms to all customers with two specific exceptions. Discounts for bulk purchases are allowed if offered on the same terms to any customer wishing to buy large volumes of data. The Land Remote Sensing Commercialization Act of 1984 makes a specific exception for the U.S. archive of land remote sensing data. The law directs U.S. private operators of remote sensing space systems to provide data from their commercial inventories at reasonable costs for reproduction and transmittal when requested for the archive by the Secretary of Commerce. To avoid competition with commercial operators, this archival data cannot be distributed by the Government during the term of the contract (until September 1994) and, thereafter, not until ten years after the date of sensor acquisition or the exclusive right of sale is relinquished by the commercial operator.

A third possible price exception could be data released for research activities. We all recognize that research is necessary to develop new products and expand markets. In the past, most Government-sponsored researchers using Landsat data either purchased their data products from the EROS Data Center at established prices or obtained copies from other researchers in Government, academia, or the private sector. Combined with cost issues, EOSAT has instituted an Agreement for Purchase and Protection of Satellite Data to protect its interest in unenhanced data. In principle, there should be no significant difference in the ability of Federal agencies to supply data to researchers because of commercialization. In fact, there will be some impact because data products obtained from EOSAT can no longer be freely copied and distributed. EOSAT and NOAA are working to develop a cohesive policy for research. See "NOAA and USGS Plan Cooperative Program for Data Preservation and Remote Sensing Research and Developments" in this issue.

Editor's Note: Only Landsat data products distributed by EOSAT after September 27, 1985, (the effective date of the contract) are restricted by the Agreement for Purchase and Protection of Satellite Data. All data products sold or distributed by the Government prior to that date can be reproduced and distributed by the owners.

Conclusion

In order to become a successful business venture, EOSAT must devise methods to increase worldwide sales of unenhanced Landsat data through the full range of photographic and digital products previously offered by the Government and by introducing new products when the Landsat 6 commercial ground system is operational. Also important to EOSAT's success are three important elements in the marketing infrastructure that must be developed for these data: foreign ground stations, the value-added service industry, and public and private sources of information about Landsat data holdings.

NOAA will remain the signatory on agreements with foreign government agencies operating Landsat ground stations for the lifetime of the Landsat 4 and 5 systems, and as needed for Landsat 6 and beyond. NOAA also will work with EOSAT to establish ground stations for portions of the world not covered by the existing network. EOSAT hopes to increase the number of stations to 20 by the end of the decade.

EOSAT is prohibited by law from entering the value-added (enhanced data) marketplace. Therefore, a primary objective for EOSAT is the stimulation of a vigorous value-added service industry. The value-added service industry will be encouraged to expand its customer base for remote sensing products and services in order to help reduce the price of individual products through volume production and resulting discounts.

Information about available Landsat data and opportunities to schedule new acquisitions are important to EOSAT's marketing strategy. EOSAT plans to increase customer access through the use of electronic bulletin board services and strategically located business offices around the world. Each office will provide microfiche browse files, computer catalogs, and a service/sales staff. NOAA will also continue to list Landsat data held by the U.S. archive with the National Cartographic Information Center (NCIC) in Federal and state-affiliate offices throughout the United States.

NOAA AND USGS PLAN COOPERATIVE PROGRAMS FOR DATA PRESERVATION AND REMOTE SENSING RESEARCH AND DEVELOPMENT

(Continued from page 1)

chive of land remote sensing data for historical, scientific, and technical purposes, including long-term global environmental monitoring. This Title further directs the Secretary of Commerce to provide for long-term storage, maintenance, and upgrading of a global, land remote sensing data set (termed "the basic data set"); to follow reasonable archival practices to assure proper storage and preservation of the basic data set; to provide timely access for parties requesting data and, to the extent practicable, to use existing Government facilities for the data archive.

To meet these data preservation requirements, the National Oceanic and Atmospheric Administration (NOAA), acting on behalf of the Secretary of Commerce and in cooperation with the U.S. Geological Survey (USGS), is developing plans to establish and operate the National Satellite Land Remote Sensing Data Archive ("the Archive") at the USGS EROS Data Center. The basic data set to be assembled and preserved at the Archive will be an irreplaceable resource for long-term global monitoring, as well as for remote sensing and Earth resources research and development. It will consist of Landsat and other U.S. satellite system data acquired over the past decade, as well as future data to be acquired by U.S. and foreign, operational and experimental, commercial and government satellite remote sensing systems. Beginning this year, plans call for the annual acquisition and addition to the archive of several thousand new scenes of Landsat, SPOT, and other satellite system

data. NOAA and the USGS are developing means to establish an Archive advisory group, with members representing government, private industry, and academic institutions, to assist in defining the scope, specific content, and acquisition strategy of the Archive basic data set.

The Archive will provide environmentally controlled storage facilities to assure long-term data quality, integrity, and preservation. As technological advancements permit, data stored on current storage media will be converted to advanced and more permanent storage media, such as optical disks, to improve data durability, integrity, and reliability. Data processing and product generation facilities, equipment, and capabilities required for Archive operations will be provided, as will an efficient data catalog system, supported by appropriate accession aids and a user-accessible telecommunications network.

It is important to recognize that much of the data to be preserved in the Archive cannot be made available to the general user community for a period of years. While 15 U.S.C. 4201 requires system operators who fall under the jurisdiction of this law to provide data promptly to the Archive at reasonable costs for reproduction and transmittal when requested by the Secretary of Commerce, it also grants to those system operators the exclusive right to sell all data they provide to the Archive for a period determined by the Secretary, but not to exceed ten years from the date of sensor acquisition. For Landsat data acquired before implementation of the contract under Title II of 15 U.S.C. 4201, the contractor (EOSAT) has the exclusive right to sell those data for the duration of the contract, which expires in July 1994. A system operator may relinquish the exclusive right and consent to distribution from the Archive before that right normally expires by terminating the offer to sell particular data. After expiration or relinquishment of that exclusive right, the Government shall consider those data to be in the public domain and available upon request at prices reflecting reasonable costs for reproduction and transmittal. Access to Archive data provided by system operators that do not fall under the jurisdiction of 15 U.S.C. 4201 will be subject to conditions negotiated with those operators. However, prices for such data that are available from the Archive will reflect reasonable costs for reproduction and transmittal.

Cooperative Federal Remote Sensing Research Program

Recognizing existing and future needs to more fully exploit the capabilities of satellite land remote sensing data and technology to address important scientific, economic, and social problems, Title V of 15 U.S.C. 4201 also directs, authorizes, and encourages specified Federal organizations to conduct research and development programs that address various remote sensing topics. The Administrator of the National Aeronautics and Space Administration (NASA) is directed to continue and to enhance NASA's programs of remote sensing research and development. The Secretary of Commerce is directed to conduct a continuing program of research in applications of remote sensing, monitoring of the Earth and its environment, and development of technology for such monitoring. The Secretaries of the Interior and Agriculture, as well as other Federal agencies, are authorized and encouraged to conduct research and development programs aimed at expanding applications of remote sensing data and technology. Further, Federal agencies are encouraged to conduct remote sensing research, development, and monitoring programs in cooperation with other Federal agencies and with public and private research entities (including private industry, universities, state and local governments, foreign governments, and international organizations) and to enter into arrangements that will foster such cooperation.

To meet these legislated guidelines for remote sensing research and development and to accomplish objectives important to Federal agencies and the entire remote sensing user community, NOAA and the USGS are developing plans to establish a Cooperative Federal Remote Sensing Research Program (the "Research Program") collocated with the National Satellite Land Remote Sensing Data Archive at the EROS Data Center. This Research Program is being developed with the philosophy that substantial cost savings and improved efficiency can be realized through a cooperative approach to remote sensing research and development. By pooling resources and locating multidisciplinary expertise at a facility that already possesses significant analytical and support capabilities, it is believed that significant remote sensing research and development, both on topics of common interest and those specific to needs of the participating organizations, will be accomplished in a most cost-effective manner.

To further facilitate efficient and cost-effective research and development, a goal of the Research Program will be to arrange for access and use, for research and development purposes, of data in the Archive. Such arrangement would be based on recognition of the importance of research and development to advancing remote sensing capabilities and to increasing future data utilization. Elements of the Research Program will include 1) basic research and development required to advance the capabilities of remote sensing in general, addressing such topics as data capture and handling, geometric and radiometric rectification, data processing, data analysis and interpretation, and data merging and integration, and 2) applications development, wherein specific scientific problems will be addressed using various remotely sensed data and newly developed techniques to investigate, demonstrate, and document the capabilities of the data, techniques, and technology to solve real research and operational problems. User education programs, to effectively transfer research and development results and advancements to educational, research, and operational programs in the Earth resources community, will also be important components of this Research Program.

A cooperative agreement between NOAA and the USGS will establish the Research Program. NOAA and the USGS will solicit cooperative participation in the program by scientists from other Federal agencies, academic institutions, and the private sector. As program participation increases, research and development objectives will be expanded appropriately. Expectations are for the Research Program to evolve to a program supported by dedicated facilities and equipment and organized under a multi-agency management structure.

EDITOR'S NOTE:

In the closing era of the Federal government's management of the Landsat system, Mrs. William T. Pecora's thoughts were solicited. Bill Pecora, as Undersecretary of the Department of the Interior, had a major influence on the establishment of U.S. space remote sensing via the Landsat program. Her thoughtful letter is published here, expressing a deep concern for the uncertainties of the future:

"Nineteen eighty-five was a memorable year for LANDSAT: a very successful Tenth Pecora Symposium was held and LANDSAT celebrated its entry into the teen years.

"I have mixed feelings about those teen years. What is the future for our 'manchild'? Can 'benefit for all mankind' still be its main purpose and yet have 'commercial value' as its prime goal? Knowing full well why 'EROS' was chosen for the name of the USGS remote sensing program, I was apprehensive when the primary agencies were changed from those with science as their mandate to 'Commerce.' Would that necessitate a change in goals and the role its creators planned for it? Having been a part of the years (not months) of conception and prenatal care and a witness to the birth and launch in 1972, I feel like a mother watching her child stretch its wings and declare its independence: happy that it's maturing and feeling ready to go out on its own, but worrying about all the pitfalls it may face. Could I have done anything to give or seek more support for it at the times it so sorely needed it? Can I let go? Do I, the bystander, have the right to interfere as I watch it grow and, hopefully, not stumble? All these thoughts crowd my memory when asked to write a few words for the last (Federal) LANDSAT Newsletter.

"I am so proud of what has been accomplished these past 13 years. I know Bill Pecora, Bill Fischer, and others not here to witness LANDSAT's growth and untold, already-reaped, benefits would be proud too. But much praise must be given to those who shared their vision and dreams and tried to make them reality. I'm grateful and I know the entire world is too. All I can say now is Good Luck and Vaya con Dios."

Wyn Pecora

Ethelwyn "Wyn" Pecora
(Mrs. William T. Pecora)

LOSS OF TDRS-B

The tragic loss of the shuttle Challenger (51-L) directly impacts the Landsat system. On board the Challenger was NASA's TDRS-B. This was the second satellite in the TDRS series. Upon its deployment and checkout, the TDRS system was to become fully operational for the users. TDRS-B was to be placed at 171 degrees west longitude, over the Pacific Ocean. This would have allowed the routine collection of Landsat MSS and TM data over the Pacific Basin.

At the present, no information has been released as to the date of launching another TDRS satellite. In the series of six spacecraft contracted for, five have been built. The launch of TDRS-D had been scheduled for mid-summer 1986. It was to have become the on-orbit spare, stationed between TDRS-A and B. If either one failed, it was to have replaced the failure. TDRS-C was scheduled for early 1987. (C had been shifted in the launch schedule to allow for modification.) When new launch information becomes available, it will be published.

NOTES TO BE AVAILABLE ON MICROFICHE

Over the past few years, requests have come to Landsat Customer Services for copies of previous issues of the **Landsat Data Users NOTES**. Where extra copies were available, they were provided. However, certain issues were more popular than others, and the supply of some issues was exhausted. Occasionally, Customer Service representatives went so far as to send out black and white reproductions of articles in the **NOTES** to assist customers.

As NOAA does not have the resources to reprint all of the **NOTES**, it is in the process of converting all issues to microfiche. This project will be completed with the conversion of this issue. The **NOTES** microfiche should be available in July 1986. Presently the microfiche price has not been determined.

When the complete set of the **Landsat Data Users NOTES** is available on microfiche, it will be announced through the EOSAT newsletter. Also, after July 1986, you may contact:

Landsat Customer Services
Mundt Federal Building
Sioux Falls, SD 57198
1-800-367-2801
1-605-594-6151

NEW PUBLICATIONS

The Joint NASA/GEOSAT Test Case Project (Final Report), Part 1 and 2, Volumes I and II, plus Plates, Part 3, can be obtained from: The American Association of Petroleum Geologists AAPG Bookstore Tulsa, OK 74101 Catalog #301 $68

This is an excellent set of materials of a research venture between NASA and the GEOSAT Committee, Inc. Experimental Remote Sensing data were acquired over eight test sites containing known deposits of copper, uranium, oil, and gas.

Report on First Pilot Climate Data System Workshop
Contact Dr. Paul H. Smith, Head
Data Management Systems Facility
Space and Computing Division
NASA/Goddard Space Flight Center
Greenbelt, MD 20771

SATELLITE DATA PROGRAM AT THE NATIONAL GEOPHYSICAL DATA CENTER/WORLD DATA CENTER

NOAA's National Geophysical Data Center (NGDC) is currently developing its program to support users of satellite data.

For a number of years NGDC has had several programs that involve satellite and terrestrial geophysical data. Work is expanding to include remotely sensed data in general, as well as the integration of different types of data.

As a constituent of the World Data Centers (World Data Center A for Solid Earth Geophysics, World Data Center A for Marine Geology and Geophysics, World Data Center A for Solar-Terrestrial Physics, and World Data Center A for Glaciology), NGDC has participated in cooperative efforts of

mutual benefit and has provided some technical assistance with governmental agencies and professional bodies worldwide. It hopes to be able to continue such cooperation in the future.

David A. Hastings has just moved from the U.S. Geological Survey's EROS Data Center to assist in this effort.

For further information on NGDC/World Data Center programs in remotely sensed and terrestrial data, contact:
(If writing from the USA)
U. S. Department of Commerce
NOAA
National Geophysical Data Center
325 Broadway
Boulder, Colorado 80303
Telephone 303-497-6215

(If writing from overseas)
World Data Center A for Solid Earth Geophysics
325 Broadway
Boulder, Colorado 80303 USA
Telephone: 303-497-6215
Telex 45897
Solterwarn IAHS/WMO

IAHS/WMO INTERNATIONAL WORKSHOP ON HYDROLOGIC APPLICATIONS OF SPACE TECHNOLOGY

The International Committee on Remote Sensing and Data Transmission, of the International Association of Hydrological Sciences, and the World Meteorological Organization held an International Workshop on Hydrologic Applications of Space Technology at Cocoa Beach, Florida on August 19-24, 1985. The workshop was preceded on August 18 by a short course on Geographic Information Systems, presented by Dr. Duane Marble of SPAD Systems, Ltd., Williamsville, NY. The course was designed to introduce people to the subject in preparation for discussions in the workshop.

The symposium concentrated on hydrologic applications of remote sensing and remote data transmission, especially as to how those techniques may be applied to hydrologic modeling and geographic information systems.

Approximately 100 technical people from 34 countries attended the workshop. Papers presented orally or by poster are being reviewed. The accepted papers will be in an IAHS numbered publication by early 1986. Copies may be ordered from C. Riggs, Treasurer, IAHS, 2000 Florida Ave., N.W., Washington, DC 20009, USA. Further details concerning the workshop and future plans of the International Committee on Remote Sensing and Data Transmission can be obtained from A. Ivan Johnson, President, IRCSDT, 7474 Upham Court, Arvada, Colorado 80003, USA (Phone: 303/425-5610).

TRAINING & SYMPOSIA

May 5 - 8, 1986
Technology for Value, the Tenth Canadian Symposium on Remote Sensing. (Edmonton, Alberta, Canada) Contact: M. Deane Thompson, Technical Co-Chairperson, INTERA Technologies, LtD., –1200, 510-5th Street, S.W., Calgary, Alberta, Canada T2P 3S2, Telephone: (403) 266-0900, Telex 03-824537.

May 12 - 16, 1986
Sampling Design and Accuracy Assessment for Remote Sensing. (Sioux Falls, S.Dak.) Contact: Training and Assistance Office, USGS/EROS Data Center, Sioux Falls, SD 57198. Telephone: (605) 594-6114, FTS: 784-7114.

June 2 - 27, 1986
Remote Sensing Applications in Agriculture and Forestry: Technical Application Center of the University of New Mexico. Contact: Dr. Will D. Swearingin, Training Coordinator, TAC, University of New Mexico, Albuquerque, NM 87131, Telephone: (505) 277-3622, Telex 660461 ASBKS UNM ABQ.

June 9 - 13, 1986
Remote Sensing Principles and Practices. (Sioux Falls, S.Dak.) Contact: Training and Assistance Office, USGS/EROS Data Center, Sioux Falls, SD 57198. Telephone: (605) 594-6114, FTS: 784-7114.

June 30 - July 18, 1986
Image Processing of Satellite Data for Natural Resource Applications: International Short Course in Remote Sensing. Contact Dr. Will D. Swearingin, Training Coordinator, TAC University of New Mexico, Albuquerque, NM 87131, Telephone: (505) 277-3622, Telex 660461 ASBKS UNM.

August 17 - 22, 1986
Optical Mass Data Storage. (Town & Country Hotel, San Diego, CA.) Contact: Robert A. Sprague, SPIE Technical Committee/San Diego 86, P.O. Box 10. Bellingham, WA 98227-0010 USA. Telephone: (206) 676-3290, Telex 48-7053.

August 25 - 29, 1986
International Symposium on Remote Sensing, Resources Development and Environmental Management. (Enschede, The Netherlands) Contact: ISPRS Symposium, Comission VII, International Symposium on Remote Sensing, Resource Development and Environmental Management, c/o Intercontinental Travel (Westbloak) b.v., P.O. Box 558, 3000 AN Rotterdam, The Netherlands.

September 2 - October 3, 1986
International Remote Sensing Workshop. Open to non-U. S. scientists only. (Sioux Falls, S.Dak.) Contact: Training and Assistance Office, USGS/EROS Data Center, Sioux Falls, SD 57198. Telephone: (605) 594-6114, FTS: 784-7114.

September 29 - October 2, 1986
Fifth Thematic Conference: Remote Sensing for Exploration Geology; Mineral and Energy Exploration: Technology for a Competitive World. (Reno, Nevada) Contact: Remote Sensing Center/ERIM, P.O. Box 8618, A1, Ann Arbor, MI 48107 USA.

The Landsat Data Users NOTES was published quarterly in order to present information of interest to the user community regarding Landsat product systems and related remote sensing developments. Individuals and organizations wishing to receive single copies of the NOTES should contact Landsat Customer Services, Mundt Federal Building, Sioux Falls, South Dakota 57198, Telephone: (605) 594-6151. Comments, corrections, and queries of any kind may be directed to: Manager, Landsat Data Users NOTES, above address. This Issue, Number 35, is the final issue of the Landsat Data Users NOTES. All past issues will be available on microfiche after July 1986.

☆GOVERNMENT PRINTING OFFICE: 1981-564-078/9