The Availability of Landsat Data: Past, Present, and Future

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Abstract

It has long been recognized that the success of the Landsat program would depend on an effective distribution of its data to a wide variety of users, worldwide, in a timely manner. Since 1972, nearly $250 million worth of data have been distributed by a network of ground stations around the world. The policies of the U.S. Government affecting the distribution, availability, and pricing of Landsat data have been controversial, and have been strongly affected by the attempts to commercialize the program. At the present time, data are being distributed in the U.S. by either government or commercial entities, depending on the date of acquisition of the data in question and whether or not the customer is affiliated with the Federal Government. Although the future distribution of Landsat data is currently under discussion, it seems likely that data distribution initially will be the responsibility of NOAA. In any case, the long-term archive and distribution of all Landsat data will be the responsibility of the Department of Interior's U.S. Geological Survey.

Introduction

Six months before the launch of the first Earth Resources Technology Satellite, later named Landsat 1, William T. Pecora, a former Director of the U.S. Geological Survey (USGS), and at that time Under Secretary of the Department of the Interior (DOI), reported the following to the U.S. House of Representatives: "One of the most challenging problems for the future in supplying remote sensing data to the user is the need to keep the material simple, to deliver it in an uncomplicated form, then make it easy to use...a real need exists for new and more timely sources of environmental and resource information." (Pecora, 1972). An early proponent of satellite remote sensing of the Earth, Pecora recognized that making the data available to users in a timely and efficient manner would be critical to the success of the program.

Getting data into the hands of the users without unnecessary encumbrances has always been a goal of the Landsat program. The concept of "open skies," first proposed by the U.S. in the mid-1950s, is now generally accepted by all nations. It means, simply stated, that any nation has the fundamental right to acquire image data from space. As the U.S. established the Landsat program, it made extraordinary efforts to extend this policy, to ensure that any nation whose territory was covered by the sensors had access to the data, especially through the installation of local ground receiving stations. The U.S. also has fought long and hard in the United Nations and elsewhere to gain worldwide acceptance of non-discriminatory dissemination of unenhanced remotely sensed data.

This paper documents the past distribution of Landsat data worldwide, presents the current status of Landsat data availability, and speculates on its future through the Landsat 7 era.

History of Landsat Data Availability

U.S. Data Distribution

The laws and regulations that govern U.S. civilian satellite land remote sensing data distribution are found in the 1967 U.N. Outer Space Treaty, the 1984 U.S. Land Remote Sensing Commercialization Act (Public Law 98-365), the 1986 U.N. Principles on Remote Sensing, and the 1987 U.S. Department of Commerce Private Remote Sensing Licensing Regulations. More recently, specific guidelines for data archiving and distribution have been established by the U.S. Congress in the Land Remote Sensing Policy Act of 1992, also known as Public Law 102-555 (U.S. Congress, 1992) and by the Executive Branch in the National Space Policy released on 19 September 1996. In each case, the DOI/USGS is required to maintain a national archive of land remote sensing data. Prior to the launch of the first Landsat, NASA executed a cooperative agreement with the USGS to process, archive, and disseminate Landsat data at the USGS's EROS Data Center. Similar cooperative agreements exist between the USGS and the National Oceanic and Atmospheric Administration (NOAA) and the USGS and the Earth Observation Satellite (EOSAT) Company, now Earth Imaging Eosat, for managing Landsat 4 and 5 data; and between USGS, NASA, and NOAA for handling Landsat 7 data as they become available in 1998.

Since 1972, the series of Landsats has provided the most consistently acquired, well-calibrated, long-term remote sensing data set of the Earth's land areas. Nevertheless, data availability has never reached the level envisaged by Pecora and others when the program was conceived. Complex issues, such as private versus public sector involvement, separation or amalgamation of civilian and military programs, improved versus constrained system development, competition or cooperation with other nations, and uncertain government subsidies, have plagued the program for the last quarter of a century.

In 1979, the U.S. Government transferred management of the Landsat program from NASA to NOAA and then in 1985 from NOAA to the private sector with the expectation that the program would be operated and managed commercially.

The premise for commercializing Landsat was that, in a reasonable amount of time, revenues from product sales and ground station fees would exceed costs, Government subsidies would be eliminated, and a profitable commercial enterprise would flourish. Because revenues generated by the

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Photogrammetric Engineering & Remote Sensing, Vol. 63, No. 7, July 1997, pp. 869–875.

0099-1112/97/6307-869$3.00/0

TABLE 1. U.S. LANDSAT PRODUCT PRICE TRENDS

Year	Organization	MSS B&W 10-inch Neg.	MSS Color 40-inch Print	TM B&W 10-inch Neg.	TM Color 40-inch Print
		Photographic Images			
1980	USGS	$10	$50		
1982	NOAA	$35	$175	$35	$175
1985	NOAA	$40	$195	$80	$290
1985	EOSAT	$90	$350	$160	$500
1989	EOSAT	$90	$550	$300	$800
1990	EOSAT	$175	$1,000	$500	$1,500

Year	Organization	MSS/CCT	MSS Acq. Fee	TM/CCT	TM Acq. Fee
		Digital Tapes			
1980	USGS	$200			
1982	NOAA	$650	$790	$2,800	
1985	NOAA	$730	$1,120	$4,400	$1,600
1985	EOSAT	$660	$1,120	$3,300	$1,600
1989	EOSAT	$660		$3,600	
1990	EOSAT	$1,000		$3,960	

Sources: U.S. Geological Survey, National Oceanic and Atmospheric Administration, and EOSAT Company.

commercial operator proved to cover only a fraction of total program costs, heated debates occurred among the various institutions over appropriate Landsat product prices and the wisdom of commercializing the program. At the beginning of the program, the USGS set prices according to the DOI's legislative guidelines in which prices were based on the cost of reproducing the archived product and not on the higher costs of acquiring raw data and maintaining the archive. Thus, in the 1970s, satellite photographic images were priced between $8 and $50, a digital multispectral scanner (MSS) tape cost $200, and annual revenues were approximately $3 million (Pohl and Smith, 1979). As NOAA planned for an operational system, it hypothesized that a 5- to 10-fold price increase would easily cover ground handling costs and would increase revenues over time to $30 to $40 million annually (U.S. Department of Commerce, 1980). NOAA further hypothesized that a 10 percent growth in sales each year plus a fivefold increase in both product prices and foreign station data reception fees would generate annual revenues of $140 million by the year 2000.

In concert with the commercialization thrust, overall Landsat data prices were increased, first by NOAA, then by EOSAT, the commercial operator (Table 1). Prices of MSS and thematic mapper (TM) photographic products were increased 1,000 to 2,000 percent and those of MSS digital tapes, 500 percent. At the same time, TM digital tapes increased in price almost 200 percent. The price history and commensurate sales of Landsat data in the United States for the 11-year period from 1979 to 1989 are shown in Table 2. Not surprisingly, as data prices increased, users became more selective and sales decreased. In fiscal year 1976, the EROS Data Center (EDC) shipped almost 300,000 frames of Landsat photographic imagery (Austin and Rothenbuehler, 1989). This dropped to about 125,000 frames in 1980, to 40,000 in 1985, and to fewer than 4,000 in 1989. The EOSAT management strategy eliminated photographic imagery as a product line in 1993 and focused its entire marketing efforts on the sale of digital products. The number of Landsat digital tapes shipped by the EDC was about 3,000 in 1976, 4,000 in 1980, 6,500 in 1985, and more than 7,000 in 1989 (EOSAT also directly shipped some photographic images and digital tapes from Lanham, Maryland during this time, which are not included in these figures). The drop in photographic images shipped from one year to the next was not surprising, because this had been the trend for several years. In the early 1980s, when photographic image prices averaged $15 to $20 an item, more than 100,000 items were shipped per year. For the 4,200 photographic images shipped in fiscal year 1989, prices ranged from $90 to $1,000 an item. EOSAT attributed at least some of this loss of market share to the availability of data from government-subsidized foreign systems, such as the *Systeme Probatoire pour l'Observation de la Terre* (SPOT) and from sensors on the U.S. Government's weather satellites, such as the Advanced Very High Resolution Radiometer (Foley, 1989). These trends also showed that Landsat data were being purchased primarily by only a few government agencies and a number of aggressive corporations. Research facilities, academic institutions, educators, students, State and local governments, and the governments of less developed nations were purchasing considerably fewer data (Voute, 1987).

In the opening session of the July 1988 meeting of Directors of National Remote Sensing Centers, sponsored by the United Nations Development Program's Economic and Social Commission for Asia and the Pacific (ESCAP), the Executive Secretary of ESCAP commented on the "... widespread concern about the increasing cost of obtaining remotely sensed data," and the need to "... explore the possibility of assisting member countries to obtain such data at more reasonable prices" (Kibria, 1988). Then, one Director after another included a statement in his or her annual report that condemned pricing policies for Landsat and SPOT data. For Indonesia, it was "... the unfavorable price related to satellite imagery" (Esryam, 1988). Pakistan complained that "... the commercialization of satellite remote sensing systems and the increasing cost of space segment services could have an adverse effect on the development of remote sensing programs" (Mehmud and Mirza, 1988). Sri Lanka reported that "... paucity of funds has also limited the frequency with which air photography or satellite imagery could be obtained" (Berugoda, 1988).

Hassan and Falconer (1987) noted that, if a country purchases the tapes using precious foreign exchange reserves, multiple use of the data throughout the country or region is restricted by the condition of sale. Consequently, most remote sensing centers in less developed countries must ask for support from institutions in the industrialized nations to acquire such data.

Another area of noticeable user impact during this period was in the amount of Landsat data sold to colleges and universities. In 1976, academic customers purchased more than 25,000 Landsat photographic images and 270 digital tapes from the EDC for a total of $177,000. In 1988, they purchased only about 400 photographic images and 380 digital tapes for $330,000, approximately double the 1976 expendi-

TABLE 2. U.S. LANDSAT DATA SALES AND PRICE HISTORY

Year	Film Items Sold	Average Film Price ($)	CCT Items Sold	Average CCT Price ($)
1979	134,482	15	2,982	200
1980	128,403	15	4,139	200
1981	128,755	15	4,351	200
1982	115,025	20	4,974	250
1983	76,621	30	5,599	500
1984	34,964	60	5,042	500
1985	39,079	60	6,704	500
1986	19,061	125	7,808	1,000
1987	12,388	150	8,341	1,000
1988	9,088	150	8,530	1,000
1989	3,623	150	9,103	1,000

Source: U.S. Geological Survey, EROS Data Center, Sioux Falls, South Dakota

ture. Factors other than price may have affected demand over this 12-year period, but there was little doubt that the large price increase limited academic access to Landsat data. Furthermore, the data use restrictions placed on the data limited sharing of the data. To help alleviate this problem, EOSAT developed an image database of a limited number of scenes that could be purchased at a nominal fee by academics (Barker, 1990).

Since the first Landsat scene was recorded on 23 July 1972, the value of the data to users has rarely been questioned; however, the manner in which the data should be distributed has been continuously debated among the users, the commercial operator, the value-added industries, the Federal agencies with program responsibilities, the Congress, and the Administration. The debate culminated with the passage of Public Law 102-555. This law reversed the 1984 decision to commercialize the Landsat system (Public Law 98-365) and recognizes the scientific, national security, economic, and social utility of "land remote sensing data from space" (Sheffner, 1994). Both the Congress, through this law, and the Bush administration recognized that the commercialization of the Landsat program had failed, data distribution had been hampered by high prices, and the continuity of Landsat-type data into the next century must be maintained.

Public Law 102-555 specifically addressed Landsat data distribution by requiring the new Landsat Program Management team (first, NASA and DoD and, later, NASA, NOAA, and the USGS) to negotiate with EOSAT for a phased transition in the distribution policy for Landsat 4 and 5 (and the ill-fated Landsat 6, which failed to reach orbit) data. It further required that the policy be consistent with the prescribed Landsat 7 data policy — whereby all users will pay the same price and that price is not to exceed the cost of fulfilling user requests.

Foreign Data Distribution

Beginning with Canada, which constructed an operational receiving station prior to the launch of Landsat 1 in July 1972, 17 countries have built Landsat receiving stations over the years. Table 3 lists these countries and the dates that their ground stations became operational. With the exception of Argentina, which possessed only an MSS reception capability, all the stations were either built with both MSS and TM reception capability, or added TM capability later. Each ground station pays an annual fee for data reception and distribution rights.

Those countries with Landsat receiving stations have varied greatly in their capabilities to distribute data in a timely and reliable fashion, as well as in their willingness to provide consistent, worldwide customer services. Thus, it is difficult to generalize the ease of acquiring Landsat data from the stations. Each ground station sets its own prices; establishes its own customer services, data sales, and distribution policies; and develops its own cataloging and indexing procedures. Therefore, potential customers of one of these stations are well advised to contact the distributor in advance to ascertain prices and procedures for ordering data. In some cases, exclusive distributorship agreements have been established whereby residents of a particular country are required to purchase data through the distributor in their country rather than dealing directly with the distributor in the country where the receiving station is located.

In general, each station has received only those data that are acquired while the satellite is in direct view of the reception facility, and so its data holdings include only regional coverage as defined by the station's field-of-view. This is in contrast to the U.S. stations, which, through the use of onboard tape recorders and data-relay satellites have received image data covering nearly all parts of the Earth's surface. Figure 1 shows the approximate area of effective coverage for each ground station.

As a service to Landsat users worldwide, the USGS has maintained a computerized Landsat International Data Base that catalogs, in a common format, Landsat data acquired by both U.S. and other ground stations. This database permits users to conduct a single search of Landsat data covering their area(s) of interest, whether the data reside in a U.S. archive or elsewhere. However, the submission to and updating of metadata in the Landsat International Data Base is voluntary. So while the database includes up-to-date information on some Landsat imagery, it is not complete, because some stations have never provided information on their holdings, and the information from others is very much out of date. The status of the Landsat International Data Base is shown in Table 3.

Statistics on the amount and type of data distributed over the years by the ground stations or their affiliated distributors are not particularly reliable, as not all stations have consistently made their distribution figures public. Probably the most accurate numbers are those compiled by the Landsat Data Distribution and Marketing Working Group, an affiliate of the Landsat Ground Station Operations Working Group (LGSOWG). According to those figures, from 1979 through 1995 more than $234 million worth of data have been distributed worldwide, of which more than $103 million worth has been distributed by non-U.S. operators (see Table 4). While the proportion of photographic to digital data sold varies considerably from country to country, overall the pattern has been similar to that of the U.S. distributors; that is, a steady rise in digital products and a corresponding decline in photographic products. Whether this change is due to user requirement, or to pricing, or to supplier policy decisions is unclear.

Current Data Availability in the U.S.

Public Law 102-555 identified policy goals, strategies, and implementation guidelines for maintaining continuity of Landsat-type data into the next century. The law addressed both the near-term and long-term goals of the Landsat Program and assigned management responsibility to the Landsat Program Management team (currently NASA, NOAA, and USGS).

The law recognized the importance of preserving and ensuring long-term access to Landsat and other land remote sensing satellite data by directing the Department of the Interior to establish and manage a National Satellite Land Remote Sensing Data Archive, responsibility for which has

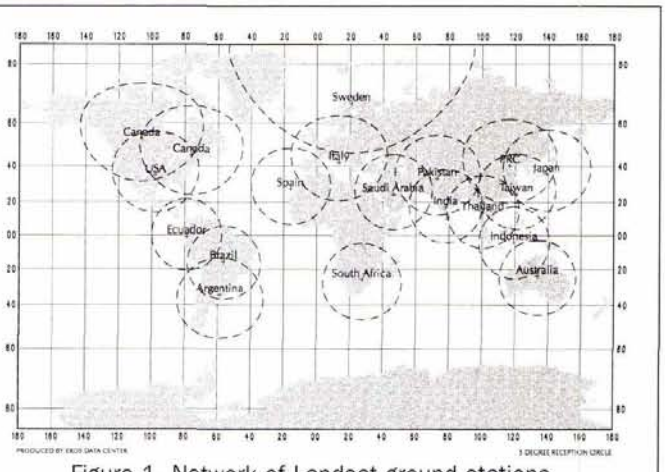

Figure 1. Network of Landsat ground stations.

TABLE 3. LANDSAT GROUND STATIONS AND INTERNATIONAL DATA BASE STATUS

Country	Established	Data Distribution Center	International Data Base Participation: Scenes	Latest Update	Acquisition Date Range
Argentina	1981	Comision Nacional de Investigaciones Especiales (CNIE) Centro De Processamiento, Avenue Dorrego 4010 1425 Buenos Aires, Argentina	10,790 MSS	5/87	9/80-8/84
Australia	1980	Australian Center for Remote Sensing (ACRES) P.O. Box 28 Belconnen, ACT 2616, Australia Tel: (61) (62) 52-4411 Fax: (61) (62) 516326 URL: www.auslig.gov.au/acres/index.htm	210,671 MSS	9/91	9/79-8/91
Brazil	1974	INPE-DGI Av. Dos Astronautas, 1758 Caixa Postal 515 12201-Sao Jose dos Campos SP Brazil Tel: (55) (0123) 229977 Fax: (55) (0123) 218743 URL: www.dgi.inpe.br	32,617 MSS 108,689 TM	5/90 5/95	5/73-9/87 3/84-1/95
Canada	1972	Canada Centre for Remote Sensing (CCRS) 2464 Sheffield Road Ottawa, Ontario, Canada K1A 0Y7 Tel: 613-952-2717 URL: www.ccrs.nrcan.gc.ca	466,225 MSS 188,616 TM	4/96 4/96	7/72-4/96 8/82-4/96
Earthnet		For any Earthnet data: Eurimage Operations Office - ESRIN-CP64			
Fucino, Italy	1975	Via Galileo Galilei 00044 Frascati, Italy Tel: (39) 6-9426285 or (39) 6-940218	398,865 MSS 135,843 TM	4/95 4/95	4/75-12/93 4/84-3/95
Kiruna, Sweden	1983	Fax: (55) (0123) 218743 URL: www.esrin.esa.it	479,622 MSS 188,600 TM	4/95 4/95	4/75-12/93 4/84-3/95
Maspalomas, Spain	1984		23,918 MSS 3,058 TM	8/91 4/95	7/84-12/90 11/87-7/94
Ecuador	1990	CLIRSEN Edificio Instituto Geografico Militar Quito, Ecuador Tel: (593) (2) 542758			
India	1980	National Remote Sensing Agency (NRSA) Department of Space, Balanagar Hyderabad-500 037, Andhra Pradesh, India Tel: (91) (040) 278560 Fax: (91) (040) 278664			
Indonesia	1982	Indonesian National Institute of Aeronautics and Space (LAPAN) JL Pemuda Persil No. 1, P.O. Box 3048 Jakarta, Indonesia			
Japan	1979	Remote Sensing Technology Center of Japan (RESTEC) Roppongi First Bldg. 2F, 1-9-9, Roppongi Minato-Ku, Tokyo 106, Japan Tel: (81) (3) 5561-9771 Fax: (81) (3) 5574-8515 URL: www.restec.or.jp	152,498 MSS 85,262 TM	8/96 8/96	1/79-6/96 4/84-6/96
Pakistan	1989	Pakistan Space and Upper Atmosphere Research Commission 43-1/P-6 Pechs, P.O. Box 3125, Karachi-Az, Pakistan Tel: (92) (21) 430121-4	3,256 MSS 4,583 TM	6/90 6/90	5/89-12/89 5/89-12/89
People's Republic of China	1987	Academy of Sciences, Landsat Ground Station P.O. Box 2434, Beijing, China Tel: (86) (10) 284861			
Saudi Arabia	1980	King Abdulaziz City for Science & Technology P.O. Box 6086, Riyadh 11442, Saudi Arabia Tel: (966) (01) 478-8000			
South Africa	1980	National Institute of Telecommunications Research Attn: Satellite Remote Sensing Center, P.O. Box 3718 Johannesburg 2000, Republic of South Africa Tel: (27) (12) 3265271 Fax: (27) (11) 642-2446 URL: www.sac.co.za	58,502 MSS 35,899 TM	11/93 8/96	7/80-9/93 1/89-6/96
Taiwan	1994	Center for Space and Remote Sensing Research National Central University Chung-Li, Taiwan, R.O.C. URL: www.csrsr.ncu.edu.tw			
Thailand	1981	Remote Sensing Division National Research Council of Thailand (NRCT) 196 Phahonyothin Road, Bangkhen Bangkok 10900, Thailand Tel: (66) (2) 5791370-9			

To date, EDC has not received international data base tape updates from Ecuador, India, Indonesia, People's Republic of China, Saudi Arabia, Taiwan, or Thailand.

TABLE 4. WORLDWIDE LANDSAT SALES REPORTED REVENUE*

Country	CY 1979	CY 1980	CY 1981	CY 1982	CY 1983	CY 1984	CY 1985	CY 1986	CY 1987
Argentina	$ —	$ —	$ 150,983	$ 76,851	$ 69,747	$ 54,982	$ 28,864	$ 67,794	$ 77,648
Australia	—	24,496	347,312	382,770	339,400	479,100	463,400	425,508	353,941
Brazil	272,220	377,901	353,513	585,823	340,953	233,486	453,578	693,280	931,516
Canada	316,875	389,654	358,715	290,637	274,758	364,890	362,485	578,000	504,289
China	—	—	—	—	—	—	—	—	—
Ecuador	—	—	—	—	—	—	—	—	—
ESA (Earthnet)	155,359	335,192	676,143	742,152	760,800	1,040,271	1,629,028	1,561,389	1,727,848
India		18,529	38,523	103,839	103,959	86,507	235,675	347,619	828,161
Indonesia	—	—	—	—	—	—	—	—	—
Japan	27,838	114,451	128,021	145,552	135,529	221,543	675,766	973,975	1,518,213
Pakistan	—	—	—	—	—	—	—	—	—
South Africa		22,800	98,000	107,937	128,634	67,752	60,495	103,892	54,006
Thailand	23,059	24,353	26,330	66,662	43,090	124,391	135,749	204,646	271,471
Taiwan	—	—	—	—	—	—	—	—	—
USA	2,242,473	2,493,639	2,663,326	3,422,753	3,850,557	3,964,186	5,776,092	8,395,224	7,834,976
Total	$3,037,824	$3,801,015	$4,840,866	$5,924,976	$6,047,427	$6,637,108	$9,821,132	$13,351,327	$14,102,069

Country	CY 1988	CY 1989	CY 1990	CY 1991	CY 1992	CY 1993	CY 1994	CY 1995
Argentina	$ 17,975	$ 7,360	$ —	$ —	$ —	$ —	$ —	$ —
Australia	750,060	829,245	991,918	1,051,900	817,451	886,754	1,425,547	3,779,482
Brazil	716,307	864,092	355,194	888,716	1,065,106	691,450	1,064,858	—
Canada	550,419	636,583	923,862	1,339,082	1,173,881	942,189	1,140,686	1,248,469
China	243,936	354,236	196,766	179,629	112,462	155,855	267,082	369,840
Ecuador	—	—	—	17,580	78,702	42,492	124,700	—
ESA (Earthnet)	2,174,485	2,851,146	2,760,242	3,243,889	2,990,478	4,348,040	3,846,051	2,864,227
India	669,819	203,928	567,619	331,563	258,999	268,800	216,878	124,037
Indonesia	—	29,771	—	—	—	—	6,425	6,425
Japan	1,321,438	1,139,807	841,757	873,836	1,488,867	1,287,070	1,786,871	2,004,209
Pakistan	—	—	21,600	148,325	83,861	151,284	262,073	159,150
South Africa	41,216	59,480	232,152	340,887	579,836	571,542	776,077	747,598
Thailand	171,485	423,069	764,879	1,017,275	847,030	1,092,744	1,471,730	1,648,109
Taiwan	—	—	—	—	—	—	5,441	—
USA	8,621,655	10,018,267	13,205,019	14,601,910	13,498,849	13,405,789	10,746,077	6,678,925
Total	$15,278,795	$17,416,984	$20,861,008	$24,034,593	$22,995,522	$23,844,009	$23,140,496	$19,630,471

*As reported by International Ground Station Management in $US.
—Indicates station not operating or data not reported.

been delegated to the USGS's EROS Data Center. The law also directed the Landsat Program Management team to negotiate with the Landsat commercial contractor, EOSAT, an agreement with respect to pricing, distribution, acquisition, archiving, and availability of all U.S.-held unenhanced Landsat data. The primary goal of the negotiation was a "phased transition" to a data policy consistent with the policy for Landsat 7. Per Public Law 102-555, conditions of the phased arrangements should require that the Landsat contractor (EOSAT) adopt provisions so that by the final phase of the transition period (initial operation of Landsat 7) the following conditions would be met:

- unenhanced data shall be provided, at a minimum, to the U.S. Government and its affiliated users at the cost of fulfilling user requests, on the condition that such unenhanced data are used solely for noncommercial purposes;
- instructional data sets, selected from the Landsat data archives, will be made available to educational institutions exclusively for noncommercial, educational purposes at the cost of fulfilling user requests;
- Landsat data users will be able to acquire unenhanced data contained in the collective archives of foreign ground stations as easily and affordably as practicable;
- data necessary to meet the needs of global environmental change researchers and national security users shall be acquired;
- the U.S. Government and its affiliated users shall not be prohibited from reproduction or dissemination of unenhanced data to other agencies of the U.S. Government and other affiliated users, on the condition that such unenhanced data are used solely for noncommercial purposes;
- nonprofit, public-interest entities shall receive vouchers, data grants, or other such means of providing them with unenhanced data at the cost of fulfilling user requests, on the condition that such unenhanced data are used solely for noncommercial purposes;
- a role for the private sector in the promotion and development of the commercial market for value-added and other services using unenhanced data from the Landsat system will be preserved; and
- unenhanced data from the Landsat system will be provided to the National Satellite Land Remote Sensing Data Archive at a price not to exceed the cost of fulfilling user requests.

Shortly after negotiations were initiated, Landsat Program Management and EOSAT reached agreement whereby EOSAT would relinquish its exclusive rights to MSS data. On 23 February 1993, the EDC began distributing digital MSS data from the National Satellite Land Remote Sensing Data Archive to all customers, with no restrictions, at $200 per scene for a systematically corrected scene. The negotiations continued regarding Landsat 4 and 5 operations and the distribution of TM data. On 11 April 1994, the Landsat Program Management and EOSAT reached agreement in principle on provisions for Landsat 4 and 5 operations and distribution, referred to as the LPM Agreement (Landsat Program Management and EOSAT, 1994). The LPM Agreement was officially

incorporated into the NOAA/EOSAT contract on 30 June 1995. Since that time, data distribution has been shared between the USGS and EOSAT.

EOSAT will continue to operate Landsats 4 and 5, at no cost to the government, until their demise, and will retain distribution rights for 5 years after the demise of the last of Landsats 4 and 5. EOSAT will distribute unenhanced TM data to the public, will set and publish commercial prices for unenhanced TM data, and will offer to sell and deliver such data on a nondiscriminatory basis. Currently, the EOSAT commercial price for a systematically corrected full TM scene is $4,400.

The EDC will distribute unenhanced TM data that are less than 10 years old to the U.S. Government and its Affiliated User (USGAU) purchaser group, and will distribute TM data more than 10 years old, and all MSS data, to any user with no restrictions. The definition of the USGAU is: "U.S. Government agencies, U.S. Government contractors, researchers involved with the U.S. Global Change Research Program and its international counterpart programs, and other researchers and international entities that have signed a cooperative agreement with the U.S. Government involving the use of Landsat data for noncommercial purposes" (LPM and EOSAT, 1994). A prerequisite for USGAU purchases of the newer TM data from the EDC will be the execution of a "United States Government and its Affiliated User Certification Form."

TM data previously purchased by the USGAU purchaser group and all future purchases of TM data by this group may be reproduced and redistributed within the USGAU, for noncommercial purchases, without restriction.

The USGS price for a systematically corrected TM full scene produced from data that are in the national archive at the EDC is $425. TM data in the archive includes all TM data acquired between July 1982 and October 1992, plus those data acquired from October 1992 to the present that have been purchased from EOSAT in response to an order. TM data acquired after October 1992, that are not in the EDC archive as a result of an order, must be purchased from EOSAT for $70 per scene times the number of scenes on the high density archive tape. The access fee ($70 times all scenes on the high density archive tape) is paid by the original requestor. All scenes thus acquired are processed, archived, and made available for $425, consistent with the USGS pricing policy for all permanently archived data.

In summary, all orders for Landsat MSS data should be directed to the EDC. Landsat TM orders should be directed to either the EDC or EOSAT as shown in Table 5. Ordering Information can be obtained from

EROS Data Center	EOSAT
U.S. Geological Survey,	EOSAT,
EROS Data Center,	4300 Forbes Boulevard,
Sioux Falls, SD 57198.	Lanham, MD 20706.
605-594-6151 (telephone)	301-552-0537 (telephone)
605-594-6589 (Fax)	301-552-3762 (Fax)
custserv@edcmail.cr.usgs.gov	custserv@eosat.com

The total amount of Landsat data accessible within the U.S. includes more than 630,000 MSS scenes, acquired between 1972 and 1992, and more than 350,000 TM scenes, acquired from 1982 to the present. Information regarding the availability of specific data can be obtained by directly contacting either the EDC or EOSAT. Users wishing to query metadata and browse systems have a number of options. Both the EDC and EOSAT support online metadata and browse systems accessible via the World-Wide Web (WWW). Other commercial systems also support metadata and browse access. Information regarding access to commercial systems can be obtained from either the EDC or EOSAT. The WWW addresses for the EDC and EOSAT systems are

USGS: http://edcwww.cr.usgs.gov/webglis/
EOSAT: http://www.eosat.com

TABLE 5. LANDSAT TM DATA DISTRIBUTION

	Date of Sensing and Distribution Site	
Customer Category	10 year and older TM data (today less 10 years)	10 year and newer TM data (incl. future acquisitions)
General Public	USGS-EDC	EOSAT
USGAU	USGS-EDC	USGS-EDC

The Future of Landsat Data Availability

Landsats 4 and 5

EOSAT will continue to operate Landsats 4 and 5 at no cost to the government until their "practical demise," and will retain distribution rights for 5 years after the demise of the last of Landsats 4 and 5. EOSAT will continue to distribute unenhanced TM data to the general public on a nondiscriminatory basis.

The EDC will continue to distribute 10-year-old and younger unenhanced TM data to the USGAU purchaser group; and 10-year-old and older TM data, and all MSS data, to any user.

The Landsat 7 Era

The Landsat 7 Project is managed under Presidential Decision Directive (PDD), NSTC-3, issued in May 1994 (White House, 1994), that established and chartered a joint Landsat Program Management team to operate the mission. Under PDD NSTC-3, NASA is responsible for developing and launching the platform and sensor and developing the ground segment; NOAA is responsible for management oversight of Landsat 7 operations and for direct management of the spacecraft and instrument; and the USGS is responsible for maintaining and preserving the long-term archive, and for operating the ground data processing system on behalf of NOAA. Launch is scheduled for 1998. Landsat 7 will carry a single instrument called the Enhanced Thematic Mapper-Plus (ETM+).

Landsat 7 data collected within the field-of-view of the international ground reception stations will be directly down-linked to those facilities. The primary U.S. data reception facility will be at the EDC in Sioux Falls, South Dakota. A second reception facility near Fairbanks, Alaska, will acquire coverage of Alaska and international coverage using the onboard recorder. An additional receiving facility in Spitzbergen, Norway, will provide backup reception. All data received at either Fairbanks or Spitzbergen will be shipped to the EDC, where the Landsat 7 Data Handling Facility (DHF) will process the down link data from all three facilities into a format suitable for archiving. All data will then be archived by NASA's Land Processes Distributed Active Archive Center (DAAC) at the EDC.

Landsat 7 mission requirements provide for distribution of uncorrected (Level 0R) products to all users, under management and data policy guidelines established by the Landsat Program Management team and implemented under NOAA's oversight. Level 0R products can be produced in the traditional scene format, can be composed of multiple scenes (up to three scenes in a single product), or can be composed of a partial scene. These ETM+ products will be distributed in the EOS version of the Hierarchical Data Format. Landsat 7 data policy conforms with Public Law 102-555, and defines a data pricing formula intended to recover the cost of fulfilling

the user request. That price is based on the requirement to offset all costs of spacecraft and mission operations as well as ground processing, with income from fees charged to international ground receiving facilities and from the sale of products. The Landsat Program Management team intends to distribute Landsat 7 data at the lowest possible cost, anticipated to be less than $500 per scene.

Continuation of the network of international ground stations is an important element of the Landsat 7 mission. Draft "Principles of Agreement" have been developed by NOAA that require each participating ground station to regularly submit an inventory of acquired scenes to the DHF. This inventory will be used to update the global Landsat 7 inventory, such that all data archived worldwide will be visible through NASA's Earth Observing System/Data Information System (EOSDIS) Information Management System (IMS).

All Landsat 7 data archived by the DHF will be accessible to all users through the IMS, which provides search and retrieval functions with graphical user interface tools. The user will be able to access Landsat 7 metadata that define the characteristics of all data acquired to date, to determine the quantity and quality of data available, and to view browse images. Upon selection of scene(s), the user will be able to activate an order process that will prompt a contact by the DAAC User Services Office at EDC to determine mode of payment and verify the product delivery option.

Although acquired under NOAA management oversight and stored in the EOSDIS short-term data archive, Landsat 7 data will eventually be moved to the long-term national archive managed and distributed by the USGS. Although no determination has yet been made regarding the most appropriate timing for this transition, a general guideline is that, as data reach three years of age, transition should occur.

Summary

It is clear that the management and data distribution policies and practices of the U.S. Government and its attempts at commercialization have prevented the Landsat program from living up to the vision and expectations of its early proponents in terms of the widespread use and application of its data. Nevertheless, the fact that nearly $250 million worth of Landsat data have been sold since 1972 indicates that the data are being used at a moderate level by certain categories of users around the world. And, finally, the Landsat program has definitely been a positive learning experience that will guide satellite data distribution policies and practices in the future.

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