REPORT BY THE U.S.

General Accounting Office

Costs And Uses Of Remote Sensing Satellites

This report provides information to the Subcommittee on Space Science and Applications, House Committee on Science and Technology, for use in examining the possible transfer of the Federal Government's civilian weather satellites and its land remote sensing satellite (Landsat) to the private sector. Specific issues are the costs of the satellites, their use by Federal agencies, and the adequacy of federally sponsored studies of the marketability of Landsat data.

GAO/RCED-83-111
MARCH 4, 1983

Request for copies of GAO reports should be sent to:

U.S. General Accounting Office
Document Handling and Information
Services Facility
P.O. Box 6015
Gaithersburg, Md. 20760

Telephone (202) 275-6241

The first five copies of individual reports are free of charge. Additional copies of bound audit reports are $3.25 each. Additional copies of unbound report (i.e., letter reports) and most other publications are $1.00 each. There will be a 25% discount on all orders for 100 or more copies mailed to a single address. Sales orders must be prepaid on a cash, check, or money order basis. Check should be made out to the "Superintendent of Documents".

UNITED STATES GENERAL ACCOUNTING OFFICE
WASHINGTON, D.C. 20548

RESOURCES, COMMUNITY,
AND ECONOMIC DEVELOPMENT
DIVISION

B-210820

The Honorable Harold L. Volkmer
Chairman, Subcommittee on Space
Science and Applications
Committee on Science and Technology
United States House of Representatives

Dear Mr. Chairman:

In a letter of April 22, 1982, the former chairman of the Subcommittee on Space Science and Applications, House Committee on Science and Technology requested that we provide background information concerning a possible transfer of the Federal Government's civil remote sensing satellites, which includes both Landsat and the weather satellites, to the private sector. Specifically, the chairman asked four questions. The questions and a summary of our responses are listed below. Additional details are provided in the appendixes to this report.

1. What Landsat and weather satellite data are the various Federal agencies using and how much are they paying for the service? Within the National Oceanic and Atmospheric Administration (NOAA), is the National Weather Service (NWS) using and paying for satellite data?

In fiscal year 1982, the Federal Government received about 25 percent of the 68,800 Landsat products (images and computer tapes) distributed worldwide. In some cases Federal agencies have paid for the data, while other Federal agencies received data at virtually no cost. According to the Department of the Interior's Earth Resources Observation Systems (EROS) Data Center, a major distribution point for Landsat data, sales to the Federal Government were $474,100 in fiscal year 1981--the latest year that information was available. The Office of Management and Budget (OMB), in an attempt to recover more costs from users, directed all Federal agencies to pay for Landsat products beginning in fiscal year 1983. The agencies have estimated they will spend about $8.5 million.

Federal agencies have used Landsat for a wide variety of purposes. The agencies which make the largest unclassified use of the data, the Departments of Agriculture and the Interior, are concerned with agricultural and natural resources information in such cases as crop conditions, mineral locations, and wildlife habitats.

The largest users of the weather satellites are the NWS and the Department of Defense (DOD). Although they received about 95 percent of the data distributed, they do not pay for the service because NWS is part of NOAA, and DOD and NOAA have agreed to share weather data. NWS considers the weather satellites an essential part of its primary mission--protecting life and property from events such as hurricanes, tornadoes and severe storms. The satellites also provide NWS with data for developing daily weather forecasts. Although DOD has its own satellites, NOAA and DOD share information and their satellites act as backup systems for each other.

2. Is NOAA's fiscal year 1983 budget estimate that Federal agencies will pay approximately $10 million for Landsat services well supported?

At the time NOAA prepared its fiscal year 1983 budget, the $9.8 million estimate appeared reasonable. According to the Director, Resources and Management Services, National Environmental Satellite Data and Information Service (NESDIS), NOAA, the estimate was based on discussions with agencies that used Landsat data. OMB required major Federal users to include in their appropriation requests the amounts that they would need to purchase Landsat data. However, the requested funding was not fully approved by the Congress. The Agriculture appropriations bill for fiscal year 1983 provided only half the funds the Department of Agriculture sought for Landsat. In previous years the Department received Landsat data without charge, but in fiscal year 1983 the Department, complying with OMB's instructions, asked for $7.4 million for Landsat data. Congress passed an appropriations bill which provided only about $3.5 million. The House-Senate conference committee reported that the proposed charges were excessive and should be renegotiated. The Department is currently considering whether to request a supplemental appropriation for additional Landsat purchases. NOAA expects to reduce Landsat services if it does not receive some of the funds.

The current estimate of Federal purchases of Landsat data is $8.5 million, $1.3 million below NOAA's original $9.8 million estimate. The shortfall was caused by the $3.5 million cut in the Agriculture budget and offset by increases in planned purchases by other agencies.

3. What is the total Federal investment in Landsat and the weather satellites? How much of this is research and development? How should it be depreciated?

According to NOAA and the National Aeronautics and Space Administration (NASA), the Federal Government's total cost for building and launching the current satellite system will reach almost $1 billion by the end of fiscal year 1983. About $573.1 million is is the cost for Landsat and $421.7 million for weather satellites. NASA, which built the Landsat system, considers all of the capital costs for Landsat to be research and development costs.

On the other hand, NOAA does not consider any of the $421.7 million spent on the weather satellites to be research and development costs. Accounting rules for Federal agencies do not generally require that depreciation be recorded. Neither NOAA nor NASA compute depreciation on its satellites.

4. What market studies have been done to determine the feasibility of a profit-making satellite system? What is the quality of these studies?

We reviewed five Federally sponsored evaluations of the usefulness of earth sensing satellites. The studies identified present and potential uses of satellite data and estimated its value. The value estimates, which ranged from about $40 million to $35 billion annually, were rough and dependent on many assumptions. The high estimate included worldwide benefits while the low estimate represented only U.S. benefits. None of the studies provided a sufficient basis for determining the current feasibility of a profit-making system.

Objectives, Scope, and Methodology

We obtained information on the uses Federal agencies were making of satellite data by contacting the Department of Defense, the Department of the Interior, the Department of Agriculture, the Environmental Protection Agency, the Department of Energy, the Agency for International Development, and other agencies. NOAA and users provided estimates of Federal agencies' expenditures.

To evaluate NOAA's estimate of fiscal year 1983 sales revenues, we discussed purchasing plans for Landsat data with Landsat's Federal users and reviewed budget and appropriations documents which indicated spending authority and plans.

We obtained NOAA and NASA estimates of the Federal investment in Landsat and the weather satellites. We also reviewed accounting principles applicable to Federal agencies for recording depreciation and research and development costs.

Finally, through discussion with NOAA and NASA officials, we determined what evaluations of the market for Landsat-type data had been sponsored by the Federal Government. We reviewed these evaluations and discussed them with agency officials concerned with the private market for the data.

We conducted our review at the Washington, D.C. area offices of the satellite operators, NOAA and NASA, and other Federal agencies which use the satellite data. This review was performed in accordance with generally accepted government audit standards.

- - - - -

We did not take the additional time to obtain agency comments, but the matters covered in this report were discussed with

agency officials and their comments are included in the report where appropriate.

As arranged with your office, unless you publicly announce its contents earlier, we plan no further distribution of this report until 15 days from its date. At that time, we will send copies to the Chairman, Subcommittee on Science, Technology, and Space; Senate Committee on Commerce, Science and Transportation; and to other appropriate congressional committees. We will also send copies to the Secretaries of Commerce, Agriculture, the Interior, State, Defense, Energy, and the Administrators of NASA and EPA. Copies will also be made available to others upon request.

Sincerely yours,

J. Dexter Peach
Director

Contents

APPENDIX		Page
I	RESPONSES TO THE SUBCOMMITTEE'S QUESTIONS ON LANDSAT AND THE WEATHER SATELLITES	1
	Federal development of civil remote sensing satellites	1
	Federal use of Landsat	2
	Federal use of Metsats	5
	NOAA's expected fiscal year 1983 reimbursement for Landsat	7
	Federal investment in Landsat and Metsats	8
	Studies of the market for Landsat data	9
II	INFORMATION ON LANDSAT DATA USES AND EXPENDITURES IN FEDERAL AGENCIES	11
III	HISTORY OF APPROPRIATIONS FOR WEATHER SATELLITES	12
IV	FEDERALLY SPONSORED STUDIES OF THE USEFULNESS OF EARTH SENSING SATELLITES	13

ABBREVIATIONS

BLM	Bureau of Land Management
DOD	Department of Defense
DOI	Department of the Interior
EROS	Earth Resources Observation Systems Data Center
FAS	Foreign Agricultural Service
GAO	General Accounting Office
MSS	Multi-spectral scanner
NASA	National Aeronautics and Space Administration
NESDIS	National Environmental Satellite Data and Information Service
NOAA	National Oceanic and Atmospheric Administration
NWS	National Weather Service
SRS	Statistical Reporting Service
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey

RESPONSES TO THE SUBCOMMITTEE'S QUESTIONS ON LANDSAT AND THE WEATHER SATELLITES

FEDERAL DEVELOPMENT OF CIVIL REMOTE SENSING SATELLITES

The National Oceanic and Atmospheric Administration (NOAA), Department of Commerce, operates the Nation's civil remote sensing satellites--four weather satellites (Metsats) and one land remote sensing satellite (Landsat). The Metsats provide weather data and are of two types: polar orbiters and geostationary satellites. Two satellites occupy a polar orbit about 540 miles high. They provide global coverage of cloud patterns, surface temperatures, moisture profiles, and other environmental data four times daily. Two geostationary satellites continually view North and South America as they orbit the earth at the same rate the earth turns. 1/ These satellites, 22,300 miles above the equator, provide pictures of developing storms every half hour. A major value of all four satellites is their ability to detect and track destructive weather events, but they are also used in making daily weather forecasts and in researching the environment.

The Federal Government controls and receives data from two ground stations located at Wallops Island, Virginia, and Gilmore Creek, Alaska. In addition, NOAA's Satellite Field Service Stations in various locations throughout the country process and disseminate this satellite data.

Although the weather satellites have provided information about the atmosphere for 20 years, Landsat spacecraft have monitored surface conditions only since 1972. The satellite's instrument, 2/ which is sensitive to visible light, as well as infrared and ultraviolet radiations, monitors different materials on the Earth's surface--water, crops, and forests--by measuring the various light waves which they reflect. This information can be identified on computer tapes and photographs produced from the Landsat data. Resource managers then use photos and tapes to survey the Earth's resources, such as crop conditions and geological formations.

The first three Landsats were experimental spacecraft managed by NASA. A Presidential directive of November 1979 assigned NOAA

1/In calendar year 1982 one of the geostationary satellites failed in orbit. Another will be launched in 1983.

2/This sensor is known as a multi-spectral scanner and has been used on all Landsats. Earlier satellites also contained television cameras. The current satellite, Landsat 4, has a more sophisticated sensor for measuring light, which is still experimental.

reponsibility for the operational satellite system, designated Landsat 4, beginning in fiscal year 1983.

The Federal Government does not plan to build any additional land remote sensing satellites after the replacement for Landsat 4 is completed in FY 1983. NOAA expects that the final satellite, known as Landsat D', will be launched in about three years.

On September 10, 1982, the Department of Commerce invited private sector representatives to present their views on the following issues and express their interest in owning or operating civil remote sensing satellites:

--What is the best mechanism to implement the current policy of transfer of Landsat to the private sector as soon as possible?

--Should the Administration consider simultaneously private sector transfer of both civil weather and land remote sensing systems?

As of February 28, 1983, the Department of Commerce was evaluating the private sector's comments. The comments ranged from opposition to approval of the transfer. Some companies indicated an interest in owning or operating the weather satellites or Landsat.

FEDERAL USE OF LANDSAT

Federal agencies account for a substantial portion of Landsat data use. In fiscal year 1982, the Federal Government received about 25 percent of the 68,800 Landsat products (images and computer tapes) distributed. While the satellite data is distributed to many different agencies for a variety of projects, the major Federal users for unclassified purposes are the Department of Agriculture (USDA) and the Department of the Interior (DOI). Non-Federal users include states, the private sector, colleges, and other nations.

Landsat data is distributed from three sources: (1) DOI's Earth Resources Observation Systems (EROS) Data Center, Sioux Falls, South Dakota, (2) the Goddard Space Flight Center, Greenbelt, Maryland, and (3) overseas ground stations operated by other nations.

The EROS Data Center provides Federal agencies and the general public with several kinds of remote sensing information. Since 1973, much of the Center's sales has involved NASA spacecraft imagery, such as Skylab and DOI aerial photography, but the facility also stores and reproduces Landsat data. For a fee, the Center provides images and tapes to state and local governments, universities, industries, non-U.S. entities, and the Federal Government. In fiscal year 1981, the Federal Government accounted for 19 percent of the Center's $2.5 million sales.

The Goddard Space Flight Center is NASA's nerve center for tracking and communicating with near-earth satellites, such as Landsat. Goddard is the principal source of Landsat data for the USDA, because of USDA's need for timely data and foreign scenes for estimating crop production abroad. In calendar year 1981, Goddard provided digital data to USDA via communication satellite and about 13,700 frames and 21 computer tapes to Federal agencies.

Another source of Landsat data is the foreign ground stations owned and operated by other nations. These stations allow direct reception of data from the satellite to a worldwide market. In calendar year 1981, there were 11 foreign ground stations in 10 nations. They distributed about 21,900 items for $2,177,540 or about 45 percent of all sales revenues. Each station paid a fee of $200,000 to the U.S. Government in calendar year 1981.

Trend in Federal use

According to NOAA, the global demand for Landsat multispectral scanner (MSS) 1/ data has remained relatively stable in the last 5 years. On the average about 80,000 scenes per year are disbursed worldwide, while Federal distribution has declined from 40,000 scenes in fiscal year 1978 to 17,000 scenes in FY 1982. NOAA expects demand from all sources to increase modestly.

According to NOAA, the decline in MSS scenes distributed to Federal agencies was caused, in large part, by several factors:

--Prices for Landsat data have increased.

--Uncertainties have arisen about the continuity of data after Landsat D', since the Federal Government does not plan to build another land remote sensing satellite.

--For mapping and charting purposes, agencies may not need to purchase data for several years, since they collected Landsat data on features which change very slowly.

--Some demonstration projects were not converted to operational status. Budget restrictions may have had some influence on Federal agencies, or they may have found alternative means of obtaining the information.

NOAA expects some growth in Federal demand in fiscal years 1983 and 1984 based on estimates of the various Federal users, and based on USDA receiving the full appropriations it originally sought for Landsat.

1/Data collected by Landsat's multi-spectral scanner is by far the most frequently used data obtained by Landsat.

Landsat serves a variety of Federal purposes

Federal agencies purchase Landsat products for a variety of applications. While fiscal year 1983 will be the first year they pay for all data, USDA and DOI remain the major users for unclassified purposes. These agencies are concerned with investigating natural resources such as crop conditions, mineral locations, and wildlife habitats. To a lesser extent, other agencies have used Landsat for mapping coastal locations, flood forecasting, and transferring satellite technology to states, private businesses, and other nations.

The chart in appendix II outlines the uses Federal agencies have made of Landsat data. More detail is presented below on USDA's and DOI's applications.

Department of Agriculture

The principal users of Landsat data within USDA are the Foreign Agricultural Service (FAS) and the Statistical Reporting Service (SRS). Both use the data for predicting agricultural production--SRS for making estimates of domestic acreage in cultivation and FAS for estimating foreign farm production. The estimates of both these agencies are used by government entities for planning, and by farmers, purchasers of farm products, commodity securities traders, the transportation industry, and others for planning and pricing decisions.

The FAS estimates are based mainly on reports of about 63 agricultural attachés who provide worldwide coverage. However, over the last several years, FAS has made increasing use of Landsat data for estimating crop production. According to the Acting Deputy Assistant Administrator for International Agricultural Statistics, Landsat data has made production estimates much more certain and has been especially valuable in predicting the size of recent grain or soybean crops in the Soviet Union, China, and Brazil.

SRS's domestic crop production estimates are based mainly on on-site farm surveys. Landsat data is used to refine estimates resulting from these surveys. In 1982, Landsat data was used for estimating farm acreage in five states. Coverage is planned for an additional state in 1983.

According to Agriculture officials, the following are some examples of the uses of Landsat data in estimating crop production.

--Because of Landsat data, FAS has been able to accurately predict poor Russian grain crops in the last few years, despite restrictions imposed by the Soviet Government on the travel of the U.S. Agricultural attachés. With Landsat information FAS could determine early--near the beginning of the growing season--that production would be low and did not have to wait until the harvest.

--Because of a recent drought in the wheat-producing region of China, many people expected the Chinese wheat crop to be poor. Landsat data showed, however, that the Chinese irrigation system was working and that the crop would not be as low as predicted.

--Landsat data has often resulted in adjusting domestic acreage estimates derived from ground sources. For example, Landsat data was first used in 1978 in estimating Iowa corn and soybean acreage. The data significantly improved the estimates for these crops.

Department of the Interior

DOI has a diversity of users and applications for Landsat data. Each one requires a small portion of the Department's budget for Landsat. In each case, Landsat is one of many tools for carrying out programs.

For example, the U.S. Geological Survey (USGS) uses Landsat scenes, which provide broad geographical coverage, to help detect possible mineral locations. USGS can devote aerial photography and manpower to the most prominent locations and increase the efficiency of operations. According to DOI officials, Landsat is a small but useful part of this USGS program called the Conterminous United States Mineral Resource Assessment Program.

Landsat images also provide a broad reconnaissance for USGS map makers. These broad-scale images provide information on road changes, industrial growth, and other manmade and natural effects which are changing the earth. With the aid of Landsat, mappers can decide when to make new maps.

Landsat is used by the Fish and Wildlife Service to make maps of vegetation, water, and terrain in the vast remote wilderness in Alaska. The maps provide basic information for the Comprehensive Wildlife Refuge Plans which Congress has required of the Fish and Wildlife Service.

Every year, the Bureau of Land Management (BLM) inventories the vegetation, water resources, and other conditions on 20,000 to 30,000 acres of land in the western United States. Since Landsat covers vast tracts of land, BLM finds the satellite helpful in providing general land cover maps of the territory.

FEDERAL USE OF METSATS

NOAA delivers about 95 percent of its Metsat data to Federal agencies. The principal Federal users are NOAA's own National Weather Service (NWS) and the Department of Defense (DOD). Both Federal and non-Federal users receive weather satellite data free

of charge. 1/ DOD and NOAA share weather data from their satellites and other sources. Other Federal agencies use weather satellite data also, but the amount is small compared to the two major users.

National Weather Service's Use of Metsats

NWS' weather warnings and forecasts are based on weather satellites, radar, and air sounding devices. For NWS' primary mission, protecting life and property from weather events such as hurricanes, tornadoes, and severe storms, satellites are critical for short-term forecasting. Satellites can track the direction of such storms unlike any aid to man before them. NOAA has attempted to show the value of satellites for one portion of disaster warning, hurricane detection. Satellites have saved at least $4.3 million annually through hurricane detection, according to a 1978 NOAA study, "The Economic Benefits of Environmental Satellites." The study states that the fuel, maintenance, and manpower costs associated with hurricane reconnaissance aircraft searching for brewing storms have been reduced. In addition, the study says satellites have played a major role in keeping the hurricane warning area to a minimum, and this has resulted in lower protection costs.

Besides their role in disaster warnings, weather satellites provide data for daily weather forecasts. NWS uses satellites to obtain some of the temperature soundings and wind measurements that go into NWS' guidance model of the weather. Local forecasters also use satellite data in developing their analyses.

Department of Defense and Metsats

DOD and NWS depend on each other for weather information and NOAA satellites play an important part in providing data. For example, during the summer of 1981, NOAA, the Department of the Navy, and the Department of the Air Force signed a memorandum of agreement for sharing the central processing of satellite data. With this agreement each of the three services is responsible for developing an area of specialization, NOAA for atmospheric soundings over the globe, the Air Force for cloud cover imagery, and the Navy for sea surface temperatures.

1/An exception is the charge for NOAA's "GOES-TAP" service, which provides satellite imagery via telephone lines connecting NOAA facilities to Federal and private users. Users pay a $1,000 initial connection fee and a $100 a month service charge. In fiscal year 1982, 209 users, including 139 Federal users, paid $29,493 for the service. In addition, NOAA's archives charged about $596,000 for satellite data. Federal requests amounted to about 60 percent of this fee. For both services Federal agencies paid about $396,000.

Although the armed services have their own weather satellites, they depend on NOAA not only for shared processing of data but as a backup to their own system for obtaining world weather information. DOD is also NOAA's primary requestor of satellite weather data outside the United States. For example, weather conditions in the Persian Gulf can be recorded on NOAA's polar orbiters.

NOAA's geostationary satellites are also important for defense purposes. Along with the polar orbiters, geostationary satellites are used extensively to provide the initial location and monitoring of severe storms and hurricanes. The decision to send Air Force "hurricane hunter" aircraft to monitor a storm is based on NOAA's satellite imagery. Geostationary satellites also provide the following:

--weather information for some missile launches,

--rebroadcast of weather information to ships for rerouting at sea, and

--imagery at some coastal military stations for briefing departing aircraft and ships.

While the military uses NOAA satellite data, NOAA also depends on the Defense Department. DOD and NOAA buy satellite launch vehicles together as an economy measure. In addition, NOAA relied on DOD's satellite data in 1980 when a civil polar orbiter failed.

NOAA'S EXPECTED FISCAL YEAR 1983 REIMBURSEMENT FOR LANDSAT

In its fiscal year 1983 budget, NOAA estimated that several Federal agencies would pay a total of about $9.8 million for Landsat data. This amount would go directly to NOAA for Landsat operations. The remainder of the Landsat budget, almost $15 million, would come from appropriations. Fees collected from non-Federal users were expected to cover the appropriation but would go directly to the U.S. Treasury.

NOAA estimated in its fiscal year 1983 budget that Federal agencies would pay as follows: USDA, $7,414,000; DOI, $200,000; NASA and other agencies, $2,171,000. The estimates were based on discussions among the agencies, according to several NOAA officials. The Office of Management and Budget required Landsat user agencies to include in their appropriation requests amounts for Landsat data purchases which totaled about $9.8 million. However, Congress did not fully approve the requested funding. USDA expected to provide the largest payment in fiscal year 1983. However, Congress decided to appropriate only about half the $7.4 million the Department had sought.

In December 1982, the 1983 Agriculture appropriations bill was passed by Congress. The House/Senate conference report ex-

plained how Congress decided to provide USDA with about half the amount requested for Landsat data purchases. The House bill contained no funds for Landsat data while the Senate bill provided the full amount. The conferees agreed to provide half of the funds, $3.5 million, requested for Landsat. The conferees stipulated that the proposed charges were excessive and could be renegotiated but that, if renegotiation failed to allow for all the data needed, the Department was to submit a supplemental request to Congress for additional funds.

The Acting Assistant Administrator, NESDIS, NOAA, told us that Landsat operations will be curtailed in fiscal year 1983 unless they receive reimbursement from USDA. USDA is currently considering whether to request a supplemental appropriation for additional Landsat purchases.

FEDERAL INVESTMENT IN LANDSAT AND METSATS

According to NOAA and NASA records, Federal capital expenditures for the civil remote sensing satellite systems, including amounts expended on satellites under construction, will total $994.8 million by the end of fiscal year 1983, about $573 million for Landsat and $421.7 million for the weather satellites. 1/ These costs include expenditures for building and launching the satellites and equipping ground stations. The costs include recent expenditures as well as funds expended as much as 20 years ago. Operating costs are not included.

NOAA estimates that an additional $615.4 million will be required to complete, store, and launch satellites now under construction or awaiting launch. Of this amount, $46.4 million would be spent for Landsat and $569 million for the weather satellites.

NASA does not account for research and development expenses apart from the costs of building its satellites. Rather, it considers all capital costs associated with its satellites to be research and development expenses. NOAA, on the other hand, does account separately for research and development expenses. In fiscal year 1982, NOAA's research and development expenses for weather satellites were about $6.2 million.

Depreciation of satellite costs

Neither NASA nor NOAA depreciate the costs of building and launching its satellites. Federal agencies are not generally required under GAO'S "Accounting Priniciples and Standards For Federal Agencies" to account for depreciation. Accounting for

---

1/Weather satellite costs include costs for two satellites which are not used to full capacity because of age or sensor failure.

depreciation would be required if NOAA attempted to fully recover the costs of providing satellite service. But NOAA's current changes for Landsat have attempted only to recover current operating expenses and not the cost of building the satellite and ground stations.

No rules for accounting for research and development costs are prescribed for Federal agencies by the Principles and Standards. When the Principles and Standards are silent, Federal agencies are to look to generally accepted acounting principles for guidance. These principles require that research and development costs be charged to expense when incurred and would not therefore be subject to depreciation.

Historical funding for weather satellites

Since 1962 when the polar satellite system became operational, NOAA has spent $1.1 billion on its weather satellite program. The pattern of funding is described in the chart in app. III.

STUDIES OF THE MARKET FOR LANDSAT DATA

The Federal Government has sponsored five evaluations of the usefulness of data from earth sensing satellites (see app. IV). 1/

Our review of these studies showed that none provided a sufficient basis for determining the current feasibility of a profit-making satellite system. Adequate marketing studies would normally include a comprehensive survey of past and potential users, a determination of individual user needs, and an estimation of price elasticities. None of these studies provided all three of these components. 2/ Moreover, some of the studies assume a sensing technology different from the present Landsat or were made before the current significant market for Landsat data in the minerals extraction industry developed.

The Director, Office of User Affairs, NESDIS, and the Chief, Exploration, Test, and Evaluation Office, Earth and Planetary Exploration Division, NASA, told us that no adequate studies of the

---

1/Other organizations in addition to the Federal Government have prepared market evaluations. For example, the French space agency, Centre National d'Etudes Spatiales, and the Communications Satellite Corporation have had market studies made. We were unable to obtain copies of these studies since these organizations regard the studies as proprietary information. Additional market assessments are scheduled for completion by NOAA in early 1983.

2/This statement is not intended as a criticism of the studies, since they were not designed to provide this information.

market for Landsat-type data had been made by the Federal Government. A NOAA study on the commercialization of civil remote sensing systems concluded that " * * * a large degree of uncertainty exists as to the viability of the private Landsat market." 1/

Although the studies we reviewed did not determine the profit potential of Landsat, some did estimate the economic benefits of earth remote sensing information. These estimates were rough and dependent on many assumptions. A 1974 study by the Earth Satellite Corporation and the Booz-Allen Applied Research Corporation showed annual benefits of $40.4 million to $106.1 million in 1973 dollars. A study by Abt Associates, entitled "Benefits, Risks, and Costs of a Civilian High Resolution Multi-Spectral Satellite-Based Earth Resources Sensing System," estimated total "global annual economic benefit to range from $30 to $35 billion in the 1985 time period." 2/

1/"Commercialization of the Civil Space Remote Sensing Systems--A Review," National Oceanic and Atmospheric Administration, August 1982.

2/See page 3 of study.

INFORMATION ON LANDSAT DATA

USES AND EXPENDITURES IN FEDERAL AGENCIES

Federal Agency	Use a/	FY 1983 Planned Expenditures
Department of Agriculture	Domestic and foreign crop reporting	$3,500,000
Department of the Interior	Mapping, resource identification	625,000
Agency for International Development	Uses and transfers technology on Landsat for agricultural and natural resource management programs in less developed countries	581,000
National Aeronautics and Space Administration	Helps research and develop applications for Federal and state governments and for other organizations. Applications have included surveying state resources and planning routes for utility lines.	546,000
Department of Defense:		
Defense Mapping Agency	Mapping offshore islands and coastal locations	100,000
Corps of Engineers	Flood forecasting, flood damage assessment models	250,000
Other agencies	Siting energy generating facilities, characterizing potential nuclear waste repository sites, researching possible Landsat applications for detecting polluted areas, and other uses.	2,871,000
Total		$8,473,000

a/A Federal agency may use Landsat for more than one purpose. We have provided only primary examples in these cases. In most of these cases, Landsat is one of several information sources.

HISTORY OF APPROPRIATIONS FOR WEATHER SATELLITES

FISCAL YEARS 1962 THRU 1982

(dollars in thousands)

Fiscal Year	Polar System	Geostationary System	Operations	R&D a/	Total Appropriation
1962	$ 45,863	$ -	$ 2,137	$ 2,200	$ 50,200
1963	34,519	-	5,481	2,225	42,225
1964	-	-	-	2,206	2,206
1965	7,135	-	2,865	2,186	12,186
1966	22,255	-	2,793	2,141	27,189
1967	20,497	-	6,487	2,034	29,018
1968	17,891	-	10,209	2,442	30,542
1969	9,282	-	10,698	2,510	22,490
1970	-	-	6,957	2,670	9,627
1971	10,070	1,600	13,327	2,667	27,664
1972	11,053	2,800	19,267	2,432	35,552
1973	8,679	8,317	18,595	3,399	38,990
1974	22,748	11,650	23,973	3,321	61,692
1975	20,855	11,800	26,714	4,500	63,869
1976	25,285	12,920	28,053	4,631	70,889
1977	32,858	21,431	30,104	5,363	89,756
1978	32,361	21,369	33,347	6,674	93,751
1979	30,458	24,413	35,018	7,707	97,596
1980	14,949	30,022	37,607	8,134	90,712
1981	28,483	11,525	37,621	6,696	84,325
1982	50,306	27,395	39,780	6,218	123,699
Total	$445,547	$185,242	$391,033	$82,356	$1,104,178

a/R&D funding appropriated separately through fiscal year 1972.

FEDERALLY-SPONSORED STUDIES OF THE USEFULNESS OF EARTH SENSING SATELLITES

--"The Economic Value of Remote Sensing of Earth Resources From Space: An ERTS [Earth Resources Technology Satellite] Overview and the Value of Continuity of Service" by Econ Inc., December 1974.

--"Earth Resources Survey Benefit - Cost Study" by the Earth Satellite Corporation and the Booz-Allen Applied Research Corporation, November 1974.

--"Report of the Interagency Task Force on Private Sector Involvement in Civil Space Remote Sensing," June 1979.

--"Benefits, Risks, and Costs of a Civilian High Resolution Multi-Spectral Satellite-Based Earth Resources Sensing System" by Abt Associates Inc., July 1981.

--"Analysis of the Private Market for Landsat Productions and Applications" by the OAO Corporation, March 1981.

(082119)

24471

AN EQUAL OPPORTUNITY EMPLOYER

UNITED STATES
GENERAL ACCOUNTING OFFICE
WASHINGTON, D.C. 20548

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE,$300

POSTAGE AND FEES PAID
U S GENERAL ACCOUNTING OFFICE

THIRD CLASS