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BEFORE THE SUBCOMMITTEE ON NATURAL RESOURCES,
AGRICULTURE RESEARCH AND ENVIRONMENT
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES
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Thank you very much for the opportunity to comment on the current Landsat program from the perspective of the U.S. Geological Survey (USGS) and the Department of the Interior (DOI). We have supported the Landsat program since its inception almost 20 years ago, and we are especially concerned about its future because of the plan to terminate the current operation of Landsat 4 and 5.

DOI ROLE IN THE LANDSAT PROGRAM

Our Department's involvement in satellite remote sensing began with the creation of the Earth Resources Observation Systems (EROS) program in 1966. Under the leadership of USGS Director William T. Pecora, the EROS program provided the stimulus for an active program of remote sensing research in the Department, and played a major role in defining the technical specifications for Landsat 1. Since the launch of Landsat 1 in 1972, the USGS has been an active partner in the Landsat program, with responsibility for processing, archiving, and distributing Landsat data, and conducting a research and technology transfer program to encourage the use of Landsat data. We have

cooperated with the National Aeronautics and Space Administration (NASA), who managed the Landsat program from 1972 until 1983, and the National Oceanic and Atmospheric Administration (NOAA), who assumed Landsat management responsibility in 1983. We now work with NOAA and the Earth Observation Satellite (EOSAT) Company, the commercial Landsat operator, to manage the Landsat data archive and handle customer orders and product generation.

During the period of NASA management, USGS appropriated funds and the income from Landsat data sales were used to cover the cost of Landsat data archiving and processing. Presidential Directive NSC-54 (issued in 1979) assigned the management responsibility for Landsat to NOAA. As part of this transition, USGS appropriations (\$2.3 million) and revenue from Landsat data sales (\$2.7 million) were transferred to NOAA in FY 1983. USGS now provides Landsat support to NOAA and EOSAT with reimbursement from NOAA. We are receiving \$0.9 million during the first half of FY 1989 for Landsat customer order handling and product generation, and \$3.0 million in FY 1989 for handling of incoming (new) Landsat data and data archiving. Part of our archive management activities includes development of a plan to convert the existing collection of Landsat digital data, now stored on magnetic tape, to a permanent medium for long-term data preservation. We are hopeful that a FY 1990 budget initiative will provide funds for the USGS to continue to protect the valuable Landsat data archive.

The USGS also supports the Landsat program by providing a formal purchasing agreement with the EOSAT Company in FY 1986 to purchase Landsat data products and services on behalf of Federal Government agencies. The major Federal

agencies purchased \$3.9 million worth of data in FY 1988, or approximately half of the total Landsat data sales handled by the USGS EROS Data Center for EOSAT. In setting up this arrangement, the USGS applies a minimum surcharge to orders that covers only part of its administrative costs. We estimate that USGS contributed approximately \$120,000 in FY 1988 towards the costs of providing this service to other agencies, who avoided the cost of setting up and managing individual agency contracts with EOSAT.

IMPORTANCE OF THE LANDSAT PROGRAM TO DOI

DOI bureaus have made substantial investments in equipment and personnel to analyze satellite data to meet the Department's land management, land and water resource assessment, and research missions. This investment has been made incrementally over the life of the Landsat program as each bureau tested and evaluated the utility of Landsat and other satellite data for various bureau programs. Centralized digital image processing facilities are now operated by the Bureau of Indian Affairs, Bureau of Land Management, Bureau of Mines, Bureau of Reclamation, National Park Service, and U.S. Geological Survey. The capital cost of the hardware and software in these facilities exceeds \$25 million, and additional resources are provided for staff and space for the operation of this equipment. In some cases these facilities are integrated with geographic information system (GIS) programs since the results of remote sensing analysis (such as a land cover classification or water resource assessment) are important inputs to data bases that are used for GIS analysis.

Landsat data are important to many DOI programs, and the premature termination of the operation of Landsats 4 and 5 would force DOI bureaus to substitute older Landsat data where they would normally use current data, use other data sources, or stop using satellite data for certain applications. The USGS chairs the DOI Task Force for Coordination of Remote Sensing, and has used this group to identify current uses of Landsat data and to determine the impact of terminating Landsat 4 and 5 operations on individual bureaus. The current uses of Landsat data listed below would be affected by termination of the Landsat 4/5 program:

Bureau of Indian Affairs

- o Land cover/land use mapping
- o Monitoring the conversion of rangeland to agricultural land
- o Mapping the extent and impact of fires

Bureau of Land Management

- o Vegetation/land cover analysis
- o Monitoring surface disturbance associated with mineral exploration and development
- o Habitat analysis
- o Detection of illicit drug cultivation

Bureau of Reclamation

- o Monitoring extent of irrigated agricultural land in western U.S.
- o Mapping surface water-quality variables in large, remote reservoirs
- o Mapping surface extent of snow cover for operational forecasting and research purposes
- o Mapping general land use patterns
- o Obtaining surface water area figures to estimate evaporation losses
- o Studying reservoir water quality, snow mapping, and irrigated lands through international cooperative programs

National Park Service

- o Inventory, management, and monitoring of resources; basic scientific research; and impact assessment for over 50 million acres of Park Service lands

U.S. Geological Survey

- o Land cover mapping in Alaska--over 250 million acres have been mapped in cooperation with USFWS, BLM, and the State of Alaska
- o Satellite image mapping of the U.S. and foreign areas (through foreign assistance programs)
- o Monitoring changes in glaciers and polar ice

Minerals Management Service

- o Studies of the forms, seasonal distribution, and movement of sea ice as it affects Outer Continental Shelf oil and gas leasing and marine mammal migration.

IMPACTS OF LANDSAT PROGRAM TERMINATION ON THE DOI

The impact of a termination of Landsat 4 and 5 data collection will be felt in several important ways by the DOI:

- o Inability to monitor changing land and water features. Many DOI applications depend on monitoring features that change, such as vegetation, water resources, snow and ice, land cover/land use patterns, flooding, and wildfires. The lack of current Landsat data will be felt immediately for those applications that require new coverage once or more each year, and over the longer term for those features that change more gradually from year to year.
- o Landsat data are optimum for large-area applications. Several bureaus have concluded that the area coverage and spatial resolution of Landsat data are optimum for many applications such as vegetation and land cover mapping over large project areas. Even though data from the French Systeme Probatoire d'Observation de la Terre (SPOT) system have

acceptable spectral bands for such applications, it takes several SPOT scenes to cover the area imaged by one Landsat scene. The processing, geometric registration, and mosaicking of data from several SPOT scenes is not feasible on an operational basis. For example, it takes nine SPOT scenes to cover the area imaged in one Landsat scene, and the cost of these SPOT scenes (\$15,300) is over four times the cost of the corresponding single Landsat scene (\$3,600).

- o Lack of unique Landsat Thematic Mapper (TM) bands not available from other satellite sensors. The Landsat TM bands (specifically the mid- and thermal-infrared bands, and also the visible blue band) provide unique data for mineral resource assessment, vegetation monitoring, and wildfire assessment. The SPOT and other foreign civil satellites do not provide data from these spectral regions.
- o Complementary uses of Landsat and SPOT data would be impacted. The use of SPOT data together with (rather than a substitute for) Landsat TM data (where SPOT data provide high spatial resolution and Landsat data provide unique spectral information) has been demonstrated for several applications, including image map preparation, wildfire monitoring, change detection (combining older Landsat TM spectral data with current high-resolution SPOT data), and assessing environmental accidents such as occurred at the Chernobyl nuclear power plant. The lack of current Landsat data will limit the opportunity for these complementary uses.
- o Landsat program interruption jeopardizes some DOI commitments to use

satellite technology. DOI bureaus have invested substantial resources to use satellite remotely sensed data. An interruption in Landsat data flow will be a tangible signal of the lack of a commitment by the government to the U.S. civil satellite program. DOI bureaus have formulated programs based on the continuing availability of Landsat data, and there is no other civilian source for data of similar information content and coverage at comparable cost. These bureaus would have to abandon proven applications and rely, if possible, on other data sources.

OTHER IMPLICATIONS OF LANDSAT PROGRAM TERMINATION

There are other consequences of prematurely terminating the operation of Landsat 4 and 5. An obvious point is the economic issue. The U.S. Government has invested over \$2 billion in the Landsat program. It has provided nearly all the funds needed to construct Landsat 6, which is scheduled for launch in 1991. We understand that it would cost only \$9 to \$10 million to continue the current minimum data collection program. Some cutbacks in system operation and data collection rates have been necessary to operate at this budget level; approximately \$25 million per year is required to take maximum advantage of the Landsat sensors and the data relay system used to collect global data coverage.

Termination of the program at this time would arbitrarily interrupt a data collection program that has collected data over a 17-year period, including over 900,000 scenes through U.S. receiving stations and approximately 2 1/2 million scenes through the network of 14 foreign receiving stations. This program interruption will no doubt raise questions about the commitment of our nation to civil satellite remote sensing and will encourage other nations to turn to other data sources. These foreign stations were initially constructed to receive Landsat data. Many have or are being modified to receive SPOT and other system data. A forced 2-year Landsat data gap between now and the launch of Landsat 6 will certainly reduce the commitment of foreign Landsat users, as I have suggested may occur within the DOI. This will further affect the prospects for the U.S. commercialization effort to successfully transfer the Landsat program to private industry.

EFFECT ON STUDIES OF GLOBAL CHANGE

I would also like to comment here, in my role as Chairman of the interagency Committee on Earth Sciences, on the consequences of this action on our ability to study the processes of global change. This historical archive of Landsat data provides the most important source of data for documenting relatively subtle (when considered on a global basis) changes that have occurred on the Earth's surface. It is essential that this historical archive be maintained, and my agency is committed to helping to do that. But we should also not let this growing record of global change be interrupted because we are too short-sighted to provide modest funding to continue

Landsat operations. Within the DOI, the USGS will be depending on continuity in the Landsat data record to document the changes in polar ice and glaciers that may reflect patterns of global warming, and the Bureau of Reclamation plans to use Landsat data to assess the impacts of climate change on our water-resource systems. Other Federal agencies and the scientific community at large will be expecting this data record to be protected and extended as long as feasible.

CLOSING COMMENTS

Thank you for the opportunity to express the views of my bureau and the DOI on this important subject. I am hopeful that my comments today, as well as those of my colleagues, help this Subcommittee as it examines options to continue to acquire data from Landsat 4 and 5 until these spacecraft fail. As I have tried to show, it makes good sense from several points of view-- economics, the missions of government agencies, understanding the processes of global change--and, perhaps most importantly--that of the American taxpayer who has supported this program for almost 20 years.