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Continued Federal support of research and development is needed to achieve the maximum benefits of satellite-based remote sensing technology, but it is premature to commit the Government to support of an operational system. Findings/Conclusions: Senate Bill 657, if enacted, would broaden the Government's role in satellite-based remote sensing technology from support of research and development to support of an operational system. The system envisioned in the bill would be centered on the National Aeronautics and Space Administration's experimental Landsat project. There is no assurance as to the net benefits, if any, which would arise from an operational Landsat system. Landsat is intended to demonstrate the use of space-related technology for down-to-earth practical benefits, but there are strong indications that current and potential users of Landsat data lack sufficient knowledge of how to use the data. There is a need for a thorough study of the interrelationships of existing or planned earth resources information systems. The advantages and disadvantages of a national system as opposed to an international system require thorough study to assist in shaping Federal policy regarding support of an operational system. There is a lack of clear-cut assignment of responsibility for the successful implementation of the overall system. Some sections of the bill could act to discourage or delay private sector participation in the system. (SC)

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STATEMENT OF
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BEFORE THE
SUBCOMMITTEE ON SCIENCE, TECHNOLOGY, AND SPACE
OF
THE SENATE COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION
ON
S.657, THE "EARTH RESOURCES AND ENVIRONMENTAL
INFORMATION SYSTEM ACT OF 1977"

Mr. Chairman and Members of the Subcommittee:

I appreciate the opportunity to appear before this Subcommittee to discuss the merits of S.657, the "Earth Resources and Environmental Information System Act of 1977." The principal basis for my testimony today is our report on "Landsat's Role in an Earth Resources Information System" and our comments on a predecessor bill, S.3759, the "Earth Resources Information Satellite System Act of 1976."

S.657, if enacted, would broaden the Government's role in satellite-based remote sensing technology from support of research and development to support of an operational system.

In our opinion, continued Federal Government support of research and development is needed to achieve the maximum benefits of remote sensing technology. Landsat has provided unique information which was previously unavailable and future technology may provide even more valuable information. However, we believe that it is premature to commit the Federal Government to support an operational system. Such a commitment should be made only if further study demonstrates that the benefits to be gained justify the allocation of resources required to establish the system.

The system envisioned by S.657 would be centered on the National Aeronautics and Space Administration's experimental Landsat project which began in 1970. Total costs for the first three missions will amount to $326 million. NASA has proposed, in its fiscal year 1978 budget, a fourth mission, Landsat-D which will be considerably more expensive. Budget estimates for Landsat-D range from $290 million to $330 million, including the cost of the launch vehicle, development costs of an experimental multispectral scanner called the thematic mapper, and 3 years of operation. If approved by the Congress, NASA Landsat costs will be

well over a half-billion dollars. The question arises--should the experimental project evolve into an operational system? The private sector alone would not be likely to establish an operational system given the magnitude of investment, the long period of time before there would be a return on the investment, and the risks involved. Thus, the Federal Government, at least in the early years, would be the predominant source of funds for an operational system.

I would like first to address some questions which should be explored prior to establishing an operational Earth Resources and Environmental Information System. Then, I will address specific provisions of S.657.

WHAT ARE THE BENEFITS OF AN OPERATIONAL SYSTEM?

The technology of remote sensing by satellite provides access to previously unobtainable information about our natural resources and environment. A broad community of experimental users in and out of Government throughout the world has used Landsat data in the areas of agriculture, mineral exploration, water resources, land use, coastal zone monitoring, mapping, oceanography, meteorology, and environmental studies.

There is no assurance, however, as to the net benefits, if any, which would arise from an operational

Landsat system. A NASA-funded study, completed in October 1974, estimated that a benefit to cost ratio of 12 to 1 could be achieved with an operational system over a period of some [illegible] years. Projected benefits of about $250 million per year would come from improved agricultural forecasting based upon the assumption that a satellite system would improve upon present methods of forecasting.

There is some disagreement over whether Landsat will provide improved crop forecasting of the magnitude envisioned by the NASA-funded study. More realistic and reliable assessments of improved crop forecasting benefits possible from an operational Landsat system may come from LACIE--the Large Area Crop Inventory Experiment project.

NASA, the Department of Agriculture, and the Department of Commerce are involved in the LACIE project to determine the feasibility of improving estimates of foreign crop production using Landsat data and weather information. Wheat was chosen as the experimental crop, and the U.S. Great Plains was the initial test area. The project, designed to proceed through 3 wheat crop years (1974-1977), is scheduled to end with an evaluation report in June 1978.

Because improved agricultural forecasting has been estimated as being the source of over one-half of the projected benefits arising from an operational Landsat system, the outcome of the LACIE project should be considered carefully in any decision or whether the Landsat system should go operational. Accordingly, we are currently reviewing the LACIE project and will provide the Congress, late this year, with information on the status of the project and future direction of effort in the field of satellite-assisted crop forecasting.

Based on available evidence, a decision at this stage of the Landsat experimental project to go operational would be based on the expectation that the system would, in time, become cost beneficial and/or the assumption that social and political benefits justify the costs.

ARE USERS' NEEDS BEING MET?

As part of NASA's Space Applications program, Landsat is intended to demonstrate the use of space-related technology for down-to-earth practical benefits. Concerns of Landsat data users are technical problems, uncertainty regarding program continuity, and the need for training of current and potential users.

As can be expected with any data gathering project, the usefulness of Landsat data varies depending on the specific needs of Earth resource managers. Frequently mentioned technical improvements needed to increase the usefulness of currently available Landsat data are

--higher spatial resolution which refers to the smallest sized area on the ground for which the sensor data can be analyzed for content,

--an Earth surface temperature measuring sensor,

--a more frequent coverage cycle, and

--faster data product delivery times.

Landsat-C will include some of these improvements and Landsat-D, if developed as planned, will make further technical improvements.

Many current and potential users of Landsat data consider the uncertainty regarding program continuity as a major deterrent to more extensive use of the data. It is clear that a decision to go operational would provide the user community the assurance it needs. However, it is not clear what must be achieved and when it must be achieved before a decision to go operational can be made.

Ideally, a comprehensive inventory of Landsat user data requirements and an estimate of the costs to meet these requirements, should be developed and then a

judgment made on the value of meeting them. Such information would assist in deciding the extent to which the Federal Government should support an operational Landsat system.

As a minimum, there should be clear statements of information needs from the major Federal Government agencies who use or plan to use Landsat data or who serve users of the data. Additionally, the agencies should state their views on the need for and composition of user charges. Such statements would also be useful in deciding whether or not an operational system is justified.

During a past review of Landsat, we found strong indications that current and potential users of Landsat data lack sufficient knowledge of how to use the data. We recommended in our report "Land Satellite Project" (PSAD-76-74, January 30, 1976) that NASA take the lead, in conjunction with potential users, in developing a plan to provide formal training to Landsat data users to realize a maximum return from the large investments already made in the Landsat project. NASA's response to this recommendation was that it considered training a current and continuing issue which would be addressed in planning with other agencies for a Landsat follow-on system. However, the question of the Federal Government's Landsat training responsibilities remains unresolved.

HOW WOULD AN OPERATIONAL SYSTEM INTERACT WITH EXISTING OR PLANNED SYSTEMS?

A decision to establish an operational Landsat system would have to take into account how it would interact with existing or planned Earth resources information systems. The broadness of the term "Earth resources and environment" is indicated in S.657, which defines the term as including but not limited to food and fiber crops, forests, water, air, minerals, and materials. Merely identifying and understanding the multitude of information systems pertaining to these resources is a formidable task. The following illustrations provide some idea of the complexity involved in interrelationships among Earth resources information systems.

Our report, "U.S. Actions Needed to Cope with Commodity Shortages" B-114824, April 29, 1974, pointed out that commodity policy formulation involves numerous Government departments, agencies, offices, administrations, and policy councils as well as additional international program agencies, energy agencies, advisory councils, and regulatory agencies.

In discussing the need for a focal point for commodity policy, the report pointed out that there are 60 or more agencies dealing with foreign economic affairs

and 64 groups which have dealt with energy activities. Determining whether and how Landsat should supplement or replace any of the information systems of the above organizations would require considerable analysis and evaluation.

A second illustration concerns the mission of the National Oceanic and Atmospheric Administration (NOAA) in the Department of Commerce. The agency conducts remote sensing activities in carrying out the responsibility for improving man's comprehension of oceanic life and the weather. NOAA manages space segments and data handling segments of systems which provide data to assist earth resources managers. NOAA's National Environmental Satellite Service manages the space segment and operates two systems. The first is the polar orbiting series of spacecraft which provide global daytime and nighttime images of the Earth's cloud cover and other weather phenomena. The second is the Geostationary Observational Satellite which provides continuous observations of weather systems, oceans, space environment, and other Earth characteristics.

NOAA's Environmental Data Service manages the data handling segment through a number of its Centers. These centers support NOAA's concern with fluctuations in climate and environment and their probable socio-economic impact.

They also support large-scale field research projects and explore and predict the effects of long-term changes in the world on global food production, energy use, and resource management. Additionally, NOAA arranges the exchange of information through world data centers, for which NOAA has the United States responsibility in most environmental disciplines. NOAA's holdings in its data centers are extensive and are found in a variety of useful forms, including satellite and radar photographs, physical oceanographic measurements, solar data, and a host of other types of material.

NOAA also uses and disseminates Landsat data. It uses the data in studies of sea-ice distribution; snow runoff potential; circulation and surface characteristics of oceans, lakes, and bays; air and water pollutants; fishery resources; and severe storm detail. The possibility exists that it would be more feasible to merge the Landsat system into NOAA's existing operational satellite systems than to establish a new operational system.

A third illustration involves the relationships among Landsat and other NASA experimental projects, such as:

--Seasat for ocean dynamics research;

--a magnetic field satellite for location of natural resources such as coal, oil, and minerals;

--Nimbus-G for pollution monitoring;

--TIROS for weather; and

--the Heat Capacity Mapping Mission for mineral potential assessments, soil moisture studies, and mapping snow coverage.

All the above projects involve satellite-based remote sensing of Earth resources for practical applications. Any established operational Landsat system should be designed to take advantage of technology gains from these and future experimental projects.

The above illustrations demonstrate the need for a thorough study of the interrelationships of existing or planned Earth resources information systems. Such a study would provide information to assist in determining whether and how the various systems would fit together in an operational system.

WILL A NATIONAL RATHER THAN AN INTERNATIONAL SYSTEM BETTER SERVE THE INTERESTS OF THE UNITED STATES?

Landsat, although financed, built, launched, and operated by the United States for national purposes, also provides natural resources and environmental information to the world community. The United States maintains an open data distribution system under which any nation, corporation, or individual may purchase Landsat data products.

International sensitivities, however, are involved in remote sensing by satellites. Sovereignty questions have been raised by several countries concerning the acquisition of data over their territory and the availability of the data to countries other than the United States and the country observed. Other countries have argued for open dissemination of all data.

Although the current experimental Landsat project appears to be gaining international acceptance, certain problems could arise if Landsat becomes operational. One potential problem involves the spatial resolution of Landsat sensors. Spatial resolution is defined as the smallest sized area on the ground for which the sensor data can be analyzed for content. Many Landsat users desire high spatial resolution for more detailed analysis of Earth resources data; however, as spatial resolution increases, the military security issues also increase.

Current planning for the proposed thematic mapper includes a 30-meter spatial resolution capability compared to 80 meters on Landsats 1 and 2. NASA officials said they do not believe that the 30-meter resolution will raise any new concerns. A Department of Defense official has testified that resolution limits may have to be established on instruments used in unclassified programs.

Users who obtain first rights or exclusive rights to Landsat data could realize economic advantages. For example, advanced knowledge of wheat production estimates would be of benefit to grain traders. Some countries may be sensitive to a system controlled by the United States, especially if private profit-making corporations are involved in the receipt and processing of Landsat data. S.657 provides that the Secretary of the Interior establish and operate the data handling segment of the proposed operational System. It further provides that all users, both domestic and foreign, shall have equal access to products of the System.

It can be argued that remote sensing technology and information about Earth resources are valuable assets which should be closely controlled to protect the technological lead and economic well-being of the United States. It can also be argued that an international system would best serve the interests of the United States on grounds that benefits accruing to other countries would result in international good-will which would more than offset the short-range U.S. technological and economic losses.

We believe that the advantages and disadvantages of a national system as opposed to an international

system require thorough study to assist in shaping Federal Government policy regarding support of an operational system.

WHERE IN THE EXECUTIVE BRANCH SHOULD POLICY DEVELOPMENT BE CENTERED?

The previous questions indicate the need for a clear statement of how the Federal Government intends to proceed in the possible evolution of Landsat from an experimental project to an operational system. Policy planning and development clearly should precede establishment of such a system.

The focal point for establishing policy and plans regarding an operational system might be in a number of places. To date, it has centered in NASA because of its heavy involvement in the current experimental phase. The Departments of Agriculture, Commerce, Defense, State, and the Interior also should be heavily involved in planning for a possible operational system. As using agencies, these departments should establish their requirements. It could be expected, however, that differing needs of the departments could not be fully satisfied because of cost and technical limitations. The problem then would be to reach a compromise which would best serve national needs. Thus, there is a need

for a policy development focal point that would not be unduly influenced by any particular set of agency needs.

S.657 provides that the Director of the Office of Science and Technology Policy would be responsible for aiding in the planning and development and fostering the execution of national policies for the establishment and operation of the proposed Earth Resources and Environmental Information System. We agree with this provision. The Director is statutorily responsible for defining coherent approaches for applying science and technology to critical and emerging national and international problems and for promoting coordination of the scientific and technological responsibilities and programs of the Federal departments and agencies. However, we believe that polic development should occur before committing the Federal Government to support of an operational system.

In our opinion, the Director of the Office of Science and Technology Policy, in conjunction with NASA and cognizant Federal agencies, should study the issues involved and report to the President and the Congress a suggested Federal Government policy role in satellite-based remote sensing technology. The study might inquire into

--the validity of economic analyses of the benefits of a Landsat operational system,

--the value of noneconomic benefits that might result from an operational system,

--mechanisms for identifying and aggregating data requirements and training requirements of users and potential users,

--the need for and composition of a user charge policy,

--the mechanics of setting up interfaces among existing and planned information systems,

--the respective roles of the Federal Government and the private sector in an operational satellite system,

--the feasibility of committing the Federal Government to support of a satellite-based system for a specified time and then terminating that support,

--the impact of concerns of other nations and international laws and treaties on space and oceans on an operational satellite system, and

--potential military security problems.

After reviewing the results of such a study, the Congress and the Executive Branch should have better information upon which to reach a decision as to whether

and to what extent the Federal Government should support the proposed Earth Resources and Environmental Information System.

OBSERVATIONS ON SPECIFIC PROVISIONS OF S.657

Your request that GAO testify on S.657 stated that the Subcommittee is particularly interested in how the legislation can be improved with respect to institutional, fiscal, and other management issues. Accordingly, I would now like to offer our observations on specific provisions of the bill.

Institutional arrangement

Under S.657, the System would consist of two segments--a space segment, which would be the responsibility of NASA, and a data handling segment, which would be the responsibility of the Department of the Interior. The bill also provides that the Director of the Office of Science and Technology Policy shall provide oversight and coordination for the System. This divided management structure concerns us because of its lack of a clear cut assignment of responsibility for the successful implementation of the overall system.

For example, section 302 (b) provides that NASA should consult with the Secretary of the Interior and with the users about the desirable characteristics of

the System. Section 303 (a) provides that the Secretary of the Interior shall assist NASA in determining the desirable characteristics of the System. If interface problems arise between the two System segments, which cannot be worked out by NASA and Interior, the Director of the Office of Science and Technology Policy presumably would work out a compromise solution.

We believe that the System would be managed more effectively and efficiently if it were directed by a single head with full responsibility and authority. Assuming that the System should be managed by one of the existing Department or Agency heads, the question is--who is the logical manager?

NASA, as a research and development organization is the proper place for assignment of responsibility to develop new satellite-based remote sensing technology. However, we believe that there should be a single head of the System who represents the interests of users of Earth resources and environmental data. Given the fact that responsibility for Earth resources and environment matters are shared by numerous departments and agencies, the choice of a single manager to equitably represent all users is not easy.

In the past, GAO has testified on the need to establish a Department of Energy and Natural Resources. If such a Department existed and it had predominant responsibility for Earth resources, the head of that Department might be a logical candidate to manage and operate the proposed Earth Resources and Environmental Information System. Because such a department doesn't exist and again assuming that the System should be managed by an existing agency, we would favor changing the legislation to assign prime System responsibility to either the Secretary of the Interior, the Secretary of Agriculture, the Secretary of Commerce, or the Administrator of NASA. The specific choice should be made only after completion of the study we are suggesting that the Director of the Office of Science and Technology Policy perform.

Private sector participation

The difficulty in transferring satellite-based remote sensing operations to the private sector is obvious. Given the lack of information on how the market for System products will evolve and what it might cost in capital and operating expenses, there is a natural reluctance for profit making concerns to invest large sums in establishing operational systems.

Section 103 (g) provides, as a matter of policy, that the System shall be developed so as to encourage participation by private industry. Section 301 (b) (6) provides that the Director of the Office of Science and Technology Policy shall determine the benefits of participation and management by the private sector in providing the products and services for the System, and recommend transferring part or all of the System to the private sector at the earliest practicable date if such transfer will allow the objectives of the bill to be met.

Despite the intent of the above sections, there are other sections which could act to discourage or delay private sector participation.

For example, section 103 (d) sets forth a policy that the System shall provide products to the user at a reasonable cost and section 303 (c) provides that the Secretary of the Interior shall furnish System data and information to Government and to private users on an equal basis. The structure and composition of user charges for System products will have an important bearing on (1) the perceptions of the private sector as to the extent to which the Federal Government will subsidize System operations and (2) development of the market for System products.

Accordingly, as I discussed earlier, the views of the major involved Federal agencies on the need for and composition of user charges should be made known. These views should be considered in the study we are suggesting.

Another section which could discourage private sector participation is 302 (c) (2), which provides that NASA shall establish the space segment required for the operational phase of the System within 7 years after the effective date of the Act. It is not clear, however, whether and to what extent the Federal Government would subsidize the System after the 7-year period. This section could be interpreted as permanently committing the Federal Government to an operational system. During the 7-year period, large numbers of users might make substantial investments and come to rely heavily on the System which raises the question of whether it would be feasible to commit the Federal Government to support the System for a specified time and then terminate that support.

Foreign policy issue

We are also concerned about the bill's provisions with respect to international relationships. Section 301 (b) (4) provides that the Director of the Office of Science and Technology Policy shall supervise relationships of Government agencies with foreign

governments or entities or with international bodies as is appropriate. Section 302 (d) calls for NASA to provide for other countries to acquire data from the space segment of the System.

We are of the opinion that the bill should recognize the responsibilities of the Secretary of State in regard to international affairs and should, at a minimum, provide that the manager of the System coordinate with the Department of State. This concern for a State Department role was also expressed by the State Department witness during your May 25, 1977, hearings.

Program evaluation

Section 401 provides that the President shall transmit to the Congress, from time to time, a report which shall include a description and evaluation of the activities and accomplishments in terms of the attainment of the objectives of the bill.

Program evaluation is a fundamental part of effective program administration and responsibility for evaluation should rest initially upon the agencies. In line with that concept, we believe the Congress should specify the kinds of information and tests which will enable it to better assess how well programs are working and whether alternative approaches may offer greater promise.

We recognize the difficulty in specifying criteria to measure the success of the System. However, we believe the evaluation reports from the President should be on a periodic basis (perhaps annually) and should include information on

--the System's estimated and actual costs and revenues,

--progress in defining the scope and magnitude of the market for System products,

--identification of other than economic benefits from the System,

--estimated dates that System responsibilities will be shifted from the Federal Government to the private sector, and

--expressions of concern by other nations regarding System operations.

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This concludes my statement. I would be glad to answer any questions.