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Satellite Remote Sensing Markets in the 1980's*

The anticipated tremendous growth, the evolution of user needs, and the expected changes in equipment and service markets are discussed.

Abstract: *Remote sensing technology has progressed rapidly during the 1970's. At the beginning of this decade, the best available Earth resources data were photographic data from medium-to-high-altitude aircraft. During the 1970's, a variety of technological developments lead to a tremendous growth in the types and quantity of satellite data available, particularly digital data. Many new satellite data collection systems are planned for launch throughout the 1980's, and the types and quantity of data available will continue to increase.*

Notwithstanding the tremendous growth in available data, use of satellite remote sensing data has lagged far behind early, optimistic estimates. The lack of timely development of operational programs using these data is particularly noticeable in the United States. There are indications, however, that use of satellite remote sensing data will soon enter a very rapid growth phase. This growth phase is expected to last throughout the 1980's and will completely revolutionize many of the current data storage, handling, processing, and analysis techniques. The forces leading up to a tremendous growth in the use of satellite remote sensing data anticipated in the 1980's, the evolution of user needs for satellite remote sensing data, and the expected changes in the equipment and services markets associated with the use of satellite remote sensing data are discussed.

Introduction

Since the launch of Landsat 1 in 1972, there has been a continuous, growing stream of satellite Earth resources data available. These data have come from Landsats 1, 2, and 3; Skylab; Heat Capacity Mapping Mission; and Seasat. Sensors aboard these satellites have provided photographic, digital, and radar data. All of these data have been utilized extensively in research programs in the United States and in foreign countries. Some operational uses of the data have also been made, particularly in foreign countries, but space-acquired remote sensing data have so far failed to approach early, optimistic estimates for their utilization in routine Earth resources investigations.

Over the next several years, a number of additional sensors are scheduled to be launched by the U.S. and foreign countries. Among these are Landsat D, Magsat, Large Format Camera, Shuttle Imaging Radar, Tethered Magnetometer, Gravsat, SPOT (France), and the JEOS satellites (Japan). These satellite sensors will continue to provide both digital and photographic data for Earth resources investigations. The growth in the amount of available data suitable for digital processing will be particularly dramatic. As shown in Figure 1, these data are expected

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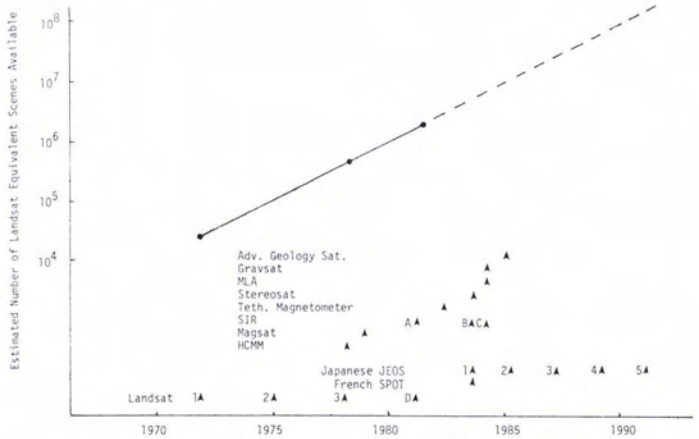

FIG. 1. Estimated growth of data suitable for digital processing.

to increase by more than three orders of magnitude by 1990, to the equivalent of more than 10^8 Landsat scenes.

That tremendous amounts of new, space-acquired Earth resources data will soon become available is a virtual certainty. However, the extent to which these data will actually be analyzed and interpreted for solving "real-world" problems remains uncertain. At one extreme, these data will continue to be used almost exclusively for research purposes. At the other extreme, satellite remote sensing data will be the predominant data type utilized in virtually all research and operational Earth resources investigations. The direction that remote sensing data use takes will obviously have a make-or-break impact on the relatively young, relatively small satellite remote sensing industry.

The Evolution of Satellite Remote Sensing Data Users

Since the launch of Landsat 1 in 1972, satellite remote sensing data have been used by many organizations studying a wide variety of natural resource issues.[1-3] For the first several years, research funded largely by NASA and USGS predominated. Then several other federal agencies began to fund their own research. Several state and regional planning agencies also experimented with land-use/land-cover mapping from Landsat digital data in 1975-1977. Most of these agencies, however, were responding to requirements of the Department of Housing and Urban Development (HUD 701) and Environmental Protection Agency (EPA 208) planning programs. The funds used to pay for these projects were primarily federal grant funds supplied to the planning agencies as part of the respective programs.

As of now, the NASA- and USGS-funded research into applications of digital Landsat data is largely complete. The remote sensing research in this country continues to be primarily at various universities, and relatively little demand for remote sensing data is directly generated by such research activities. As a result of previous research, however, several federal agencies have developed their own capability for digital processing or have purchased commercially available systems and are now using Landsat data in development programs and/or in quasi-operational programs.

A good indication of the extent of current use of Landsat data by various sectors is found in the EROS Data Center computer compatible tape sales data. Fiscal year 1978 data reveal that the largest purchasers are the federal government (33 percent), industry (31 percent), and foreign organizations (24 percent).[4] These purchases generally reflect operational and quasi-operational uses of the data.[5-10] State and local government purchases of Landsat data, although limited at present, also represent operational uses of the data. Any expansion in the use of satellite remote sensing data, therefore, will depend on the expansion of operational programs which utilize satellite remote sensing data.

The general situation with respect to the use of Landsat data in foreign countries is significantly different from that in the United States. Data and information about cultural and natural resources do not exist in most of the world to the extent that these data are available in the U.S. Consequently, many countries and international organizations are formulating operational satellite

remote sensing programs without the extended research phase which has preceded most operational remote sensing activities in the U.S. Furthermore, many developing countries are using satellite remote sensing data in a much wider range of problem areas than those of the more developed countries. The magnitude and complexity of the problems facing countries with large populations and limited access to natural resources require coordinated planning, often in the regional context. Remote sensing through satellites has now made it possible for developing countries to obtain otherwise unavailable resource data, which assists them in planning their economic and social development.

The extent to which foreign countries are utilizing Landsat data was revealed in a 1977 survey conducted by METRICS.[11,12] Among the statistical results of the survey were:

- More than 110 countries are participating in some form of remote sensing activity;
- More than 1000 organizations worldwide are involved in remote sensing activities;
- More than 75 countries have utilized Landsat data in various types of resource and mapping studies;
- More than 20 countries and/or international organizations have existing or proposed ground stations capable of receiving Landsat data;
- More than 30 countries are classified as having advanced remote sensing programs; and
- More than 20 United Nations and other international assistance organizations are actively promoting the use of remote sensing data in less developed countries or are using this technology in conjunction with existing development projects.

The history of the Landsat program has been one of transition from a total research orientation to the present emphasis on operational and quasi-operational programs. Each of the three major user segments (federal government, industry, and foreign organizations) has developed at its own pace. A fourth potential major user group, state and local agencies, has yet to develop fully, but all four of these groups appear to have made the transition from research to an operational orientation. Therefore, all seem poised to expand substantially their use of satellite remote sensing data, and past trends indicate that this expansion will be predominantly digital.

An Optimistic Scenario

It appears that the satellite remote sensing area is poised for dramatic growth over the next several years. The exact timing of the rapid acceleration in growth rates is unsure, but should coincide approximately with the launch of Landsat D, now scheduled for 1981.

There are a number of reasons to expect that the forecast growth acceleration will occur within the next two to four years. First, satellite Earth resource data will become much more readily available and more timely than in the past. As more ground stations capable of receiving Landsat and other Earth resources data become operational around the world, the timely availability of desired local data increases. The recent move toward standard data formats by all ground station operators will also improve global utilization of the data. The tracking and data relay satellite system (TDRSS), coupled with appropriate Domsat links, should help to make worldwide Landsat data available on a timely basis to U.S. users.

A second reason to expect a dramatic growth is improvements in data quality and an increase in the types of data available. As each new data type becomes available, the potential user community is enlarged and the availability of a new type of data tends to increase the utilization of previously acquired data. Improved data quality will further increase its utility. As spatial resolution improves, satellite data more closely approximate the high- and medium-altitude aircraft photographic data that have been used successfully for many years.

Finally, economics will play a very significant role in satellite remote sensing data use. For example, "Proposition 13" is already having a positive impact on the use of satellite remote sensing data by state and local agencies. The growth in expenditures by governments at all levels since World War II has been unparalleled in recent history. However, a very real uncertainty in the directions of government spending was created by the passage of Proposition 13. Although directly affecting only California, it has had significant fallout at all levels of government. One reaction to this among state and local government agencies has been to switch from requiring the "best" available data to specifying the most cost-effective data to solve a particular problem. Inter-agency cooperation (i.e., less duplication of services) also has been significantly boosted by these new economy moves.

In many foreign countries satellite data are the only data. Thus, the above economic arguments apply primarily to the U.S. and some other more developed countries. It should be noted, however, that many coun-

tries already make more operational use of the Landsat data than does the U.S.

In summary, the anticipated increases in the use of satellite remote sensing data will result from three evolving trends: timely worldwide data availability, technological improvements yielding both improved data quality and more types of resource data, and relative economic austerity. These trends should foster significant increases in the use of satellite remote sensing data in all areas of the world.

A Digital Future

As the use of satellite remote sensing data has evolved from research to operational applications, the emphasis on digital data has grown steadily in all market segments. With the increased number of operational programs and the increased amount of data soon to be available, digital processing will expand at a much faster rate than in the past. In a few years, virtually all applications will rely on digital data.

Because of the extremely diverse nature of the needs of organizations using Landsat data in the future, many new products and services will be demanded. Digital image processing systems will polarize either into systems that are larger, faster, and more complex with increased capabilities or into systems that are smaller, less expensive, and simpler with decreased capabilities. The larger systems will have to be developed to serve high volume users, whereas the simpler systems will be required by low volume users. Special-purpose systems will be demanded with hardware and software specifically customized for a particular industry or applications area. Thus, the market for digital systems will not only grow from its present level, but must also adapt to meet changing, expanding needs.

Many new products and services will be demanded by remote sensing data users in the next decade. Many data users (particularly those requiring large volumes of data) will require access to satellite data in real-time or near real-time. This trend is already evident in foreign countries with the establishment of many Landsat ground receiving stations. Timely data access is expected to become a mandatory requirement of many U.S. data users, and this need should continue to expand internationally.

Many users will not need, nor be able to use efficiently, full scene data. To serve these users, fractional scene data on high density cassettes, cartridges, or flexible diskettes will be required. High resolution, time-lapse sequences to show changing local and regional development patterns, and partially processed or custom processed data, will be available on video tapes for ease of display and study.

Geographic and natural resources data bases, of which remote sensing data form a part, will become much more prevalent in the 1980's. This will increase the demand for communications/computer networks to provide multiple access to data files and analysis models. This in turn will create a demand for minicomputer- or microcomputer-based stand alone analyst stations with limited processing capabilities to interface with the larger mainframe computers.

In a paper of this length, it is impossible to explore all of the product and service opportunities to become available over the next decade. As the above examples indicate, however, there will be increased demands for variations of current equipment and services as well as demands for as yet non-existent equipment and services.

Conclusions

The 1980's will be a significant decade for Earth resources and associated concerns, and satellite sensing systems will continually expand to play a more dominant role in future Earth resources activities. In the past there have been only two space programs which have had a significant, continuing impact on day-to-day activities—communications satellites and weather satellites. In the next decade, remote sensing satellites should take their place alongside communications satellites and weather satellites, and the satellite remote sensing market will develop and mature into a vastly expanded, viable worldwide market. As far as space activities are concerned, the 1980's will be the decade of remote sensing satellites.

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Fourteenth International Symposium on Remote Sensing of Environment

San José, Costa Rica
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This series of symposia, the only one of its kind conducted on an international level, is intended to promote increased international co-operation in research, development, and application of this technology; and to stimulate an exchange of information on all aspects of this multi-disciplinary field.

The Fourteenth Symposium will be organized and conducted jointly by the Environmental Research Institute of Michigan (ERIM) and the Costa Rican Instituto Geográfico Nacional (IGN).

The program for the symposium will stress the application of this technology for development, particularly topics of relevance to Latin America; and will include both Conventional Sessions, consisting of a limited number of invited presentations, and Poster Sessions, for the presentation of papers selected from contributions received in response to a Call for Papers.

Both Conventional and Poster Sessions will be included to treat utilization of remote sensing techniques for applications in Agriculture, Climatology, Environmental Quality, Forestry, Geography, Geology, Hydrology, Meteorology, and Oceanography, as well as monitoring, assessment, and management of Water, Soil, Vegetation, Cultural, and Marine Resources.

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