10-Year Industry Forecast

Phases I-III – Study Documentation

GRAND PRIX FIRE
LAKE ARROWHEAD, CALIFORNIA
1-METER FALSE COLOR IKONOS® IMAGE

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Forecast Cover Image

The image provided by Space Imaging on the Forecast cover is a 1-meter Ikonos satellite image of the Grand Prix fire in the Lake Arrowhead region of California. Of particular interest are the cloud plumes and hot spots heading up-ridge from the area of San Bernardino (note that North is down in this image) on 28 October 2003. The image inset, showing several hot-spots near homes and roads, illustrates the detail available in a high-resolution satellite image. Once the fire is contained, the perimeter and severity of the fire can also be mapped using satellite imagery. The pan-sharpened image was created by blending the 1-meter panchromatic band with 4-meter multispectral bands. The image is displayed as a false color composite, thereby rendering the vegetation in red-tones and water in black. Roads, residential areas, docks, and other man-made structures are clearly identifiable in the image, as well as land cover type. To see more satellite images of the California wildfires, go to our Gallery on www.spaceimaging.com.

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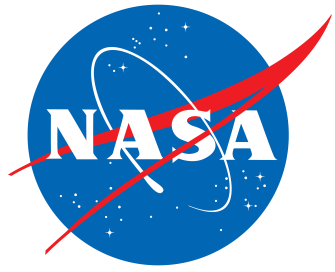
Prepared for

The American Society for Photogrammetry and Remote Sensing

Submitted by Mr. Charles Mondello, Dr. George F. Hepner, and Dr. Ray A. Williamson



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For more information on the 10-Year Industry Forecast, visit
http://www.asprs.org/asprs/news/forecast.html

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1 Executive Summary of the NOAA/NASA/ASPRS 10-Year Industry Forecast

In August of 1999, the National Aeronautics and Space Administration (NASA) and The American Society for Photogrammetry and Remote Sensing (ASPRS) agreed to undertake a comprehensive study of the remote sensing and geospatial information industry in the United States. Their ultimate goal was to develop a continuing forecast of the remote sensing industry. In 2002, the National Oceanic and Atmospheric Administration (NOAA) formally joined NASA and ASPRS to support the documentation and analysis of the forecast and to provide further information to the private sector and government agencies.

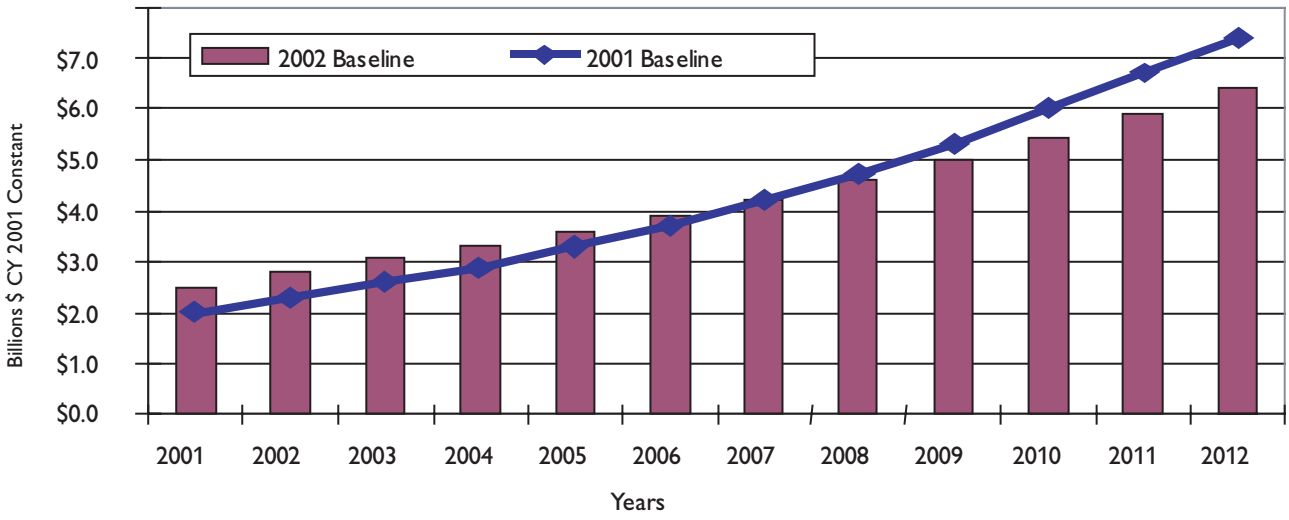
An estimated 175,000 people are employed in the U.S. remote sensing and geospatial information industry, which includes those commercial firms, not-for-profit organizations, governmental agencies, and academic institutions involved in the capture, production, distribution, and application of remotely sensed geospatial data and information, primarily for the civilian sector. It is a rapidly growing segment of the much larger information industry.

New technological advancements facilitate the application of remote sensing to a wide range of disciplines, from the sciences to myriad practical applications. Prior to this study, few comprehensive data about the industry, and no reliable, unbiased assessments of the industry's future existed. This study is an attempt to remedy these limitations by combining the experience of the talented volunteers of the membership of ASPRS with the knowledge, experience and resources of NASA, NOAA and the U.S. Geological Survey (USGS) in a continuing forecast of the industry and the key factors that affect it. This report provides historical, technical and policy context about the nucleus of the research project, the recently completed Ten-Year Industry Forecast Phases I-III. This document summarizes the Forecast's methodology, analyzes its results, and assesses their implications for the industry and for government policy.

The forecast is composed of three phases to date. Phase I, which was completed in December 2000, characterized the industry, and developed a financial and activity baseline and an initial forecast. Phase II, completed in 2002, centered on the identification and assessment of the end users of remote sensing and geospatial information products. Phase III focused on validating the results of Phase I and II and delivering an updated technology and market assessment, especially given the potential impacts on the industry following the terrible events of September 11, 2001. Post-Phase III (Phases IV and on) activities will center on developing a revised market forecast and standardizing methods for continuing the rolling forecast.

> ***"Industry members hold an optimistic view of future industry growth, estimating that it will increase by 9 to 14 percent per year."***

The industry is undergoing rapid change as technology improves and potential clients realize the benefits of using geospatial data and analytical technologies for their information needs. In 2001, the industry gained estimated revenues totaling $2.4 billion, not including sales of satellite systems and aircraft platforms. Based on the 2000 and 2001 surveys of gross revenue, the industry currently appears to be growing at rates of between 9 and 14 percent per annum. Phase III of the forecast assessed the effects of September 11, 2001 on industry growth. Consistent with the contraction of the U.S. economy since 2001, study respondents reduced their growth projections in Phase II to 9% over the next few years (from 14% in Phase I).



Survey responses revealed that most firms in the industry are relatively small (< 100 employees) and focused on providing specific, narrowly defined services or data. By contrast, the few large firms (greater than 500 employees) generally provide a wide range of services. Most of the civilian remote sensing industry involves the provision of mapping and engineering applications needed by governments at all levels. The many smaller firms that under gird the industry are less inclined to support internal R&D and workforce development, are more affected by governmental competition with their services, and are less able to meet foreign competition force-

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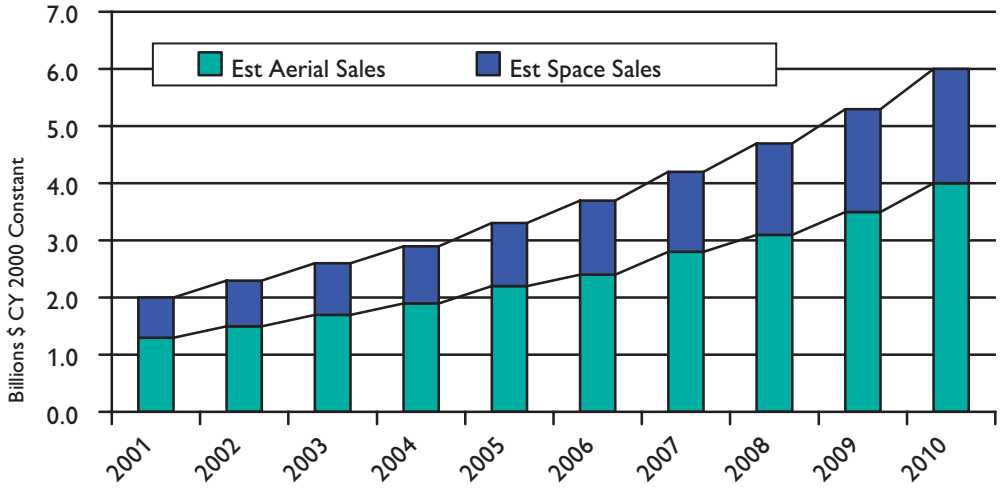
fully. Because of their size, smaller firms generally do not have the financial resources to support a significant amount of R&D.

> ***"...the introduction to the market of high-resolution satellite imagery has enhanced, rather than undercut, sales of data..."***

Over the past decade the commercial remote sensing industry has experienced significant technological change and improved market penetration. New sensor technologies, both in aerial and space systems offer myriad new information capabilities.

The development of high-resolution commercial satellites (better than 1 meter black and white and 2.5 meter multispectral) has opened new data and new collection methodologies to the ultimate information customer. In response, in part, to competition from satellite remote sensing, the aerial industry has also developed new methods of capturing geospatial data in computer-friendly digital form. Initially, some analysts believed that satellites would usurp aerial's market share, but this survey shows that both segments are growing and augmenting each other. In several cases, satellite and aerial data producers have formed strategic partnerships to enhance each others' market opportunities.



> ***"...opportunities for private firms and academia are tightly coupled with the information needs of all levels of government."***

Federal, state, and local governments participate in the remote sensing marketplace by purchasing data and services and by providing research and development (R&D) funding. Government agencies constitute the largest single class of customers for data and services. They also hire analysts with skills in RS/GIS. Industry interactions occur primarily business-to-business and business to government, with minimal direct interaction with citizen consumers. As a result, the private sector is heavily influenced by governmental involvement in the marketplace.

Much of the civilian R&D for both government and private sector takes place in academic institutions. The future workforce for the industry depends on the viability and responsiveness of the academic community to the rapidly changing technological developments and skill needs of the industry.

> ***"Federal government policies...have had a major influence over the development of the market for remote sensing data, new technologies and other applications within the geospatial industry."***

Federal government policies, developed and refined over the years, have had a major influence over the development of the market for remote sensing data, new technologies and other applications within the geospatial industry. Conversely, inconsistency in governmental policy has introduced extra uncertainty and risk for the industry.

Federal funding has developed the basic technologies for all forms of satellite remote sensing and contributed markedly to the development of advanced airborne instruments, such as light detection and ranging (LIDAR), interferometric synthetic aperture radar (IFSAR, INSAR), and hyperspectral digital sensors. For stated reasons of national security, the federal government has limited the development of high-resolution civilian satellite sensors and maintained sharp boundaries between the technology developed for national security and civilian uses.

In the early 1990s, more liberal federal policies began to promote the use of satellite data for a wide variety of uses. As government at all levels is the primary purchaser of data, the price and licensing of data are key issues evolving in the private sector, especially in the satellite domain. Inconsistent, or highly variable, governmental policies are particularly worrisome because they introduce an extra element of risk for industry, especially for satellite data firms. In order to stay in business, these firms need supportive governmental policies that allow them to recoup the massive investments they have made in modern satellite technology. By comparison to the satellite segment of the industry, the aerial market is very large, and has a profitable, more assured business model. On April 25, 2003, the White House issued a new commercial remote sensing policy that further eased previous restrictions on the commercial collection and

sale of satellite remotely sensed data. Among other things, the new policy provides guidance for establishing a "long-term, sustainable relationship between the United States Government and the U.S. commercial remote sensing space industry".[1]

Phase III results regarding the real and potential effects of the attacks of September 11, 2001 on governmental policy indicate that increased restrictions on the public availability of geospatial information have had a negative effect on organizations producing geospatial data and information, especially in data export, airspace restrictions and data purveyance to the public. The user community, primarily civilian government and private sector, cited little change in 2002 and anticipated minimal impacts in the future.

Many recognize that keeping data prices low and eliminating data-use restrictions for government-supplied, low and moderate resolution satellite data, has helped to stimulate the commercial market while providing a public geospatial infrastructure meeting many data needs. The prices charged for commercial satellite data products must recover the costs of developing, building, and operating the satellite system, just as they must for aerial data services. Increased resolution, position accuracy, and other capabilities increase the utility and value of data to the customer. Nevertheless, many educators expressed considerable anxiety about future access to data, not only with respect to funds to acquire data, but also the right to use and share new, advanced data with few restrictions. The federal government could assist the academic community to improve its research capacity and the development of more efficient ways to apply improved data by underwriting more of the data costs for research and education.

In some disciplines, government agencies may compete with commercial entities in the provision of data and services. Some commercial suppliers of data and value-added services voiced strong concern about perceived government competition with these suppliers. In order to foster industry development and growth for the benefit of the United States, it will be important for government at all levels to avoid unnecessary competition with the private sector.

> ***"The development of a capable workforce is of major concern for continued industry growth...Lack of retention of entry level workers is hampering the long term health of the industry."***

Governmental and private sector leaders declared a strong need for properly educated and trained entry-level employees. This need has become more pronounced as market growth has increased and much of the workload has shifted from the government to the private sector.

In interviews, corporate officers cited the shortage of trained workers emerging from educational programs and the lack of the required skill sets among many of the graduates. All sectors agree that an educated workforce is critical to the continued growth of the industry and increased utility of geospatial information to the economy.

[1] White House, "U.S. Commercial Remote Sensing Policy," Fact Sheet, April 25, 2003.

Most RS/GIS programs in the U.S. are offered in departments or colleges of geography, natural resource management, forestry, and civil engineering. Other disciplines offer individual courses in RS/GIS, but these three disciplines provide the homes for most instructional programs of multiple, integrated courses. These academic programs are small and cannot adjust rapidly to new advancements taking place in the industry. Further, as noted earlier, the smaller firms generally have limited resources for additional on-the-job training to compensate for any educational deficiencies in new staff.
As the industry expands and changes, meeting industry needs will require increased funding for RS/GIS educational programs, in order to modernize curricula and instructional and research infrastructure (equipment, software, labs) and to retrain faculty in newer sub-disciplines and technologies. Educators must themselves deliver new, integrated curriculum programs to meet future needs.

Certificate programs (non degree, supplemental programs) are gaining increased acceptance in the educational community. These programs provide a means for disciplinary specialists to retool their knowledge and skills to take advantage of the geospatial information revolution in their disciplinary areas without committing to a multi-year degree program.

It will be necessary to raise the status of the field of geospatial information in the larger educational framework in order to achieve continual support within university administrations. Such support is required to meet future information demands, to have properly prepared K-12 students who have knowledge of RS/GIS upon entering college, and to attract and support quality graduate students.

The study also revealed concerns over the retention of qualified employees. Phase II showed that the age structure of workers in the industry follows a bi-modal distribution, with most either older, experienced workers or younger employees, new to the industry. There are relatively few in the mid career range. These data suggest that many younger employees are leaving the industry for better opportunities, potentially creating a shortage of mid-level personnel. The reasons for this trend are not clear. However, because many industry employees earned degrees outside of remote sensing and GIS, they may feel drawn to accept positions in their original fields of interest in the broader information industry (such as computer science) when such positions become available, thus contributing to the exodus.

> ***"The development of new analytic methods and new geospatial technologies will lead to future growth,... Data customers especially desire higher resolution and improved positional accuracy."***

Phase I of the study revealed ample opportunities for growth in diverse market segments. Although mapping, civil government, national defense and global security applications of geospatial data/information currently dominate the market, the needs of local and state government for homeland security, environmental assessment, and infrastructure applications are substantial and are likely to increase.

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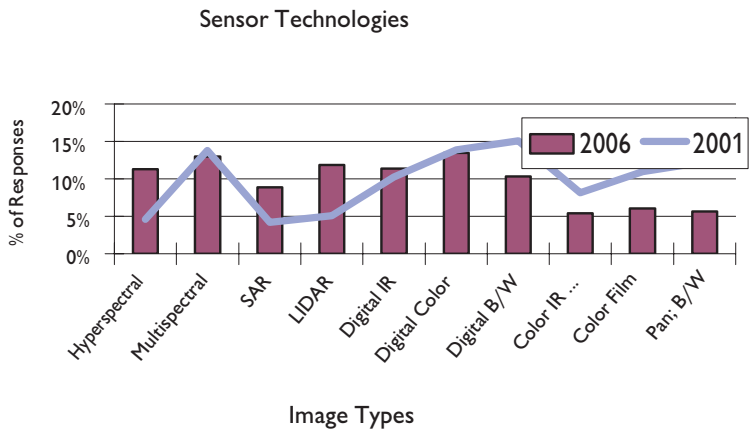
Smaller firms are attempting to provide specialized value-added services on both satellite and aerial products to meet customer needs. Further, the use of both aerial and satellite data is increasing. Hence, the industry appears to have opportunities both for a greater number of firms and continued growth among diverse markets. For example, industry gains only a small portion of revenues from certain business activities with strong geospatial requirements, such as real estate and insurance. These businesses could bring future market opportunities if geospatial information can be tailored to their special needs and potential customers are educated in using such information effectively.

In aerial remote sensing, the transition to digital sensor technologies, some capable of direct geo-registration and elevation collection has opened up new markets for urban mapping and infrastructure inventory and analysis. In general, sensor technologies have increased in diversity and improved in capability during the past two decades. Digital aerial cameras coupled with inertial measurement and onboard GPS enable the low cost acquisition of geopositioned information, which will assist in opening new markets, especially where pricing has limited acceptance of remotely sensed information.



Data users are evaluating the replacement of multispectral data with hyperspectral data. Growth will be seen in the key areas of hyperspectral, SAR (IFSAR), and LIDAR for aircraft, especially as sensor systems evolve that provide low cost, broad area coverage. Hyperspectral sensor systems in development will offer automated feature detection, identification and classification. Markets as diverse as defense, precision agriculture and forestry all benefit from change detection technology. The elevation component of remote sensing from IFSAR and LIDAR sensors also provides high growth potential. These systems can provide data to create highly accurate digital elevation models (DEMs) to markets in need of superior geopositioning and terrain information.

Factors beyond the remote sensing industry further play into data utilization, which affects industry capabilities. While computers have kept pace with increases in resolution and data processing, not all levels of users can keep up with these advances. Improvements in resolution often require users to invest in costly improvements both in data storage and data networking.

Further, issues of high data cost, delays in acquisition, and licensing of data sales may inhibit adoption of these data by users. Continued industry growth will only occur with the implementation of improved technology and government policies that support geospatial research and development in a number of disciplines.

Phase II evaluated the customer's data needs by undertaking a detailed requirements analysis of "use versus need" as a function of multiple user types. Data characteristics included Ground Sample Distance (GSD), Geopositional accuracy, data layers, elevation accuracy and data timeliness. While all are important to the remote sensing industry, small GSD and high geopositional accuracy are critical. Neither the needs of the academic data customers nor those of governmental data customers are being met at sufficiently high levels of accuracy.

Forecast data imply that data users desire resolutions smaller than three feet (0.9 m). GSDs such as these provide key details of object content and characterization. Data sets may be used to assess urban infrastructure or for high accuracy mapping. Further, they can be used to delineate details in the environmental, forestry and agriculture segments. High-resolution imagery over broad areas requires high levels of data storage, which will require improvements in computer storage capacity and access speed. Geospatial data and information users desire improved geopositional accuracy, signifying market opportunities for firms interested in achieving more stringent geo-positioning. Direct geo-registration techniques have increased data collection firms' ability to achieve improved positioning, but additional R&D will be required to reduce costs and improve market penetration of high accuracy techniques.

Overall, the remote sensing industry is growing, though supportive government policies will be needed to foster continuing growth. There is a tight coupling between the commercial, government and academia in this highly fragmented industry. New technologies, data and sensors from air and space are fostering growth. However, limited workforce availability, as well as inconsistent federal policy on data holdings, technical restrictions and exports, limit industry growth.