Global Earth Observation Trends

The issue of global sustainability is more pressing than ever before. Population growth is coupled with a growing demand for resources, especially in some of the world's most populous countries. Global water consumption is progressing at twice the rate of population growth. Energy needs are growing as developing countries emulate Western consumption patterns. As most energy is produced from fossil fuels, this increases pollution. Resources are being subjected to unprecedented exploitation, with many renewable resources close to exhaustion or irremediable change.

For decades, society has invested in the development of space technologies to improve the quality of life on Earth. The world is beginning to see the tangible fruits of this commitment. Telecommunications satellites bring voice and data communications to the most remote parts of the world. Global positioning systems can locate objects to within a meter on the ground.

In the field of Earth observation, orbiting satellites can distinguish humans on the surface of Earth. Radar sees at night and through cloud to map surface features and track even millimeter-level changes over time. Scientific satellites can trace the evolution of key components of the Earth's ecosystem like carbon dioxide emissions and ozone levels.

Nonetheless, major hurdles remain before Earth observation can be comprehensively applied to improve public and private sector management the world over. These challenges are present in both the developing and developed world, and deal with issues ranging from awareness and system maturity to capacity building, investment levels and cultural barriers between user and supply communities.

An analysis of Earth observation trends relating to technology, service and access issues, and the players implementing Earth observation solutions, highlights a number of issues that bear on policy and decision making in relation to the environment, resources and security.

Major Hurdles

- Low user awareness of satellite observation capabilities
- Slow transition of satellite use from research to operations
- Insufficient capacity building investment in user communities
- Low investment in applications and services
- Gaps between users and suppliers of data.

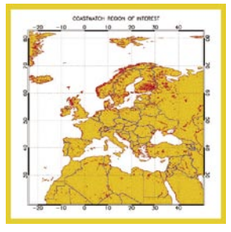
Technology

Twenty years ago, only three countries operated a small number of Earth observation satellites – the United States, Russia and France. Today, over 20 nations operate Earth observation sensors on 60 platforms.

Satellite data are available not only throughout the world, but commercially for procurement by governments, not-for-profit organizations and companies. Infrastructure investment and maintenance once posed a formidable challenge for developing countries. Today service companies offer more and better information than in the past, with little or no infrastructure in the receiving country. Satellites in orbit over one area can collect information and download it in another country.

Other technological advances have reduced the size and expense of the infrastructure that is required, while diminishing its complexity. The advent of compact computing capacity and electronics, and more powerful batteries, has enabled significant reductions in satellite size and weight. These improvements continue. Coupled with more widespread efforts for training and capacity development, solid pockets of world-class infrastructure have been created in developing nations. Indeed, certain developing nations have surpassed developed nations in their application of space technologies to terrestrial problems. This is particularly true in India and China, which develop and launch satellites to meet a wide array of domestic and international needs on a routine, operational basis. Smaller nations from every continent are demonstrating their ability to build and launch satellites.

In the coming decade, constellations of satellites working as a single system will orbit the Earth. The increased data streams and derived information will allow decision makers to be virtually present –through their remote vision– in any region of the world at almost any time. The most advanced countries will have daily access to high-resolution, all-weather data in most places on the globe.



Services

In most of the world, Earth observation is now seen as a powerful tool of change for decision makers. Earth observation offers unprecedented levels of information and a holistic view of the environment and resources both at home and abroad. Countries investing in Earth observation will be better informed. This allows them to exercise more influence on environmental and economic debates. They can take pro-active positions on issues of global importance, such as climate change, biodiversity, or integrated resource management, in addition to supporting domestic development.

In the past, technical shortcomings on the ground limited service capabilities. With the development of decentralized capacities to store and archive large volumes of data, and with the ability to process large volumes of data in near real-time, many of the hurdles to operational Earth observation services have been removed. Recent years have seen the emergence of applications based on automated treatment of data and integration into GIS, which can include large amounts of non-space data.

Nevertheless, major hurdles remain in applying satellite systems on an operational basis to the environment, resources, disasters and security. Many satellite developers remain focused on research applications and have not adapted satellite design and operations to the different needs of operational users. When countries have tried to stimulate a commercial response to these issues, the slow emergence of a robust commercial market has made entrepreneurial efforts a struggle.

The most significant barrier remains the gap between users and solution providers, apparent in their different cultures and separate vocabularies. It will require significant bridging activity between users and suppliers to better coordinate capabilities with needs at every phase of satellite mission development and operations. As awareness of the full potential of Earth observation satellites grows within governments and in civil society, there will be increased pressure on satellite mission designers to be responsive to user needs, and greater ability in user communities to articulate those needs clearly. The emergence of service-focused Earth observation companies and organizations in countries as diverse as India, Israel, Russia, Canada and France demonstrates that as awareness grows, there is a growing willingness on behalf of governments to finance Earth observation-based products and services.

Access

In the future, decision-makers the world over will have access to integrated information systems that combine regularly updated space data with *in situ* measurements for precise and tailored information needs. This will serve the interests of governments, not-for-profit organizations and industry in furthering the development of the world's poorest nations through leap-frog development.

The creation of GEOSS will increase the access of the developing world to global environmental data and harness global Earth observation efforts in support of global environmental challenges. Similarly, the International Charter "Space and Major Disasters" and more recent United Nations initiatives to coordinate global Earth observation data for disasters demonstrate high-level political will to ensure the benefit of Earth observation is shared by all countries.

Nevertheless, there are forces that constrain the access to satellite data, particularly high-resolution data, in areas of global tension. During the recent wars in Afghanistan and Iraq, the US and French governments took steps to prevent the free distribution of commercial data over these areas. While the growing number of satellite data providers makes limiting distribution challenging, measures to control access are actively pursued by several leading spacefaring nations. These actions may place unexpected constraints on access to data and products in coming years.

In addition, numerous countries require support to develop domestic capacities that will allow them to fully benefit from opportunities offered by Earth observation.

The players

As technologies evolve and satellites become more powerful but less expensive to build and operate, a growing number of countries and enterprises are, or will be, interested in procuring them. In the coming decade, over 100 Earth observation satellites are expected to be launched. A summary of the most significant planned and proposed missions is included at the end of this section.

Much attention has been focused on the slow evolution of the international commercial Earth observation market relative to the commercial satellite communications market. To a certain extent, this is an inappropriate comparison. Governments will, and should, continue to be the major customers of Earth observation solution providers, as it is generally a governmental mandate to address social and economic development issues, facilitated through Earth observation. Whether satellites are built and operated by governments or private sector companies is a question of implementation, provided that sufficient investment is made in satellite infrastructure and service development. If commercial market growth is expected to be slow, companies will be unable to justify investing enough to meet civil needs. Recognizing this, most countries invest in Earth observation as a strategic consideration, without regard to commercial success or failure. All major Earth observations satellite systems have been funded by governments or companies directly dependent on government revenue for their survival, including SPOT and more recently, Ikonos and QuickBird.

Different countries have chosen different paths to achieve Earth observation goals. The US has led global efforts in applying space solutions to environmental problems. Working closely with the Japanese, French and European space agencies, and a growing number of other international partners, the US has developed a large number of science-focused missions that greatly contribute to answering fundamental science questions and on-going environmental monitoring. In addition, satellites and sensors such as Landsat and the Moderate Resolution Imaging Spectroradiometer (MODIS) on the US Aqua and Terra satellites produce a baseline of widely available data that supports growing numbers of applications around the world. Data from the Advanced Very High Resolution Radiometer (AVHRR) aboard NOAA satellites are probably the most widely-used and easily available data. They are particularly useful for determining large-scale land cover changes.

The European Commission and ESA are together meeting on-going needs by integrating space data from all available sources with other information under the program Global Monitoring for Environment and Security (GMES). This program positions Europe for leadership far beyond the space-based Earth observation sector. It provides European companies with unparalleled access to global environmental and resource-based information and forms a solid basis for cooperation with Africa, China and Russia and, eventually, will do so with India and Brazil. While many services rely heavily on foreign data, the long-term vision is for Europe to develop an independent space infrastructure.

In China, environment and resource managers have been actively involved in structuring the systems that use space data. The data are collected from international sources, with a growing contribution from rapidly expanding Chinese systems either developed domestically or in partnership as in the case of the China-Brazil Earth Resource Satellites.

In India, domestic technology development has been successful in meeting concrete development challenges relating to agriculture, ocean management, regional planning and disaster management, among others.

Countries without a developed space capability today have many more opportunities than in the past to enter the field. They can use global and regional services provided by others or develop their own infrastructures. Advances in space technologies, data processing, information distribution systems and education and training programs will each have a role to play in the development context. Declining costs, technology transfer partnerships and international aid make such advances available even to the world's poorest countries. Few could have imagined such a change even a decade ago. Decision makers of the next generation will be able to "see" the world around them in astounding detail and model the results of their decisions. Decision makers of today must prepare for these new tools and position their organizations to benefit best from these rapid changes.

Area	Trend	Impact	Decision Maker Response
Technology	Broader international proliferation of satellite technology	Increased competition in high technology sectors	Renewed investment in high technology
	Smaller, less expensive and more numerous satellites	Significant increase in quantity and quality of environmental and resource data	New partnerships to benefit from data streams; increased demand for responsible environmental stewardship
	Faster computing technologies and better modeling	Feasibility of new, near real time and automated satellite-based services	Investment in integration of data and convergence of technologies; study of potential savings through satellite-based operational services
Services	Growing user awareness of usefulness of Earth observation	Widespread use of Earth observation for environment and resource management and reporting	Recognition that Earth observation has become a mainstream tool in addressing global issues; adopting Earth observation perspectives in decision making process
	Emergence of user-driven, service-based organizations	Better services for users; increased efficiency and productivity in resource sector; providers responding to better defined user needs	Investment in Earth observation technologies and integration with user communities; use of business-case considerations; need for users to articulate Earth observation requirements
	Seamless integration of Earth observation with GIS, navigation and communications technologies; increasing visualization of objective environmental phenomena	Enhanced management capabilities; heightened general awareness of quality and extent of global environment	Higher standards for management; inclusion of natural environmental goods and services in public accounts
Access	Emergence of high-level political will to ensure broad access	Recognition of Earth observation as a public service as well as a commercial product	Support to integration of Earth observation data in information management systems
	Significant capacity building in developing world	Growing number of countries with Earth observation infrastructure and expertise	Negotiation of new partnerships; enhanced South-South collaboration
	Free data, products and services for critical public good applications (weather, disaster management)	Increased use of Earth observation, particularly where few systems are currently in place	Increased capacity and influence of civil society organizations
	Security concerns in developed world	Access control legislation and technology export restrictions	Development of domestic technologies
Players	Growing number of players	Increased competition, inventiveness and diversity of uses	Positioning in a growing, maturing sector
	Closer international collaboration to address Earth science questions	Progress in understanding impact of human activity on Earth systems	Pro-active reorganization of industry and legislation
	Growing investment and engagement of users in data transformation and use of Earth observation	Proliferation of automated and operational applications of the data	Positioning; higher standards of information use; bridge building between user community and data producers
	Commercial suppliers facilitating developing world capacity building	Proliferation of technologies and capacities	Renewed high technology investment, proactive partnership strategy