8-1999

Commercial satellite imagery comes of age

Ann FLORINI
Singapore Management University, annflorini@smu.edu.sg

Yahya DEHQANZADA
Carnegie Endowment for International Peace

Commercial Satellite Imagery Comes of Age

By Ann M. Florini, Yahya Dehqanzada

Published in Issues in Science and Technology, Volume 16, Issue 1, September 1999, Pages 45-52

The quality and detail of commercial images are taking a leap forward; governments will have to learn to live with it.

Since satellites started photographing Earth from space nearly four decades ago, their images have inspired excitement, introspection, and, often, fear. Like all information, satellite imagery is in itself neutral. But satellite imagery is a particularly powerful sort of information, revealing both comprehensive vistas and surprising details. Its benefits can be immense, but so can its costs.

The number of people able to use that imagery is exploding. By the turn of the century, new commercial satellites will have imaging capabilities approaching those of military spy satellites. But the commercial satellites possess one key difference: Their operators will sell the images to anyone.

A joint venture between two U.S. companies, Aerial Images Inc. and Central Trading Systems Inc., and a Russian firm, Sovinformsputnik, is already selling panchromatic (black-and-white) imagery with ground resolution as small as one and a half meters across. (Ground or spatial resolution refers to the size of the objects on the ground that a satellite sensor can distinguish.) Another U.S. company, Space Imaging, has a much more sophisticated satellite that was launched in late September 1999. It can take one-meter panchromatic and three- to five-meter multispectral (color) images of Earth. Over the next five years, nearly 20 U.S. and foreign organizations are expected to launch civilian and commercial high-resolution observation satellites in an attempt to capture a share of the growing market for remote-sensing imagery.

The uses of satellite images

These new commercial satellites will make it possible for the buyers of satellite imagery to, among other things, distinguish between trucks and tanks, expose movements of large groups such as troops or refugees, and identify the probable location of natural resources. Whether this will be good or bad depends on who chooses to use the imagery and how.

Governments, international organizations, and humanitarian groups may find it easier to respond quickly to sudden refugee movements, to document and publicize large-scale atrocities, to monitor environmental degradation, or to manage international disputes before they escalate to full-scale wars. The United Nations, for example, is studying whether satellite imagery could help to significantly curtail drug trafficking and narcotics production over the next 10 years. The International Atomic Energy Agency is evaluating commercial imagery for monitoring compliance with international arms control agreements.

But there is no way to guarantee benevolent use of satellite images. Governments, corporations, and even small groups of individuals could use commercial imagery to collect intelligence, conduct industrial espionage, plan terrorist attacks, or mount military operations. And even when intentions are good, it can be remarkably difficult to derive accurate, useful information from the heaps of transmitted data. The media have already made major mistakes, misinterpreting images and misidentifying objects, including the number of reactors on fire during the Chernobyl nuclear accident in 1986 and the location of the Indian nuclear test sites just last year.

The trend toward transparency

Bloopers notwithstanding, the advent of these satellites is important in itself and also as a case study for a trend sweeping the world: the movement toward transparency. It is more and more difficult to hide information, not only because of improvements in technology but also because of changing concepts about who is entitled to have access to what information. Across issues and around the world, the idea that governments, corporations, and other concentrations of political and economic power are obliged to provide information about themselves is gaining ground.

In politics, several countries are enacting or strengthening freedom-of-information laws that give citizens the right to examine government records. In environmental issues, the current hot topic is regulation by revelation, in which polluters are required not to stop polluting but to reveal publicly just how much they are polluting. Such requirements have had dramatic effects, shaming many companies into drastically reducing noxious emissions. In arms control, mutual inspections of sensitive military facilities have become so commonplace that it is easy to forget how revolutionary the idea was a decade or two ago. As democratic norms spread, as civil society grows stronger and more effective in its demands for information, as globalization gives people an ever-greater stake in knowing what is going on in other parts of the world, and as technology makes such knowledge easier to attain, increased transparency is the wave of the future.

The legitimacy of remote-sensing satellites themselves is part of this trend toward transparency. Images from high-resolution satellites are becoming available now not only because technology has advanced to the point of making them a potential source of substantial profits, but because government policies permit and even encourage them to operate. Yet governments are concerned about just how far this new source of transparency should be allowed to go. The result is inconsistent policies produced by the conflicting desires of states to both promote and control the free flow of satellite imagery. Although fears about the impact of the new satellites are most often expressed in terms of potential military vulnerabilities, in fact their impact is likely to be far more sweeping. They shift power from the former holders of secrets to the newly informed. That has implications for national sovereignty, for the ability of corporations to keep proprietary information secret, and for the balance of power between government and those outside it.

The new satellite systems challenge sovereignty directly. If satellite operators are permitted to photograph any site anywhere and sell the images to anyone, governments lose significant control over information about their turf. Both spy and civilian satellites have been doing this for years, but operators of the spy satellites have been remarkably reticent about the information they have collected, making it relatively easy for countries to ignore them. Pakistan and India may not have liked being observed by the United States and Russia, but as long as satellite operators were not showing information about Pakistan to India and vice versa, no one got too upset. Although the civilian satellites that operated before the 1990s did provide imagery to the public, they had low resolution, generally not showing objects smaller than 10 meters across. This provides only limited military information, nothing like what will be available from the new one-meter systems.

Under international law, countries have no grounds for objecting to being imaged from space. The existing standards, the result largely of longstanding U.S. efforts to render legitimate both military reconnaissance and civilian imaging from space, are codified in two United Nations (UN) documents. The 1967 Outer Space Treaty declared that outer space cannot be claimed as national territory, thus legitimizing satellite travel over any point on Earth. And despite years of lobbying by the former Soviet bloc and developing countries, who wanted a right of prior consent to review and possibly withhold data about their territories, the UN General Assembly in 1986 adopted legal principles regarding civilian remote sensing that made no mention of prior consent. Instead, the principles merely required that “as

soon as the primary data and the processed data concerning the territory under its jurisdiction are produced, the sensed state shall have access to them on a nondiscriminatory basis and on reasonable cost terms." In other words, if a country knows it is being imaged, it is entitled to buy copies at the going rate. Even then, countries would not know who is asking for specific images and for what purposes. If an order is placed for imagery of a country's military bases, is that an nongovernmental organization (NGO) trying to monitor that country's compliance with some international accord or an adversary preparing for a preemptive strike?

There is a major economic concern as well. Corporations with access to satellite imagery may know more about a country's natural resources than does the country's own government, putting officials at a disadvantage when negotiating agreements such as drilling rights or mining contracts. And as we have all seen recently, highly visible refugee flows and humanitarian atrocities can attract intense attention from the international community. The growing ability of NGOs and the media to track refugee flows or environmental catastrophes may encourage more interventions, even in the face of resistance from the governments concerned. Will the lackadaisical protection of sovereignty in the 1986 legal principles continue to be acceptable to governments whose territory is being inspected?

Over the next five years, nearly 20 U.S. and foreign organizations are expected to launch civilian and commercial high-resolution observation satellites.

Corporations may also feel a new sense of vulnerability if they are observed by competitors trying to keep tabs on the construction of new production facilities or to estimate the size of production runs by analyzing emissions. This is not corporate espionage as usually defined, because satellite imaging is thoroughly legal. But it could make it difficult for corporations to keep their plans and practices secret.

Not only its competitors will want to keep an eye on a particular corporation. Environmentalists, for example, may find the new satellites useful for monitoring what it is doing to the environment. This use will develop more slowly than will military applications, because one-meter spatial resolution is not significantly better than existing systems for environmental monitoring. Political scientist Karen Litfin has pointed out that environmental organizations already make extensive use of existing publicly available satellite images to monitor enforcement of the U.S. Endangered Species Act, to document destruction of coral reefs, and to generate plans for ecosystem management. Environmental applications will become far more significant when hyperspectral systems are available, because they will be able to make fine distinctions among colors and thus provide detailed information about chemical composition. That day is not far off; the Orbview 4 satellite, due to be launched in 2000, will carry a hyperspectral sensor.

Environmental groups are not the only organizations likely to take advantage of this new source of information. Some groups that work on security and arms control, such as the Verification Technology and Information Centre (www.fhit.org/vertic) in London and the Federation of American Scientists (www.fas.org) in Washington have already used, and publicized, satellite imagery. As publicly available imagery improves from five-meter to one-meter resolution, humanitarian groups may find it increasingly useful in dealing with complex emergencies and tracking refugee flows. They will be able to gather and analyze information independent of governments–an important new source of power for civil society.

In short, the new remote-sensing satellites will change who can and will know what, and thus they raise many questions. Who is regulating the remote-sensing industry, who should, and how? Does the new transparency portend an age of peace and stability, or does it create new vulnerabilities that will make the world more rather than less unstable and violent? When should satellite imagery be treated as a public good to be provided (or controlled) by governments, and when should it be treated as a private good to be

created by profit seekers and sold to the highest bidder? Who gets to decide? Is it possible to reconcile the public value of the free flow of information for pressing purposes such as humanitarian relief, environmental protection, and crisis management with the needs of the satellite industry to make a profit by selling that information? Is it even possible to control and regulate the flow of images from the new satellites? Or must governments, and people, simply learn to live with relentless eyes in the sky?

Present U.S. policies fail to address some of these questions and give the wrong answers to others. By and large, U.S. policies on commercial and civilian satellites lack the long-term perspective that can help remote sensing fulfill its promise. And there are distressing signs that other countries may be following the United States down the wrong path.

The trials of Landsat

U.S. policy on remote sensing has gyrated wildly among divergent goals. First, there has long been a dispute over the purpose of the U.S. remote-sensing program. Should it be to ensure that the world benefits from unique forms of information, or should it be to create a robust private industry in which U.S. firms would be dominant? Second, the question of which agency within the U.S. government should take operational responsibility for the civilian remote-sensing program has never been resolved. Several different agencies use the data, but none has needed it enough to fight for the continued survival of the program. These two factors have slowed development of a private observation satellite industry and at times have nearly crippled the U.S. civilian program.

The story begins with the launch of Landsat 1 by the National Aeronautics and Space Administration (NASA) in 1972. However, Landsat 1's resolution (80 meters multispectral) was too coarse for most commercial purposes; scientists, educators, and government agencies were its principal patrons. In an effort to expand the user base and set the stage for commercialization, the Carter administration transferred the program from NASA to the National Oceanic and Atmospheric Administration (NOAA). Ronald Reagan, a strong believer in privatization, decided to pick up the pace despite several studies showing that the market for Landsat data was not nearly strong enough to sustain an independent commercial remote-sensing industry. To jump-start private initiatives, NOAA selected Earth Observation Satellite Company (EOSAT), a joint venture of RCA Corporation and Hughes Aircraft Company, to operate the Landsat satellites and market the resulting data.

The experiment failed disastrously because the market for Landsat imagery was just as poor as the studies had foretold and because the government failed to honor its financial commitments. Prices were raised dramatically, leading to a sharp drop in demand. For several years Landsat hung by a thread.

During this low point, France launched Landsat's first competitors, which had higher resolutions and shorter revisit times; their images were outselling Landsat's by 1989. The fate of Landsat's privatization was sealed when the United States discovered its national security utility during the Gulf War. The U.S. Department of Defense spent an estimated $5 million to $6 million on Landsat imagery during operations Desert Shield and Desert Storm. In 1992, Congress transferred control back to the government.

But Landsat's troubles were not yet over. In 1993, Landsat 6, the only notable product of the government's contract with EOSAT, failed to reach orbit, and the $256.5 million spacecraft plunged into the Pacific. Fortunately, Landsat 7 was launched successfully in April 1999, and it is hoped that it will return the United States to the forefront of civilian remote sensing.

Commercial remote sensing emerges

Congress established the legal framework for licensing and regulating a private satellite industry in 1984, but no industry emerged until 1993, when WorldView Inc. became the first U.S. company licensed to operate a commercial land observation satellite. Since then, 12 more U.S. companies have been licensed, and U.S. investors have put an estimated $1.2 billion into commercial remote sensing.

This explosion of capitalist interest reflects political and technological changes. First, the collapse of the Soviet Union removed barriers that stifled private initiatives. Throughout the Cold War, U.S. commercial interests were constantly subordinated to containment of the Soviet threat. Investors were deterred from developing technologies that might be subjected to government scrutiny and regulation.

Second, a newfound faith that the market for remote-sensing data will grow exponentially has spurred expansion of the U.S. private satellite industry. Despite enormous discrepancies among various estimates of the future volume of the remote-sensing market, which range from $2 billion to $20 billion by 2000, most investors believe that if they build the systems, users will come. Potential consumers of remote-sensing data include farmers, city planners, map makers, environmentalists, emergency response teams, news organizations, surveyors, geologists, mining and oil companies, timber harvesters, and domestic as well as foreign military planners and intelligence organizations. Many of these groups already use imagery from French, Russian, and Indian satellites in addition to Landsat, but none of these match the capabilities of the new U.S. commercial systems.

It would be self-defeating for the United States to violate the long-held international norm of noninterference with satellite operations.

Third, advances in panchromatic, multispectral, and even hyperspectral data acquisition, storage, and processing, along with the ability to quickly and efficiently transfer the data, have further supported industry growth. In the 1980s, information technology could not yet provide a robust infrastructure for data. Now, powerful personal computers capable of handling large data files, geographic information system software designed to manipulate spatial data, and new data distribution mechanisms such as CD-ROMs and the Internet have all facilitated the marketing and sale of satellite imagery.

Fourth, after Landsat commercialization failed, the U.S. government took steps to promote an independent commercial satellite industry. Concerned that foreign competitors such as France, Russia, and India might dominate the market, President Clinton in 1994 loosened restrictions on the sale of high-resolution imagery to foreigners. The government has also tried to promote the industry through direct subsidies to companies and guaranteed data purchases. Earth Watch, Space Imaging, and OrbImage, for example, have been awarded up to $4 million to upgrade ground systems that will facilitate transfer of data from their satellites to the National Imagery and Mapping Agency (NIMA). In addition, the Air Force has agreed to give OrbImage up to $30 million to develop and deploy the WarFighter sensor, which is capable of acquiring eight-meter hyperspectral images of Earth. Although access to most of WarFighter's imagery will be restricted to government agencies, OrbImage will be permitted to sell 24-meter hyperspectral images to nongovernment sources. The Office of Naval Research has agreed to give Space Technology Development Corporation approximately $60 million to develop and deploy the NEMO satellite, with 30-meter hyperspectral and 5-meter panchromatic sensors. The U.S. intelligence community has also agreed to purchase high-resolution satellite imagery. Since fiscal 1998, for example, NIMA has reportedly spent about $5 million annually on commercial imagery, and Secretary of Defense William Cohen says he expects this figure to increase almost 800 percent over the next five years.

Shutter control

To legitimize satellite remote sensing, the United States pushed hard, and successfully, for international legal principles allowing unimpeded passage of satellites over national territory and for unimpeded distribution of the imagery flowing from civilian satellites. To regain U.S. commercial dominance in the technology, the United States is permitting U.S.-based companies to launch commercial satellites with capabilities substantially better than those available elsewhere. But the United States, like other governments, hesitates to allow the full flowering of transparency. Now that the public provision of high-resolution satellite imagery is becoming a global phenomenon, policy contradictions are becoming glaringly apparent. What are the options?

One possibility is to take unilateral measures, such as the present policy of export control with a twist. Unlike other types of forbidden exports, where the point is to keep some technology within U.S. boundaries, imagery from U.S.-controlled satellites does not originate within the country. Satellites collect the data in outer space, then transmit them to ground stations, many of which are located in other countries. To maintain some degree of export control in this unusual situation, the United States has come up with a policy called "shutter control." The licenses NOAA has issued for commercial remote-sensing satellites contain this provision: "During periods when national security or international obligations and/or foreign policies may be compromised, as defined by the secretary of defense or the secretary of state, respectively, the secretary of commerce may, after consultation with the appropriate agency(ies), require the licensee to limit data collection and/or distribution by the system to the extent necessitated by the given situation."

But shutter control raises some major problems. For one thing, satellite imagery is a classic example of how difficult it is to regulate goods with civilian as well as military applications. Economic interests want to maintain a major U.S. presence in what could be a large and highly profitable industry that the United States pioneered. National security interests want to prevent potential adversaries from using the imagery against the United States or its allies, and foreign policy interests prefer no publicity in certain situations.

Yet denying imagery to potential enemies undercuts the market for U.S. companies, and may only relinquish the field to other countries. Potential customers who know that their access to imagery may be cut off at any time by the vagaries of U.S. foreign policy may prefer to build commercial relationships with other, more reliable providers. These difficulties are further complicated by the fact that the U.S. military relies increasingly on these systems and therefore has a stake in their commercial success. Not only does imagery provide information for U.S. military operations, but unlike imagery from U.S. spy satellites, that information can also be shared with allies–a considerable advantage in operations such as those in Bosnia or Kosovo.

An extreme form of shutter control is to prohibit imaging of a particular area. Although it runs counter to longstanding U.S. efforts to legitimize remote sensing, the government has already instituted one such ban. U.S. companies are forbidden to collect or sell imagery of Israel "unless such imagery is no more detailed or precise than satellite imagery . . . that is routinely available from [other] commercial sources." Furthermore, the president can extend the blackout to any other region. Israel already operates its own spy satellite (Ofeq-3) and plans to enter the commercial remote-sensing market with its one-meter-resolution EROS-A satellite in December 1999. Thus, allegations persist that Israel is at least as interested in protecting its commercial prospects by hamstringing U.S. competitors as it is in protecting its own security.

Shutter control also faces a legal challenge. It may be unconstitutional. The media have already used satellite imagery extensively, and some news producers are eagerly anticipating the new high-resolution

systems. The Radio-Television News Directors Association argues vehemently that the existing standard violates the First Amendment by allowing the government to impose prior restraint on the flow of information, with no need to prove clear and present danger or imminent national harm. If shutter control is exercised in any but the most compelling circumstances, a court challenge is inevitable.

Even if it survives such a challenge, shutter control will do little to protect U.S. interests. Although the U.S. satellites will be more advanced than any of the systems currently in orbit other than spy satellites, they hardly have the field to themselves. Russia, France, Canada, and India are already providing high-resolution optical and radar imagery to customers throughout the world, and Israel, China, Brazil, South Korea, and Pakistan are all preparing to enter the commercial market. Potential customers will have many alternative sources of imagery.

Persuasion and voluntary cooperation

An alternative is to persuade other operators of high-resolution satellites to voluntarily restrict their collection and dissemination of sensitive imagery. However, the U.S. decision to limit commercial imagery of Israel was based on 50 years of close cooperation between the two countries. Would the United States be able to elicit similar concessions from other states that operate high-resolution remote-sensing satellites but do not value U.S. interests to the extent that the United States values Israel's interests? There is little reason to believe that the Russians, Chinese, or Indians would respect U.S. wishes about what imagery should be disseminated or to whom.

The prospect for controlling imagery through international agreements becomes even more precarious as remote-sensing technology proliferates, coming within the grasp of other countries. Canada, for example, plans to launch RADARSAT 2, with three-meter resolution. Initially, NASA was to launch the satellite but expressed reservations once it became clear just how good RADARSAT's resolution would be. Whether the two countries can agree on how the imagery's distribution should be restricted remains to be seen, but Canada's recent announcement of its own shutter-control policy may help to alleviate some U.S. concerns.

The only practical choice is to embrace emerging transparency, take advantage of its positive effects, and learn to manage its negative consequences.

If, as certainly seems possible, it proves unworkable to control the flow of information from satellites, two options remain: taking direct action to prevent satellites from seeing what they would otherwise see or learning to live with the new transparency. Direct action requires states to either hide what is on the ground or disable satellites in the sky. Satellites generally travel in fixed orbits, making it easy to predict when one will be overhead. Hiding assets from satellite observation is an old Cold War tactic. The Soviets used to deploy large numbers of fake tanks and even ships to trick the eyes in the sky. Objects can be covered with conductive material such as chicken wire to create a reflective glare that obscures whatever is underneath. One security concern for the United States is whether countries that currently do not try to conceal their activities from U.S. spy satellites will do so once they realize that commercial operators can sell imagery of them to regional adversaries. Officials fear that commercial imagery may deprive the United States of information it currently acquires from its spy satellites.

Although concealment is often possible, it will become harder as satellites proliferate. High-resolution radar capable of detecting objects as small as one meter across–day or night, in any weather, even through clouds or smoke–will reduce opportunities for carrying out sensitive activities unobserved. Moreover, many new systems can look from side to side as well as straight down, so knowing when you are being observed is not so easy.

If hiding does not work, what about countermeasures against the satellite itself? There are many ways to put satellites out of commission other than shooting them down, especially in the case of unprotected civilian systems that are of necessity in low orbits. Electronic and electro-optical countermeasures can jam or deceive satellites. Satellites can also be spoofed: interfered with electronically so that they shut down or change orbit. The operator may never know whether the malfunction is merely a technical glitch or the result of a hostile action. (And the spoofer may never know whether the target satellite was actually affected.) Such countermeasures could prove useful during crises or war to prevent access to pictures of a specific temporary activity without the legal bother of shutter control or the political hassle of negotiated restraints. But during peacetime, they would become obvious if carried out routinely to prevent imaging of a particular site.

The more dramatic approach would be to either shoot a satellite down or destroy its data-receiving stations on the ground. Short of imminent or actual war, however, it is difficult to imagine that the United States would bring international opprobrium on itself by destroying civilian satellites or committing acts of aggression against a sovereign state. If the United States could live with Soviet spy satellites during some of the most perilous moments of the Cold War, it is unthinkable that it would violate international law in order to avoid being observed by far less threatening adversaries. Moreover, the U.S. economy and national security apparatus are far more dependent on space systems than is the case is any other country. It would be self-defeating for the United States to violate the long-held international norm of noninterference with satellite operations.

Get used to it

The instinctive reaction of governments confronted by new information technologies to try to control them, especially when the technologies are related to power and politics. In the case of high-resolution remote-sensing satellites, however, the only practical choice is to embrace emerging transparency, take advantage of its positive effects, and learn to manage its negative consequences. No one is fully prepared for commercial high-resolution satellite imagery. The U.S. government is trying to maintain a kind of export control over a technology that has long since proliferated beyond U.S. borders. The international community agreed more than a decade ago to permit the unimpeded flow of information from satellite imagery, but that agreement may come under considerable strain as new and far more capable satellites begin to distribute their imagery publicly and widely. Humanitarian, environmental, and arms control organizations can put the imagery to good use. Governments, however, are likely to be uncomfortable with the resulting shift in power to those outside government, especially if they include terrorists. And many, many people will make mistakes, especially in the early days. Satellite imagery is hard to interpret. Junior analysts are wrong far more often than they are right.

Despite these potential problems, on balance the new transparency is likely to do more good than harm. It will allow countries to alleviate fear and suspicion by providing credible evidence that they are not mobilizing for attack. It will help governments and others cope with growing global problems by creating comprehensive sources of information that no single government has an incentive to provide. Like any information, satellite imagery is subject to misuse and misinterpretation. But the eyes in the sky have rendered sustained secrecy impractical. And in situations short of major crisis or war, secrecy rarely works to the public benefit.

Recommended reading

C. Bryan Gabbard and Kevin M. O'Connell, *Emerging Markets of the Information Age: A Case Study in Remote Sensing Data and Technology* (Santa Monica, CA: RAND Corporation, 1996), 18.

Karen Litfin, “Public Eyes: Satellite Imagery, the Globalization of Transparency, and New Networks of Surveillance,” unpublished manuscript, 1999.

Michael M. May, “Safeguarding our Military Space Systems,” *Science* 232 (April 18, 1986): 336340.

Robert P. Merges and Glenn H. Reynolds, “The News Media, Satellites and The First Amendment: A Case Study in the Treatment of New Technologies,” *High Technology Law Journal* 3 (Spring 1988): 31.

“Principles Relating to Remote Sensing of the Earth from Outer Space,” *Principle XII*, UN General Assembly Resolution 41/65, 1986.

Courtney A. Stadd and Ronald J. Birk, “No Strings Attached? Commercial Remote Sensing Companies Hope that U.S. Government Policy Will Keep Pace with the Industry’s Rapidly Expanding Needs,” *Imaging NOTES* 14, no. 4 (July/ August 1999): 20.

Ray A. Williamson, “The Landsat Legacy: Remote Sensing Policy and the Development of Commercial Remote Sensing,” *Photogrammetric Engineering & Remote Sensing* 63, no. 7 (July 1997): 883.

Ann M. Florini is a resident associate and Yayha Dehqanzada is a research assistant at the Carnegie Endowment for International Peace in Washington, D.C.