Imaging NOTES

EARTH REMOTE SENSING
FOR SECURITY
ENERGY AND
THE ENVIRONMENT

Winter 2009
Vol. 24 >> No. 1

Geoprocessing & Serving

- OGC
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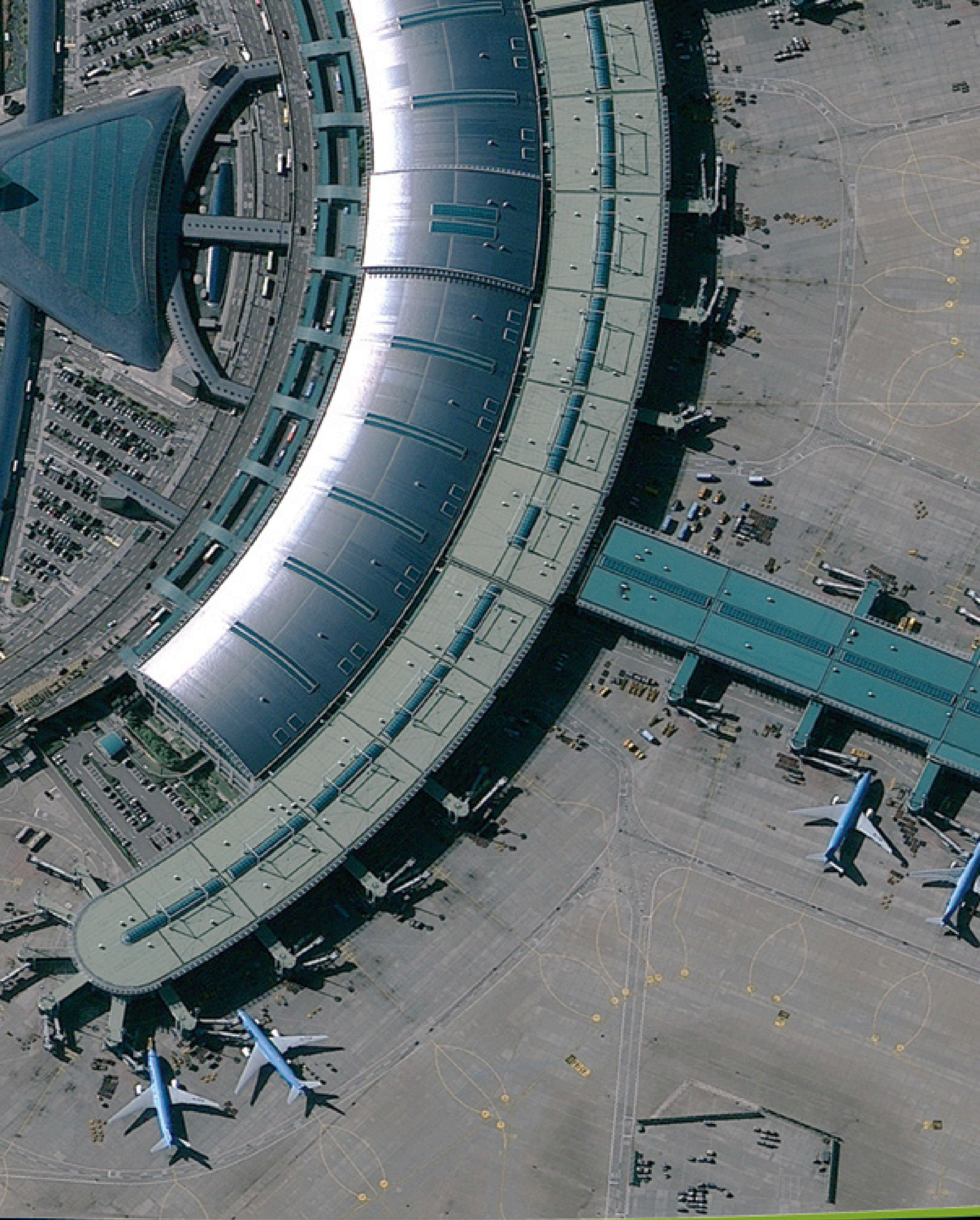
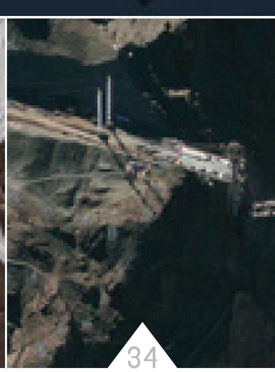
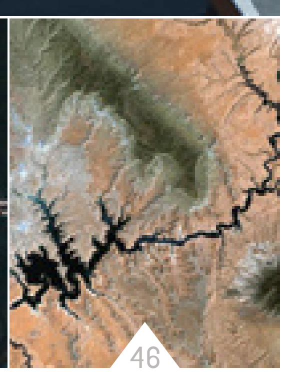
SECURE WORLD FOUNDATION PARTNERSHIP

LANDSAT FUTURE BRIGHT

SUSTAINABLE CITIES







Winter 2009

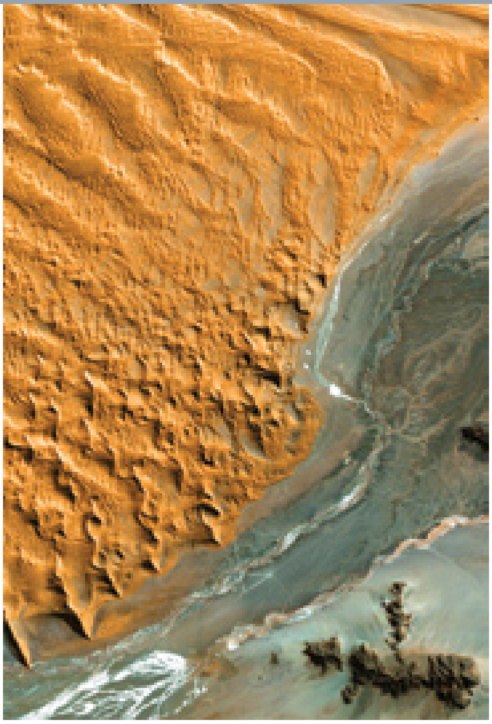
CONTENTS

>COLUMNS

>FEATURES

Namib Dunes

COVER IMAGE



The gorgeous image on our front cover is of the Namib Desert, which is part of the Namib-Naukluft National Park, an ecological preserve. Namibia is located on the southern tip of Africa, along the east coast. Coastal winds create the tallest sand dunes in the world there, with some dunes reaching 980 feet (300 meters) in height.

Additional Landsat images are included in our Hindsight Guest Editorial on page 46, a column by Shaida Johnston about the good news for land imaging that was announced at the Pecora Symposium. Included in that good news is the fact that Landsat imagery is now available for downloading free of charge! To view selections, use the USGS Global Visualization Viewer at http://glovis.usgs.gov or the USGS Earth Explorer tool at http://earthexplorer.usgs.gov.

This image, courtesy of the U.S. Geological Survey, was taken on Aug. 1, 2000.

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Winter 2009 / Vol. 24 / No. 1

OUR MISSION

Imaging Notes is the premier publication for commercial, government and academic remote sensing professionals around the world. It provides objective exclusive in-depth reporting that demonstrates how remote sensing technologies and spatial information illuminate the urgent interrelated issues of the environment, energy and security.

Imaging Notes has a partnership with Secure World Foundation (www.secureworldfoundation.org).

Imaging Notes is affiliated with the Alliance for Earth Observations, a program of The Institute for Global Environmental Strategies (www.strategies.org).

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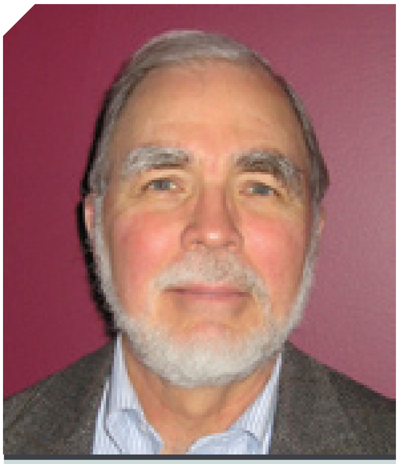
The Challenge of Meeting Human Security Needs A NEW PARTNERSHIP

SECURE WORLD FOUNDATION FORUM

In 2007, a few years after I became editor of *Imaging Notes*, I took on the exciting and daunting task of leading the Secure World Foundation (SWF), a Colorado-based operating foundation focused on building more effective international governance of space activities. One of SWF's key efforts centers on strengthening or developing the policies and institutions that improve the utility of space technologies in support of human and environmental security needs. Recognizing that *Imaging Notes* could assist in this effort, publisher/owner Myrna James Yoo and I agreed to form a partnership to further the coverage of these issues.

Imaging Notes, with the tagline, "Earth Remote Sensing for Security, Energy and the Environment," will focus more on topics that can loosely be grouped under the heading of human and environmental security. Long-time readers of the magazine will recognize that this editorial course is not an entirely new direction. *Imaging Notes* covered an International Polar Year project in Spring 2008. It has previously covered such topics as the use of Google Earth to highlight the environmental and human health hazards of mountaintop removal by coal interests in West Virginia and to reveal efforts by the U.S. Holocaust Museum and Google to help people view and understand the genocide in Darfur (Summer 2007).

The magazine has also broken stories on direct imagery evidence of concentration camps in North Korea (Summer 2005), on first images of the Chinese nuclear submarine (Winter 2005-06), and on the destruction of the Gaza Strip in Palestine (Fall 2004). Also, it has highlighted the efforts of SPOT Image, Inc. and its partners in Planet Action to use its significant data archive to support projects on the study of global environmental change around the planet (Summer 2007).



RAY A. WILLIAMSON, PHD, is editor of Imaging Notes and Executive Director of the Secure World Foundation, an organization devoted to the promotion of cooperative approaches to space security (www.SecureWorldFoundation.org).

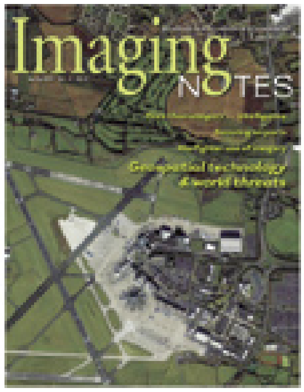
We will continue to solicit informative articles on the "what, wherefore, and how to" of meeting human and environmental security needs, and we will be adding the dimensions of international policy–legal and institutional mechanisms needed for ensuring that the benefits of space activities reach people effectively and efficiently.

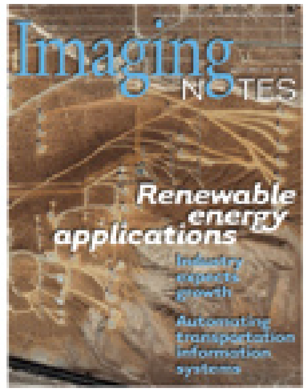
Human security is a concept that was developed out of the experiences of the Cold War in which major power politics very often rode roughshod over the needs of individuals, communities, and small states. Proponents of the human security approach assert that in tackling security, rather than focusing effort and wealth on territorial security, development efforts should instead focus on people. As articulated in a major 1994 United Nations Development Program (UNDP) report [http://hdr.undp.org/en/reports/global/hdr1994/], the concept involves seven aspects of human existence: economic security, food security, health security, environmental security, community security, personal security and political security. None of these loosely-defined concepts is independent of the others. Indeed, each depends upon the others in complex, sometimes surprising ways.

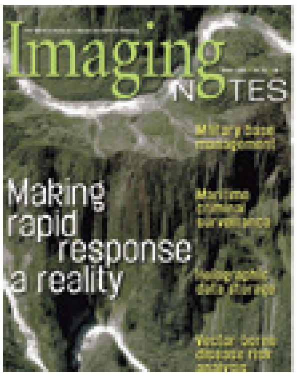
Earth observing systems, telecommunications systems, and satellite position, navigation, and timing (PNT) systems (e.g., the U.S. Global Positioning System) all have a role in improving human security throughout the world. These space systems are essential in supporting all seven of these security aspects.

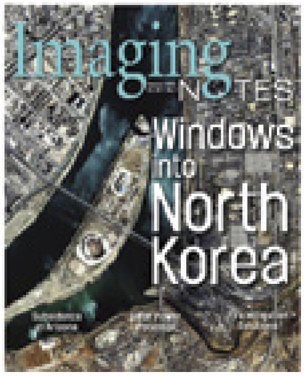
The increased global transparency provided by high resolution optical space systems like GeoEye-1, Worldview-1, Cartosat, and Spot 5 now makes it possible to assess environmental conditions following natural disasters and to monitor humanitarian disasters on a nearly daily basis. Moderate resolution systems like Landsat, CBERS (see Fall 2008 article), and the Disaster Monitoring Constellation (DMC) provide the needed moderate resolution data to follow long-term trends over large regions. With moderately high spatial resolution and high time resolution capabilities, the new RapidEye constellation fills a critical gap in transparency by covering nearly any region once a day. Radarsats 1 & 2 and TerraSAR provide high resolution radar coverage at night and through clouds.

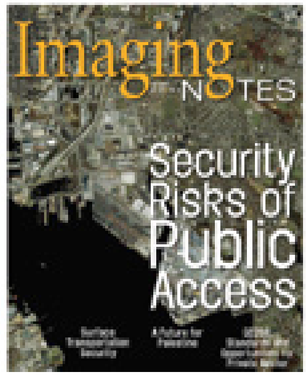
Now as never before the world community operates sufficient numbers and varieties of satellite systems to make

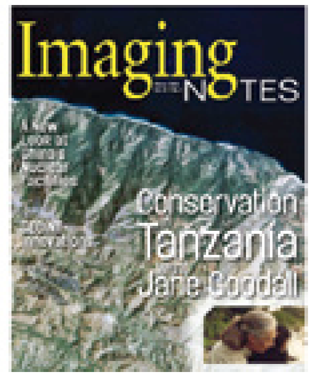


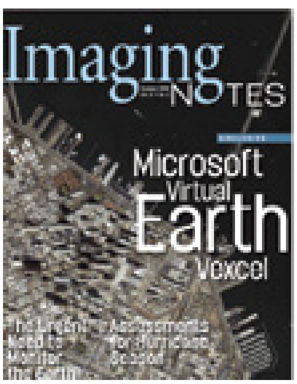


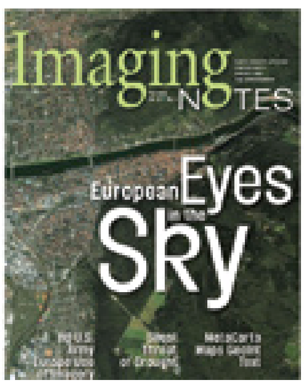


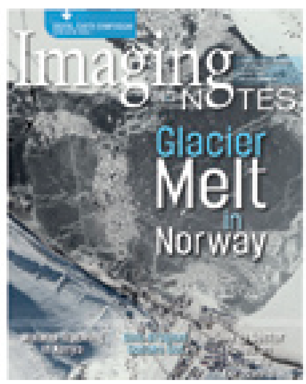


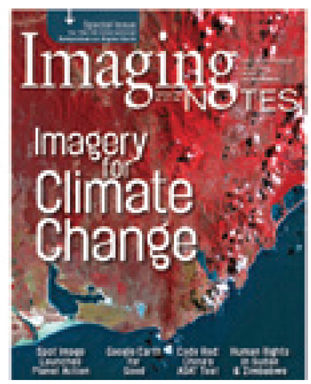


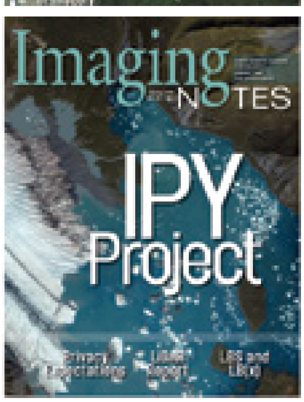


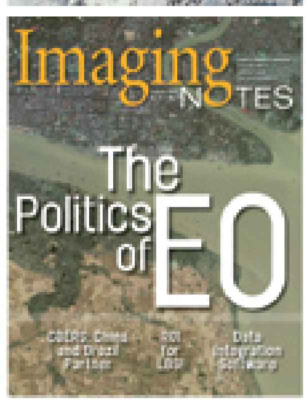


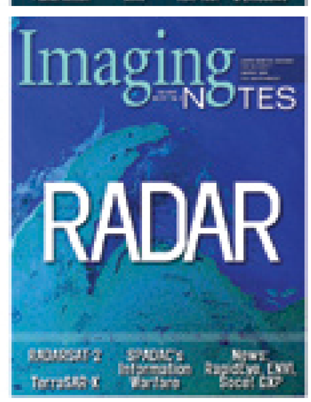












NOTE We are pleased to announce that the archive of *Imaging Notes* is now free on our website, rather than by paid subscription- www.imagingnotes.com/archive.

an enormous positive difference in the lives of billions of people around the world. The benefits to society worldwide are potentially very great. Yet in order to deliver these benefits efficiently and effectively, space systems operators will have to be better organized, and they will have to develop the appropriate tools to turn data into useful information and appropriate services. They will also have to collaborate more deeply and effectively with satellite and ground systems operators around the world.

The European program of Global Monitoring for Environment and Security (GMES) is a major step toward creating unified applications that integrate the output of space systems with more traditional, detailed local-scale data and information. This program is a major collaborative effort by the European Union and the European Space Agency. In the coming year, in addition to data collected from ground-based sensors and contributing satellites, GMES will include four "sentinel satellites" providing data for some 18 specific applications designed to support Europe's needs for accurate information about the planet.

In 2003, the United States led an effort to create a global organization that would do very much the same thing on a global scale, initiating the Global Earth Observing System of Systems (GEOSS). Some 74 State members and 51 Participating Organizations now contribute data and information to GEOSS, an effort that is coordinated by a secretariat located in Geneva. We urge the Obama Administration to assert strong leadership in this organization and help it fulfill its enormous potential in assisting development and reducing human suffering around the globe.

For years we have been told that investments in Earth science and observations were not important enough, but now with the clear links we see between human security, national and global security, and climate change, we must work to maximize the capabilities of Earth observations.

As one of the world's leaders in satellite Earth observations, the U.S. faces a moral imperative to focus more on applying the power of these systems to real world problems than it has in the past. Links between NASA and National Science Foundation and the applications agencies like NOAA and USGS are often broken or very weak. Repairing the weaknesses in the U.S. system will require greater investment and a greater effort by the applications agencies. U.S. AID could play a critical role in bringing U.S. technologies to the world by applying the power of space systems to human security needs in the poorest countries.

For years we have been told that investments in Earth science and observations were not important enough, but now with the clear links we see between human security, national and global security, and climate change, we must work to maximize the capabilities of Earth observations. The new U.S. administration appears to be committed to putting greater energy into the scientific study of global change and into efforts to slow its worsening effects.

With its partnership with Secure World Foundation, this magazine is devoted to assisting that effort with timely, insightful applications articles on solutions to human security needs. Future issues will cover the roles of satellite observations and geospatial technologies in understanding and responding to global change, in natural disaster mitigation and response, and in preventing the sorts of manmade disasters that directly harm human security. «

◀ MISSION
Secure World Foundation promotes the development of cooperative and effective use of space systems for the protection of the Earth's environment and human security.

Imagery as Inspiration

NEXT-GEN MAPPING

Attending the 2009 Consumer Electronics Show (CES)–the largest trade show in the world, with over 2700 exhibitors and 150,000 attendees–was our kickoff to the new year. As a consumer trade show, it doesn't attract much attention from the I/RS community. However, the lines between business and consumer applications are increasingly blurred as consumer devices and software drive Enterprise 2.0 (the integration of Web 2.0 into business communication).

CRAIG BACHMANN & NATASHA LÉGER

are partners in ITF Advisors, LLC, an independent consulting firm with a focus on next-generation strategy and on translating the increasingly complex new media business environment's impact on business models, markets and users.

▲FIGURE 1

The famous "EarthRise" image taken from Apollo 8 on Dec. 29, 1968 by Bill Anders. The Earth is rising over the horizon of the moon.

We attended CES in search of new consumer electronics devices and innovations that would impact the geospatial market. The connected digital life continues to be the central focus of CES and the consumer electronics industry, with high-definition flat screen televisions, Internet-ready televisions, 24/7 connected mobile devices, high-definition 3D that provides an immersive experience, and netbooks that connect to the cloud/Internet. The buzz in media and communications for several years now has been around convergence of the three screens–TV, computer, and mobile. The highlights at CES were 3D televisions in the home, netbooks, and in-vehicle navigation. So what does all this have to do with I/RS? Everything, if the goal is to grow beyond the core markets of defense, agriculture, and oil and gas.

In *Culture Code: An Ingenius Way to Learn Why People Around the World Live and Buy as They Do*, Clotaire Rapaille discusses the importance of being "on code" to effectively market products and services. In other words, he believes that what people and organizations think they are selling most often does not equate with the reason for which consumers/customers are buying. This misalignment is what limits the growth and marketability of products and services.

Among his many examples, Rapaille describes why Americans buy cars. His studies demonstrated that purchases have nothing to do with the conventional wisdom of gas mileage and safety, but instead have everything to do with a sense of freedom and a distinct experience. The gas mileage and safety, in his view, are commodities. A good example of this is the success of Toyota's SCION, a car that is "incomplete" and designed for the buyers to complete and customize to their liking, creating their distinct experience.

What is the "code" for I/RS and geospatial solutions?

THE INSPIRATION CODE

Over the last three years, we have written about new technologies and in particular how Internet distribution of imagery has created greater awareness and opportunities for new products and services. All true. However, what is needed for this market to really take off is a new marketing paradigm–a new way of looking at imagery. The "code" for expanding growth of imagery beyond its core market, we believe, resides in curiosity, inspiration, and context.

We have been reflecting on the global economic downturn of the past year, and, like many others, have been asking ourselves what is going wrong and what role location and imagery can play in resuscitating the economy. It strikes us, as people and organizations have been focused on executing plans that were based on bubble theory, the over-arching theme of the meta-narrative (also known as a 'master' or 'grand' narrative–an over-arching theme that influences behavior–for example, the mission to the moon, The Cold War, The American Dream, and The Civil Rights Movement), that a sense of value has been lost. In fact, a sense of inspiration in real value has been lost. There was a time when a satellite launch made front-page news and

space missions captured the imagination. It was inspiring to watch a rocket blast off into space. Inspiration brings a deeper sense of meaning and value to the world at large, a drive that is founded on change to create something better. We can do better.

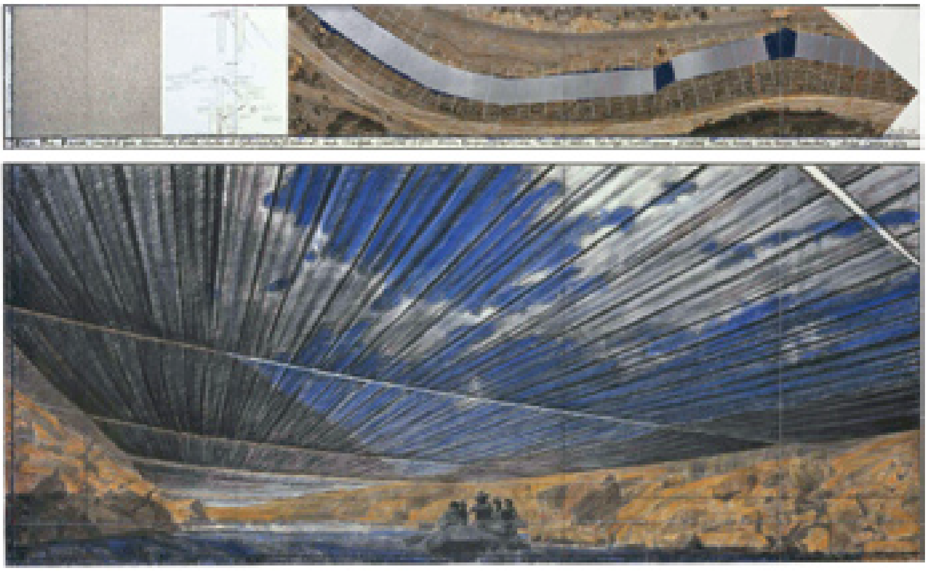
▲ ***FIGURE 2***

Textile art from Leah Evans incorporating imagery and fabrics includes "Alluvial Fields", 24"x27", which is appliqued silk, velveteen, and hand-dyed cotton with embroidery - www.leahevanstextiles.com.

As the satellite imagery business emerged from military and intelligence roots, the industry marketed imagery as a monitoring, surveillance and control product/tool. While obviously a core business for the I/RS industry, there are alternative markets that have been touched by Google Earth and others. Satellite imagery has moved from the Pentagon to Main Street, literally. Google Earth's success is due to more than simply making imagery accessible to the masses. Its success lies in its connection to humanity; zooming into

▼ *FIGURE 3*

CHRISTO, "OVER THE RIVER," PROJECT FOR ARKANSAS RIVER, STATE OF COLORADO. Drawing 2008 in two parts: 38 x 244 cm. and 106.6 x 244 cm. (15 x 96" and 42 x 96"). Pencil, pastel, charcoal, wax crayon, enamel paint, fabric sample, aerial photograph with topographic elevations and technical data. Photo: Wolfgang Volz. Ref. #68. COPYRIGHT CHRISTO 2008.



Earth from space and flying over specific regions has tapped into people's inner curiosity and has inspired them to want to know more about their surroundings. Google Earth is on code!

Imagery is now part of the digital media landscape. It can be distributed and shared easily. As a digital asset, it can be viewed on any of the three screens—television, computer, and mobile. This means it can be used for many life-changing, world-changing, and business-changing messages. A new marketing paradigm based on curiosity, inspiration, creativity and innovation is critical to building the new imagery value chain and to ensuring that the imagery industry does not become simply the backdrop for next-generation geo-platforms that are energized to create and drive new value.

Therefore, the innovation in consumer electronics becomes more important to the future of I/RS. How can the I/RS industry leverage distribution across three screens? Currently the industry is dependent on the computer screen and is slowly moving to the mobile screen. How could the market be expanded if people were able to stream imagery from their computers to their 50-inch high-definition plasma television screens?

IMAGERY AS INSPIRATION

Inspiration comes in many forms, some that may escape the traditional I/RS market focus. Many of the most inspirational images have been taken from space, such as this very famous image called "EarthRise" taken from Apollo 8 in 1968 (See ***Figure 1***). All pictures tell stories. All pictures are art. Pictures tell and reflect the story of life from evolution to revolution, from beginning to end, from the mundane to the eccentric. A picture taken from space that captures the progress and setbacks of the planet—that captures our humanity—is surely worth more than the proverbial 1,000 words, and it most certainly merits being more than a snapshot that maps, tracks, and monitors people and assets.

Imagery is being used in ways never before imagined. Leah Evans is an artist who uses GIS and imagery as inspiration for new textile art. Her work combines aerial photography, maps, and satellite imagery. She says that she is inspired by "the use of maps in organizing our ideas of land and explores map language and imagined landscapes. Through my research and experience I have decided that maps create more questions than they answer." See ***Figure 2***. Ms. Evans speaks with many geospatial professionals who come across her work at trade shows, or conferences where she is asked to present. "Geospatial professionals view imagery as art and they are so excited to see someone capture the images from an artistic perspective," she said. Curiously enough, when asked if she uses Google Earth she responded in the negative. She relies on images she finds in books or at the library. She feels that the beauty of the imagery is lost when viewed on the computer. Ms. Evans is expressing a high-tech product through a low-tech medium. Perhaps there are lessons here.

Another artistic example is the work of Christo and Jeanne-Claude, who are known as the wrapping artists (though they resent this characterization), for "wrapping" the Reichstag in Berlin, for surrounding Florida islands with floating fabric, and for installing 7,503 gates with billowing orange fabric panels in Central Park, New York. Their most recent work in progress, "Over The River," involves suspending horizontal fabric panels over 8 selected areas of the Arkansas River in Colorado. At the risk of interpreting their artistic motivation, Christo and Jeanne-

▲ ***FIGURE 4***

CHRISTO, "THE GATES," PROJECT FOR CENTRAL PARK, NEW YORK CITY. Drawing 2004 in two parts: 38 x 244 cm. and 106.6 x 244 cm. (15 x 96" and 42 x 96"). Pencil, charcoal, pastel, wax crayon, aerial photograph, fabric sample and hand-drawn technical data. Photo: Wolfgang Volz. Ref. *47. COPYRIGHT CHRISTO 2004.

Claude are in our view geographic artists. They are inspired by the beauty of life, and the contrasts of geography and location.

After the artists have selected the site, their professional engineers and survey teams use aerial photography to further define the technical details necessary to realize the temporary work of art. For "The Gates," aerial photography provided an additional tool for the artists showing the 23 miles of walkways they selected. Original preparatory drawings and collages, sometimes incorporating aerial imagery, such as those in ***Figures 3 and 4***, are sold to finance their projects. More examples of Christo and Jeanne-Claude illustrations incorporating imagery may be seen at their website: www.christojeanneclaude.net.

THE ROI ISSUE

Managers, and in particular MBAs, have been trained in ROI (return on investment) calculation and look at every cost from an ROI perspective. GIS has traditionally struggled with the ROI issue (see also our Summer 2008 column) because of the high total costs associated with ownership of a system. Managers look for the cost justifications in terms of cost savings or revenue growth. Geographic people, like Carl Reed, CTO of the Open Geospatial Consortium, see it from a different perspective. "Instead of looking at it as an ROI, we should look at it in terms of risk management. Geospatial information saves lives, and should be used to improve the planet." With a contextual geospatial view, we are more informed, and therefore become more responsible.

Imagery is informational and communicates much more than the pixels and x/y coordinates. It tells a story; it provides context when combined with other data, and especially when compared over time. A new acquaintance described the use of satellite imagery in moving from London to Philadelphia, Pennsylvania. While not "GIS" experts, the family used Google Earth and Zillow.com (a real estate application) to better understand, not just the house as a residence, but the environment—the neighborhood, the trees, the streets… all the things that inspire a family to decide "this is the place."

A series of poor management and policy decisions has been made over the last several years due to a lack of transparency, which we believe includes a lack of understanding of the bigger picture—a lack of context—which brings us back to the need for using location and imagery to resuscitate the economy. Using imagery and maps to inspire creativity; identify issues, challenges, and market gaps; communicate context; connect the dots; and build sustainable value chains are surely better ways of making money than securitizing bad mortgages. The geo-view is the path to the long-view and can help in reversing the short-term thinking that has destroyed value and companies over the last three decades. It is time for the industry to reach for the next marketing paradigm, not as a "commodity," but as an inspirational piece of a true value chain. Put CES on your calendars for 2010, and focus on the new imagery "code." «

Infrastructure Stimulus: Green Economy and Green Jobs

A new era is upon us, with palpable tension for 2009. Citizens in Washington and around the country appear to have focused, finally, on seriously working our way out of the mess we have gotten into. And what a mess it is. Al Gore's message on global warming is now being accepted as reality by most citizens at a time of competing crises and economic implosions that simply boggle the mind. Our saving grace appears to be that intelligent leadership, under the Obama administration, is ready to take charge and tackle the litany of challenges and issues facing our nation and the world.

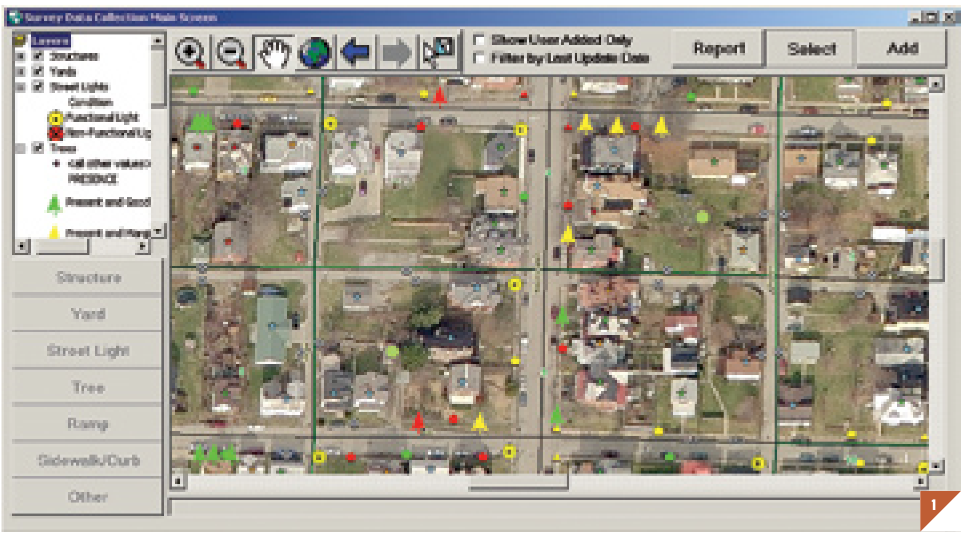
Rome was not built in a day, but it was built by engineers. And we can expect to see a lot of green and sustainable engineering projects at state and local levels working to rebuild America while providing new impetus for the creation of green-collar jobs. Aligning and funding The Green Jobs Act (passed in 2007) with the Infrastructure Stimulus Package, and perhaps tying mortgage refinancing schemes with energy conservation retrofits, would help to educate, empower, and engage a whole generation of young citizens, leading them into productive green collar careers.

If you haven't already, I suggest you read Van Jones' book, *The Green Collar Economy*, along with a series of reports by the Center for American Progress (www.americanprogress.org), to delve more deeply into the economics involved in creating a blueprint for green-engineering our way out of city decay and social pathos. Positive thinking for the New Year: The good news is that the remote sensing and GIS communities recognize the credible and crucial roles they must play in this new era of green hope.

Green engineering encompasses a wide range of civil engineering and public works operations. Improved building codes for new construction seen in U.S. Green Building Council (www.usgbc.org) and LEED (Leadership in Energy and Environmental Design) standards are often viewed as the poster children for green buildings. However, significant work is required immediately to retrofit existing homes and other buildings for energy conservation to save money and reduce energy loads from fossil-fuel-driven electric grids (***Figures 1 and 2***).

Over two decades, research and operational experience have proven that remote sensing with infrared scanners is a cost-effective approach to assessing thermal losses in residential and industrial facilities. Integrating thermal loss imagery with GIS parcel and district databases can be used to investigate energy audits and to assess options for engaging industry and homeowners with conservation and retrofitting campaigns. Retrofitting campaigns will require large labor pools of caulking and insulation workers, as well as people trained in solar panel installation.

Currently, energy audits are being conducted throughout the state of Maryland and the City of Baltimore using utility billing information combined with computational models and selected onsite instrumentation. Spatial data information systems and aerial measurements can



▲**FIGURE 1**

Satellite imagery-based spatial information system used for inventory and field survey assessments for Waynesburg, Pennsylvania (courtesy of JMT).

DR. TIM FORESMAN is a founding member of the International Society for Digital Earth and former chief scientist for UNEP. He is senior associate with Johnson, Mirmiran and Thompson (JMT), a green engineering firm in Maryland (tforesman@jmt.com).

◀ **FIGURE 2**
VAIO field data collection recorders for house-to-house survey and inventory (courtesy of JMT).

provide a more meaningful and quantitative approach to energy audit initiatives.

Transportation is another green engineering domain that has a document history of applied remote sensing and GIS technology. The challenge is to accelerate the use of spatial data and information systems to help design and re-define environmentally sound and sustainable transportation systems. Bikeways and pedestrian pathways, given short shrift in the past, are increasingly being considered serious options for reducing CO_2-polluting car miles and for promoting healthy and sustainable lifestyles in urban centers. The $4-dollar-a-gallon experiment in the summer of 2008 demonstrated a significant and continued increase in ridership on mass transit buses and trains.

Increased application of aerial coverage and spatial analysis is required to work with the planners and communities to find new alternatives for moving the masses. From impervious surface assessment to hydraulics to National Pollution Discharge Elimination System (NPDES) reporting, transportation engineers and planners require more remote sensing and better integrated spatial database systems to do their jobs more effectively.

Tree planting, biological corridors, waste water and water systems, landscape architecture, airports and harbor construction, wetlands protection, and community planning are all components of the new green engineering enterprise philosophy that is required to design and construct a healthier and more sustainable world around us. Remote sensing and GIS are paramount for both creating and integrating the spatial information technology framework for engineers.

Importantly, these spatial technologies are critical for engaging decision-makers and other citizens in visualizing and comprehending the scope and magnitude of green engineering operations. Citizen support is mandatory to maintain comprehensive infrastructure re-building. Scientific visualization, using remote sensing and GIS, was credited by Maryland's Governor Glendening for the historic passage of the Smart Growth legislation. We know it works. Now is the time for this community to unabashedly promote spatial technology for the new green engineering revolution. President Obama's Infrastructure Stimulus package will require nothing less to succeed. «

Spatial data and decision support systems will serve a crucial role in re-engineering a green and sustainable society.

LEVERAGING AN IMAGING CONSTELLATION

The Future of Imagery

HOW OFTEN DO YOU REQUIRE NEW IMAGERY COLLECTIONS FOR YOUR GEOSPATIAL projects? In the past, receiving new data was largely beyond your control, as reception was dependent upon when the satellite would be over a given area of interest and what the weather forecast was at the time of potential image collection. Snapshots in time also offered some clues, but the real value of accessing fresh data is being able to identify patterns and rate and impact of change. How fast is the pine beetle destroying the forest? What was destroyed by a tornado or tsunami? How many villages have been destroyed by rebel fighters?

Now, we are entering a new era of imagery collection that will address these critical questions of frequency and temporal analysis. With the addition of GeoEye-1 to its satellite constellation, along with MJ Harden's fleet of aircraft, GeoEye can accomplish timely imagery collection more easily by providing daily collection capability—weather still permitting. An imagery constellation closes the time sequence gap that was once created by limited imagery collection assets.

GeoEye's Imagery Constellation Assets

With the successful launch of GeoEye-1 on September 6, 2008, GeoEye now has two high-resolution satellites. Since September 1999, the IKONOS satellite has been collecting imagery at 82-cm resolution, which means it is capable of seeing objects the size of a car windshield. GeoEye-1 collects 41-cm imagery, which is good for detecting items the size of home plate on a baseball diamond. (Due to current U.S. policy, the imagery is re-sampled to half-meter ground resolution). MJ Harden, a GeoEye company, owns and operates aerial imagery assets, more specifically Digital Mapping Cameras (DMC) and an Optech LiDAR sensor. The DMC collects imagery down to 6-cm resolution, revealing objects on the ground the size of an envelope. The Optech LiDAR sensor is an excellent source for digital elevation data, which is used for accurately determining flood plains, for engineering-grade accuracy and for many other uses.

The GeoEye constellation creates a highly accurate digital, land-base foundation using historical as well as current geospatial data. When integrated with systems that provide data aggregation, analysis, and viewing, these products allow users to implement a variety of different applications.

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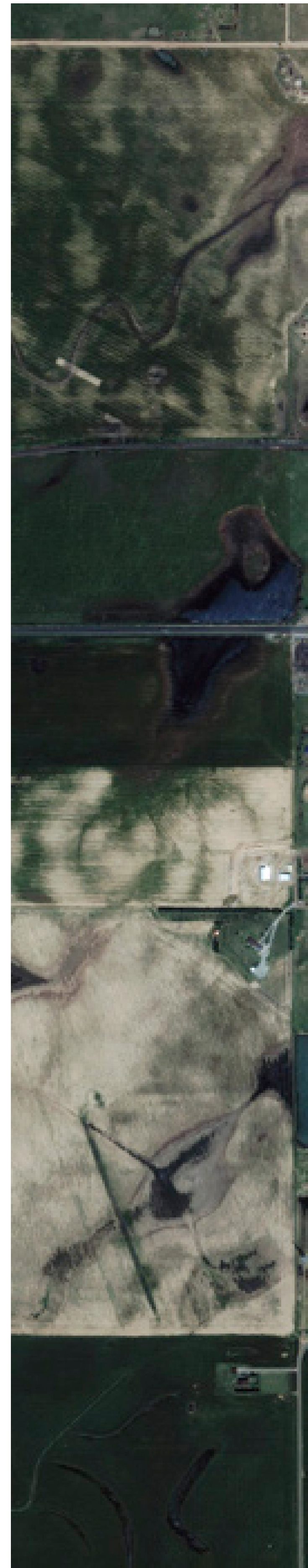
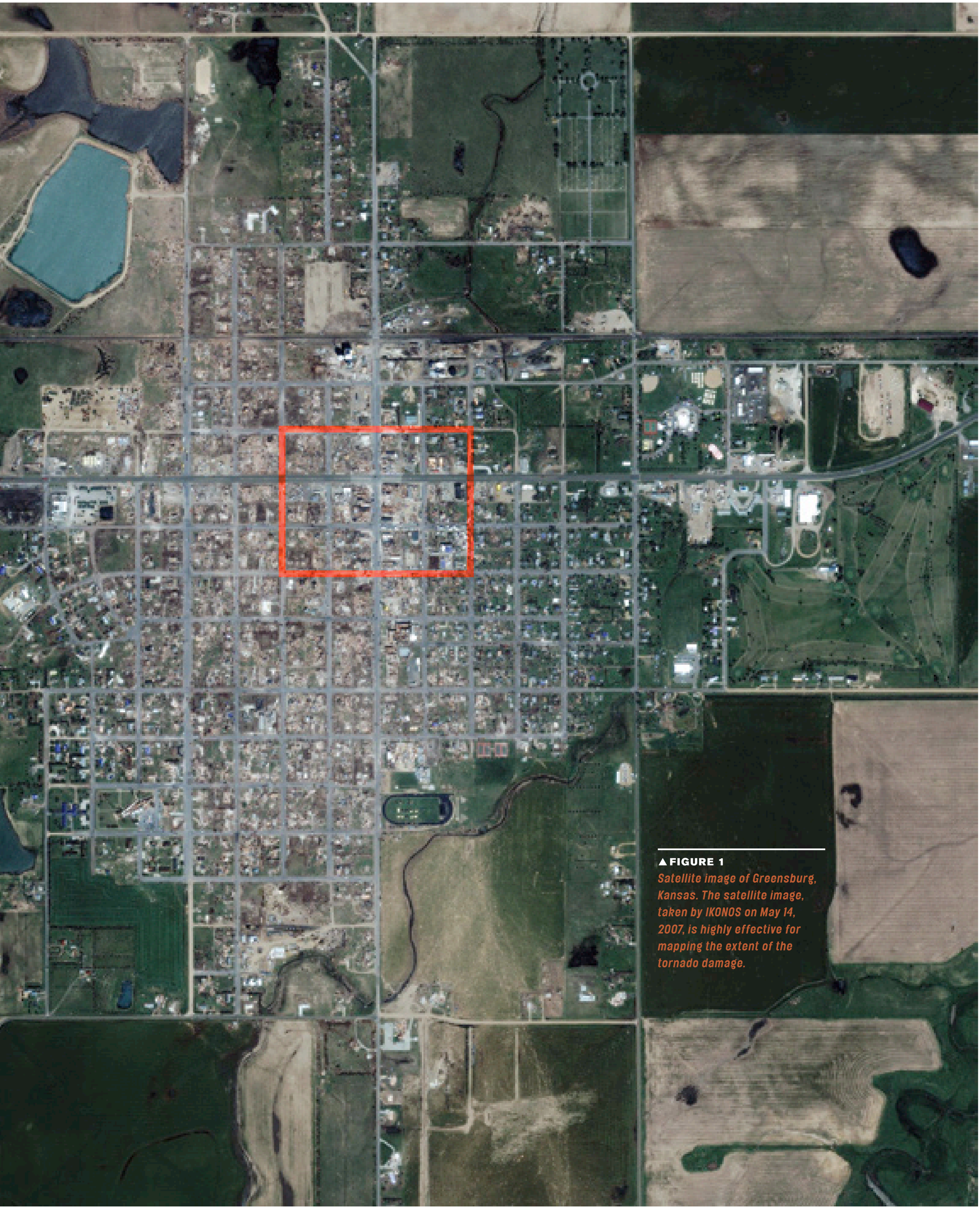
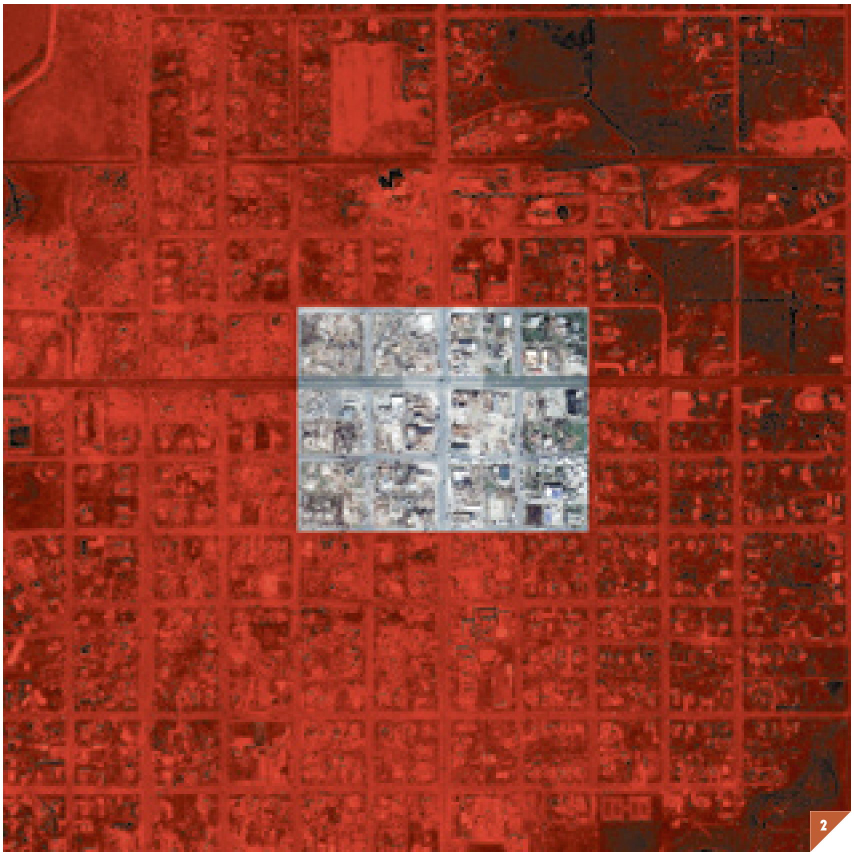
EDITOR'S NOTE: Additional articles about constellations from other data providers, such as DigitalGlobe and SPOT Image, will appear in future issues.





▲ **FIGURE 1**

Satellite image of Greensburg, Kansas. The satellite image, taken by IKONOS on May 14, 2007, is highly effective for mapping the extent of the tornado damage.



◀ **FIGURE 2**
Aerial image of Greensburg, Kansas, from MJ Harden, taken May 12, 2007.

The Visual Benefits of an Imagery Constellation

The concept of an imagery constellation is one in which an imagery provider is able to leverage various collection assets, either satellite or aerial, to deliver the requirements of customers. For example, with more than one high-resolution satellite, customers are guaranteed not only more coverage of the planet, but more frequency and currency with twice the number of 'eyes in the sky.' And combining more satellite revisits with aerial imagery enables a time-sequenced, precision image down to six centimeters. A constellation of imagery assets provides the currency, resolution, and accuracy that facilitates response to any developing situation. When combined with the historical archive, such a constellation easily shows the change that has occurred.

Figures 1 and ***2*** show satellite and aerial images of Greensburg, Kansas, following the tornado of May 4, 2007. The satellite image is valuable for mapping the extent of damage, while the aerial image provides more detail.

In addition to latency of revisits, the biggest concern from potential commercial customers has been the inability of imagery providers to guarantee capacity on the satellite; however, the satellite and aerial constellation addresses this concern. Also, there is ample capacity on GeoEye-1 to meet the company's important obligations to the U.S. government while meeting the many demands of commercial customers.

With multiple satellites and aerial imagery collection assets from which to choose, commercial users can now expect a greater chance of daily coverage, along with a growing archive of rich content. The '5Cs' of capacity, currency, clarity, coverage, and content—combined with facilitated distribution of imagery through the Internet and with new geospatial solution applications that no longer require specialized knowledge—are revolutionizing the way the commercial market uses imagery.

The imagery constellation allows for maximizing the 5Cs of imagery collection:

- **Capacity** Having more eyes in the sky increases the likelihood for collection of areas of interest for all users.
- **Currency** Up-to-date imagery and digital elevation models are required for time-sensitive applications such as emergency response and disaster management.
- **Clarity** From 1 meter down to 6 centimeters, the constellation's resolution provides for the most detailed of applications such as forestry, insurance, transportation, and engineering.
- **Coverage** By providing a temporal sequence of data, the archive allows customers to determine the amount of change over an area of interest. This change can help with future planning and portfolio management of existing assets, be they street networks or claims management for insurance.
- **Content** Imagery provides the organizing principle for geospatial data. It allows the user to visualize the earth, while the image map accuracy allows any geospatial content such as streets, demographics, or land use to be easily registered, displayed, and used by customers.

GeoEye tasked its IKONOS satellite on Nov. 20 to collect an image of the Saudi Arabian supertanker Sirius Star, which was hijacked off Kenya on Nov. 15, 2008. The IKONOS satellite imaged a large area of water off the horn of Africa and was able to locate the tanker about five miles off the Somali coast. The image of the tanker is being used to show authorities how commercial remote sensing satellites in conjunction with other technologies is able to track and identify ships at sea for better maritime domain situational awareness. See ***Figure 3***.

The Constellation Value Proposition to Commercial Market

So what does the future hold? How can a satellite and aerial constellation be used to provide additional insights and to improve business performance?

With a constellation of satellite and aerial assets, another real value is in monitoring areas of interest that are specific to a given customer. In the future, this would allow customers to subscribe to their areas of interest, search the archive for existing data, and order the assets to collect new data based on collection frequencies of their choice.

The Insurance Market

Considering previous imagery samples will reveal how the property and casualty insurance market can leverage the constellation. High-resolution imagery is used to identify flood zones, to estimate damage to property from natural disasters, and to geographically reference aging structures that are becoming more vulnerable to risk of forest fires and other events.

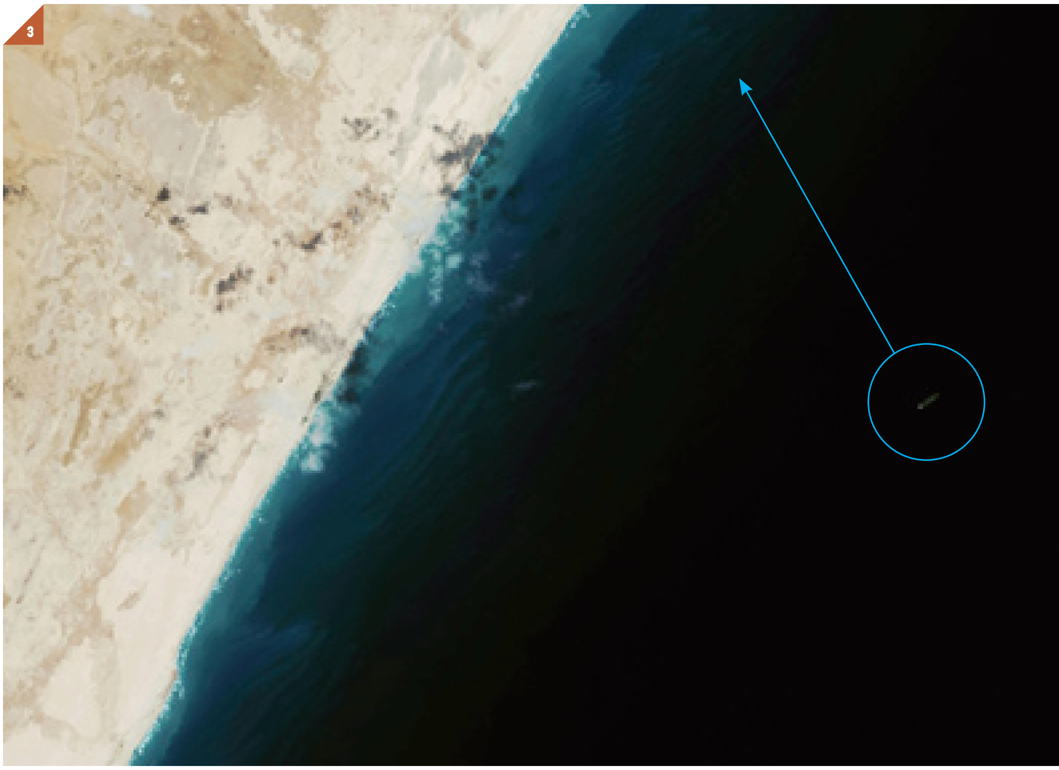
These images of Enterprise, Alabama show the area before and after a tornado, which is relevant for the insurance industry. The visualization is important in assessing damage. See ***Figures 4-5***.

In addition, high-resolution imagery increases overall risk management and improves underwriting effectiveness and efficiency when combined with other geospatial data to visualize and identify customers. The value proposition is that companies can now view high-resolution archive or newly collected imagery, perform analysis to extract features, and target “good risks,” thereby obtaining new revenue that might previously have been overlooked. Conversely, insurance companies can use these techniques to avoid taking on “bad risks.”

Insurers can reduce costs of initial underwriting of personal residences by viewing properties in advance and using imagery as a substitute for sending a person (underwriter or photographer) to make a site visit. Underwriters can use imagery to enhance “due diligence” on renewals to assess changes to a property risk profile. By utilizing imagery in

▼FIGURE 3

Sirius Star Tanker from Saudi Arabia, which was hijacked by Somali pirates on Nov. 15, 2008. The ship was released on Jan. 9, 2009 after a ransom of $3million was paid by the owner, Vela, which is based in the UAE, and a subsidiary of the Saudi Arabian state oil company, Saudi Aramco. Image was taken Nov. 20, 2008 by IKONOS.



▲FIGURE 4
Enterprise, Alabama before a tornado. Image taken Dec. 2, 2006 by IKONOS.

▲FIGURE 5
Enterprise, Alabama after the tornado. Image taken March 5, 2007 by IKONOS.

archive and new collections from air or space, high-resolution imagery products provide the following value propositions:

- Underwriters can utilize the archive for renewals to see how the overall condition of the property has changed over time.
- If change has occurred, underwriters can then determine if the property is a higher or lower or unacceptable risk.
- Revenue can be improved by using images, geospatial data, and analyses to price individual risks more accurately. Risk can be evaluated on a house-by-house basis instead of just by zip codes.
- The technology saves time and costs when used to reduce site visits.

High-resolution imagery products, along with mapping and search-engine software, provide the following value for claims management. First, they optimize resource deployment by using current imagery content to replace adjuster site visits where appropriate (e.g. the property is completely destroyed). They create early estimates of potential catastrophic losses, and they manage claims expenses by using images to identify causal factors of a loss and/or using images to conduct a sample audit of claims being made.

An expansive image archive, along with current data, provides the baseline to develop loss models to understand, manage, and communicate portfolio risks more effectively. All properties in the portfolio can be examined to determine the exposure for a specific geographic region. The industry understands that underwriting and portfolio risk management depend on factors beyond the property being underwritten, factors such as landmarks, hazards, and existing geographic portfolio concentrations. High-resolution imagery products, combined with other geospatial data, are critical to understanding these important risk management factors.

Imagery has traditionally been of greatest value to the defense and intelligence community and to select industries that employ geospatial experts required to manipulate it. To these customers, imagery is mission critical. With the advent of a combined satellite and aerial constellation, the future of the imaging market will evolve from serving these traditional customers to one of solving a variety of other customer-specific problems. In a competitive, global marketplace, what makes imagery critical to a broader market is the ability to deliver competitive advantage… that is, the speed of detection, the value of current data, the time value of imagery, the ability to view details on the ground, and even to add the digital elevation data. «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Making Sustainable Cities Real

AUTODESK AND NCDC AFFECT URBAN ENVIRONMENTS

IT'S BEEN FIFTEEN SHORT YEARS since the President's Council on Sustainable Development first grappled with the definition of sustainability—a now ubiquitous term that is often overused, misused and perhaps, given its importance, not used nearly enough. President Clinton established the President's Council on Sustainable Development (PCSD) in June 1993 to advise him on developing bold new approaches to achieving economic, environmental, and social equity goals. Since then, Digital Earth technology has arrived at a dizzying speed, providing a "glass house" view of the planet.

Clear scientific evidence suggests that humanity is living unsustainably, and that efforts are needed to keep human use of natural resources within sustainable limits. Subsequently, a tide of mainstream understanding and consensus is emerging around the urgency of using resources more efficiently. In every direction, on nearly every issue, from energy to water to land use to greenhouse gas emissions, on every continent and in every country, the world is waking up to the idea that we are all in this together and we'd better act fast.

Over half of the world's population now live in urban areas. Given the sheer impact cities have on the use of resources, city governments understand their crucial role as change agents and are responding with timely and sweeping proclamations of going green. In July of 2007, 600 mayors from across the United States

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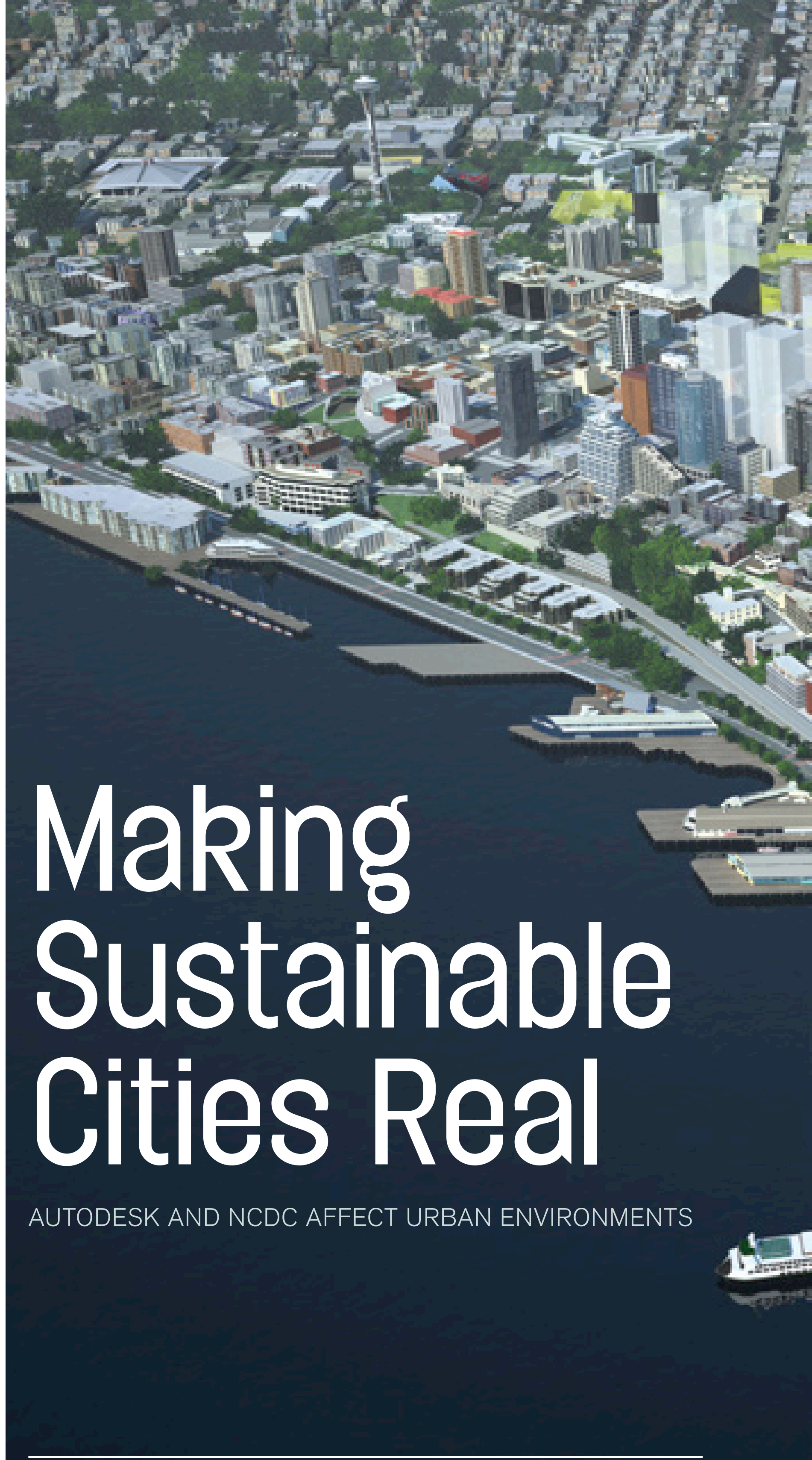


▲FIGURE 2
This digital city model of Seattle was created using Autodesk software; it combines aerial imagery with GIS, CAD and BIM data. Image courtesy of Parsons Brinckerhoff.

- IRRIGATED AREA (H-M-L)
- IMPERVIOUS AREA
- TREE & SHRUB COVER
- NON-IRRIGATED
- LANDSCAPED AREA

▲**FIGURE 1**

Water issues were addressed for the town council of Castle Rock, Colorado, by NCDC Imaging.

Statistics on Parcel ID 20906

(TOTAL AREA; 186,632 SQ. FT.)

	PERCENT	SQ. FT.
IMPERVIOUS	60%	111,849
HIGH IRRIGATED	20%	36,680
M-L IRRIGATED	11%	19,858
NON-IRRIGATED	8%	15,600
LANDSCAPE	0%	N/A
TREE COVER	<1%	N/A
UNCLASSIFIED	<1%	N/A

and Puerto Rico signed the U.S. Conference of Mayors' Climate Protection Agreement, pledging by 2012 to reduce carbon dioxide emissions by 7 percent below 1990 levels. As of December 2008, 910 mayors have endorsed the accord. Under it, participating cities commit to taking the following three actions:

1. Strive to meet or beat the Kyoto Protocol targets in their own communities, through actions ranging from anti-sprawl land-use policies to urban forest restoration projects to public information campaigns;
2. Urge their state governments and the federal government to enact policies and programs to meet or beat the greenhouse gas emission reduction target suggested for the United States in the Kyoto Protocol; and
3. Urge the U.S. Congress to pass the bipartisan greenhouse gas reduction legislation, which would establish a national emission trading system.

This spirit of cooperation by cities as central players in maintaining planetary health shows great progress and arrives none too soon. Growing support from mayors across the world is significant; by 2050, two-thirds of the 9.4 billion people sharing the planet will live in cities (according to Doug Eberhard of Autodesk). At the rate of current development, with buildings consuming 39 percent of all energy use and 68 percent of total electricity, emitting 38 percent of all greenhouse gases, and contributing 30 percent of all waste outputs, pragmatic steps must be employed immediately to meet the demands of the future. Aging cities' infrastructures undoubtedly will be pushed to the limit when the world's population doubles in just 40 years.

With so much at stake, figuring out ways for cities to move beyond proclamations and good intentions to achieving their sustainability goals is imperative. Can geospatial technologies be employed to make sustainable cities real? So far, U.S. policy makers show a mediocre record of using information already available to them. (Think Atlanta, running out of water in 2007).

Putting more information in the hands of those charged with managing resources better won't necessarily work unless data can be analyzed and synthesized collaboratively across disciplines. Solutions require a holistic approach that can deliver significant resource efficiencies with economic gains. Luckily, new advanced technologies for satellite mapping on a large scale have reached the point where they can revolutionize the way resources are managed.

One of the companies working at the forefront of these technologies is NCDC Imaging. NCDC Imaging & Mapping is a Native American-owned small business firm (Colorado Springs, Colo.). The firm develops innovative remote sensing and GIS solutions for natural resource assessment, environmental management, emergency response planning, agriculture, renewable energy and geo-referenced meteorological applications.

Jason San Souci, Executive Vice President/COO with NCDC, explains, "GIS allows a new level of viewing and analysis of geographic data that can reveal patterns and insight not otherwise apparent." The example he uses is of quantifying the value of trees in urban communities. "We know that urban trees offer shade on hot sunny days. Summertime studies have shown a 1-2 degree Fahrenheit decrease in temperature for every increase of 10 percent vegetation cover. Houses shaded by trees need 4-25 percent less energy for cooling than those standing in the open. Homes sheltered by trees from wind reap winter heat savings of as much as 10.3 thousand BTUs or approximately $52.00 annually."

He also noted, "Trees also reduce noise and act as a natural air filter. Community forests increase property values, enhance recreation, and lead to reduced crime rates and safer neighborhoods. Given these benefits, it's an easy decision for cities to invest in their urban tree cover. But in order to arrive at informed decisions and effective conservation strategies, decision makers need to have an exact survey of what's there."

GIS data can show the existing number and location of trees in a city, how much carbon those trees store each year, the potential for air pollution mitigation, annual storm water savings, temperature fluctuations due to missing or extra tree cover, and other data. Decision makers can see clearly how much more a city can save by planting more trees. This example can be applied to a host of issues across separate municipal departments. "If the left hand can learn what the right hand is doing, as it were, multi-disciplinary collaborations on carbon emissions, storm water, transportation, land use development… virtually any individual project can be observed to see how it affects the total big picture," explains San Souci.

GIS technology can provide key measurements of carbon sequestration and air pollution levels, and of their changes over time. With the help of multi-resolution digital imagery, city planners can view highly detailed visual pictures and can conduct critical analysis, budgeting, forecasting, and modeling on a multitude of municipal functions such as water conservation, erosion control, air quality modeling, renewable energy, and smart growth planning. Policy makers then can understand resource complexities better, allowing them to arrive at sustainable solutions with economically favorable terms.

The town of Castle Rock, Colorado, recently put technology to good use in order to meet its overall water conservation goals. In 2006, the town's utilities began investigating the concept of using water budgets. A lack of access to large sources of renewable water, in combination with an ever-increasing population, was stressing its water resources as well as its environmental stewardship responsibilities.

Town council managers could see that saving a potential 35 percent in water use was in the town's best interests, according to Billie Owens, Program Analyst for Castle Rock Utilities. The town needed a rate structure that was easy to understand, would provide customers with the water they needed at a reasonable rate, and would create an incentive to conserve water. The town also needed to stabilize agency revenue while making efficiency a central part of its mission. Town managers set about finding the most efficient means of capturing irrigated areas for over 14,000 customers.

That's where NCDC Imaging came in. The company was working on a project in nearby Aurora, Colorado, where irrigated area data had been produced using high-resolution satellite imagery to support a lawn irrigation return flow study. In early 2007, Castle Rock and NCDC shared data needs and requirements and soon began mapping work using imagery collected the previous summer.

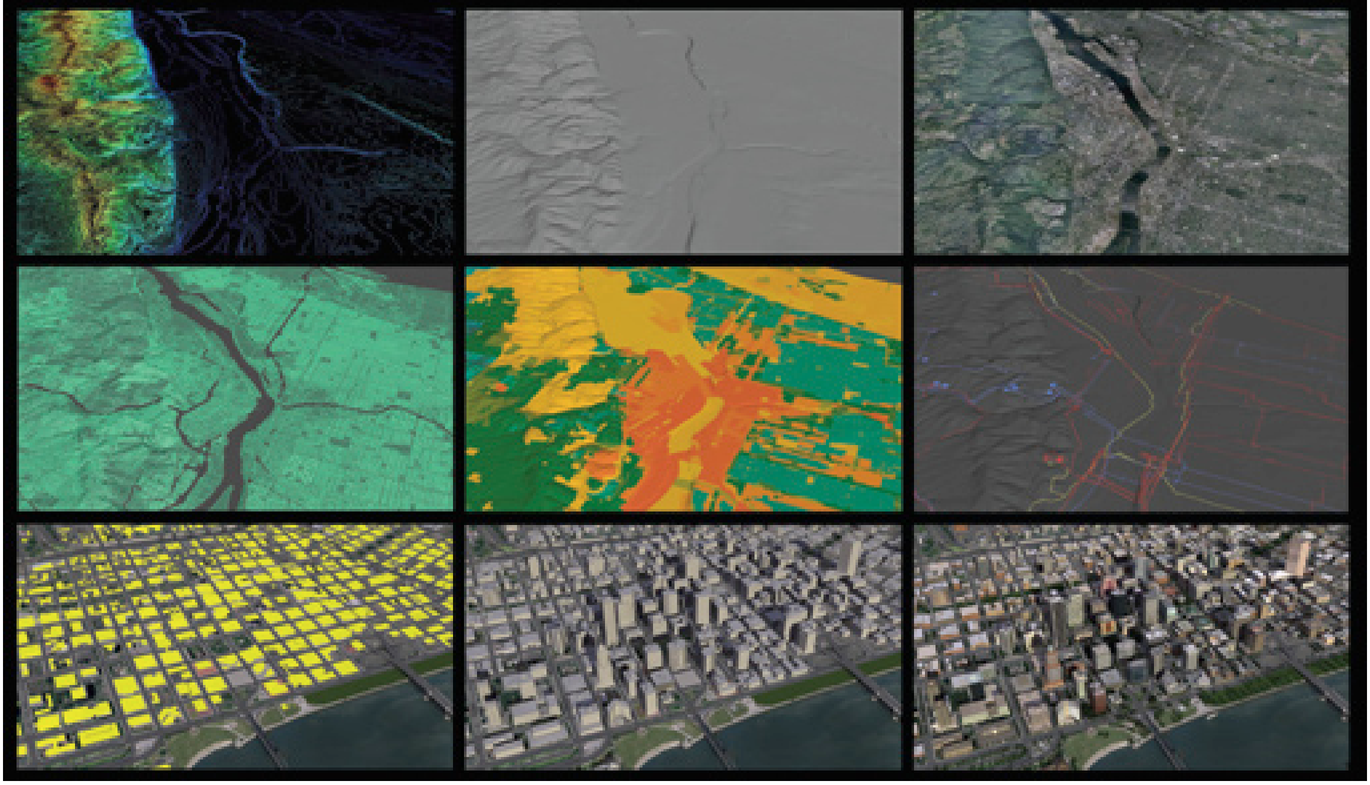
Over the next couple of months, data on irrigated vs. non-irrigated areas, impervious surfaces, trees, and other features were collected through a mostly automated image analysis approach. The results were merged with Castle Rock's parcels to produce statistics useful for developing a water budget rate structure and other long-term resource planning purposes. See ***Figure 1***.

The project allowed the town to understand its customers and to use data to evaluate water usage patterns by user category, landscape, and irrigation efficiency, as well as to identify the amount of landscaping associated with varying residential lot sizes. From there, Castle Rock was able to develop a water budget and to begin forecasting for the future. The analysis prompted further policy development work on additional water conservation practices, storm water issues, environmental sustainability, and even lawn irrigation return flow efficiencies.

"The analysis prompted further policy development work on additional water conservation practices, storm water issues, environmental sustainability, and even lawn irrigation return flow efficiencies."

A Digital City is Worth 100,000 Words

Another company exhorting the virtues of using new technology to build and share smarter models across municipal departments is Autodesk, Inc., a leader in 2D and 3D design software for the manufacturing, building and construction, and media and entertain-



▲**FIGURE 3**
Various data sources have been combined to create a digital city model of Portland used to support numerous projects and agencies. Image courtesy of NC3D.com.

ment markets. Since its introduction of AutoCAD software in 1982, Autodesk has developed the industry's broadest portfolio of state-of-the-art digital prototyping solutions to help customers experience their ideas before they are real.

The company recently announced its Digital City initiative, which allows municipal leaders to plan, design, construct and operate cities in better and more sustainable ways. A digital city allows stakeholders from the public, city government, construction, and business communities to work together to understand how many different proposals could impact the urban environment by experiencing the future of the city before it becomes real. The technology is designed to provide a collaborative environment for visualizing, analyzing and simulating the future impact of urban design and development at a city-wide scale. Doug Eberhard, Industry Evangelist and Sr. Director at Autodesk, says simply, "A digital city is worth 100,000 words."

Decision makers can look at and share files early in the design cycle, making sustainable design more efficient and cost-effective. Three-dimensional models help ideas come to life and "snap into place." For instance, developers can look at a model, determine if a watershed can support placement of a project in a certain location, and correct any mistakes before a project gets built or environmental degradation occurs. Projects are completed faster because there is more accuracy and transparency, and the models help build trust in the larger community.

Autodesk recently announced that it would work with Salzburg, Austria, as its first pilot city to integrate city data into a highly detailed 3D model. The goal of the pilot program is for Salzburg to be able to bring together 3D models of above- and below-ground features in an open platform that supports secure and robust integration of CAD; building information modeling (BIM); and geospatial, civil engineering, and infrastructure data over a wide geographic area. By combining these data with realistic visualization, analysis and simulation tools, a digital city can deliver an intuitive and compelling way to understand the impact of plans and proposals from any point in time and from any point of view. See ***Figures 2-3***.

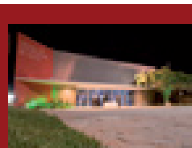
The combination of city data with realistic visualization and simulation tools will allow Salzburg to view and interact with the city landscape, as well as to analyze the impact of future urban planning, tourism, and economic development projects before they are built.

As sustainability continues to move to the forefront of public consciousness and is seen by many as the natural progression in human evolution, cities are dedicating their efforts to feeding and powering themselves with minimal reliance on surrounding open spaces, and to creating the smallest possible ecological footprint for their residents. Geospatial technologies are already playing a central role in sustaining human existence on Earth and will continue to help move entire metropolitan regions closer to achieving their sustainability goals in the years ahead.

NOTE See Geoff Zeiss' article on 3D simulations in urban environments in the Fall 2007 issue of *Imaging Notes* at www.imagingnotes.com/archive.

XIV SBSR

Brazilian **Remote Sensing** Symposium



Natal Convention Center

April 25-30, 2009

Natal, RN, Brazil

The XIV Brazilian Remote Sensing Symposium will be held on April 25-30, 2009.

April 25 and 26 (Saturday and Sunday) are reserved for courses.

The Opening Ceremony and the opening of the Technical Exhibition is on April 26 (Sunday evening). The Technical Exhibition will be open from April 27 to 30 (Monday to Thursday).

The oral sessions, panels, workshops, round tables, guest lectures and other activities will be held from April 27 to 30.

All the activities will be held at the Convention Center of Natal city, RN, Brazil. Natal is one of the main touristic cities in the country, with many natural beauties - especially its very nice sea coast - and is an important emerging pole in remote sensing. The city has a very good infrastructure which meets the needs of the *SBSR* and offers excellent hotel accommodations.

Registration Form, Exhibition Information and Full Program

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PROGRAM

- More than 1,000 papers
- 20 Workshops and Special Sessions
- 10 16-hours Courses
- Exhibition Fair

THEMES

The following main topics will be discussed:

- ✓ Agriculture; Forest and Vegetation; Land Use and Cover Change;
- ✓ Analysis and Application of High and Low Spatial Resolution Data;
- ✓ Analysis and Application of Multispectral and Hyperspectral Data; Multitemporal Analysis;
- ✓ Applications of Data Collection Systems and Telemetry; Cartography and Photogrammetry; Sensor Systems;
- ✓ Atmosphere; Monitoring and Environmental Modelling; Soils and Soil Moisture;
- ✓ Classification and Data Mining Techniques; Image Processing;
- ✓ Coastal Management; Geology; Hydrology; Oceanography;
- ✓ Data: Systems, Management and Policies; Education;
- ✓ Geographic Information: Science, Systems and Applications;
- ✓ Health; Pollution; Urban Environment;
- ✓ RADAR: Research, Development and Applications; LIDAR;
- ✓ High Resolution.

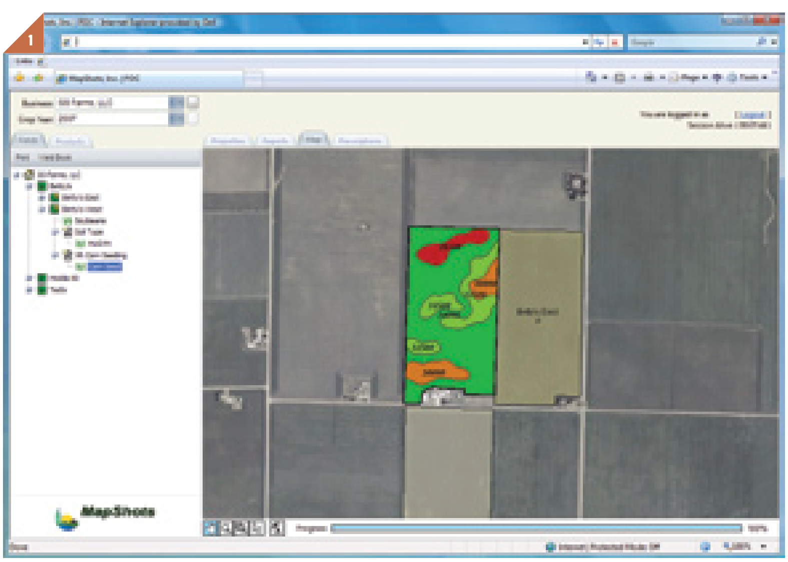
Rapidly Serving Imagery

FOR PRECISION AG AND COUNTY AND STATE GOVERNMENTS

ACROSS A BROAD RANGE OF INDUSTRIES AND THROUGHOUT CITY, COUNTY, state and national governments, understanding the changing Earth is a vital part of decision-making processes. As technology continues to improve, satellite imagery and aerial photography have the ability to capture higher resolution data, providing greater understanding of any area of interest.

In the past, this data was often too large to serve over the Internet with efficiency. However, maturing standards and improvements in web services, data compression, metadata standards, delivery and processing power are making this technology readily available. Below are three examples outlining how large volumes of imagery are being served efficiently to support precision agriculture, a county's appraisal office, and an entire state government dataset infrastructure.

▼ **FIGURE 1.**
ERDAS Image Web Server and GIS integration for precision agriculture.



Cultivating Imagery for Better Crops

Though the fact is sometimes not realized by the non-agricultural sector, farms are businesses too, and need to be as efficient as possible. Along with soaring oil prices, farmers have had to contend with soaring fertilizer prices – as well as fierce competition from overseas providers. Traditional farming methods are often unable to meet the growing demands and cost pressures, increasing the need for advanced technology to ensure optimum crop yield and quality.

To increase efficiency of production, as well as output yields, farmers in first-world countries have turned to high-tech precision agriculture. Individual farmers and corporations implementing precision agriculture techniques not only reap cost savings benefits, but also are better equipped to meet the needs of the populations they serve.

Agriculture data management is different from other types of data management in the vast volume of data that is regularly analyzed. For the farmer, the earth really is constantly changing. To make the best decisions, the most accurate and up-to-date data must be collected, often for the smallest segments of a specific area. Precision agriculture utilizes geospatial technologies, including global positioning (GPS), sensors, satellite and aerial images, and information management tools, to assess and understand variations.

Collected information may be used to evaluate optimum sowing density, to estimate fertilizers and other input needs, and to predict more accurately crop yields. These techniques avoid applying inflexible practices to a crop, regardless of local soil and climate conditions, and may help to assess local situations of disease or lodging more effectively.

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ERDAS
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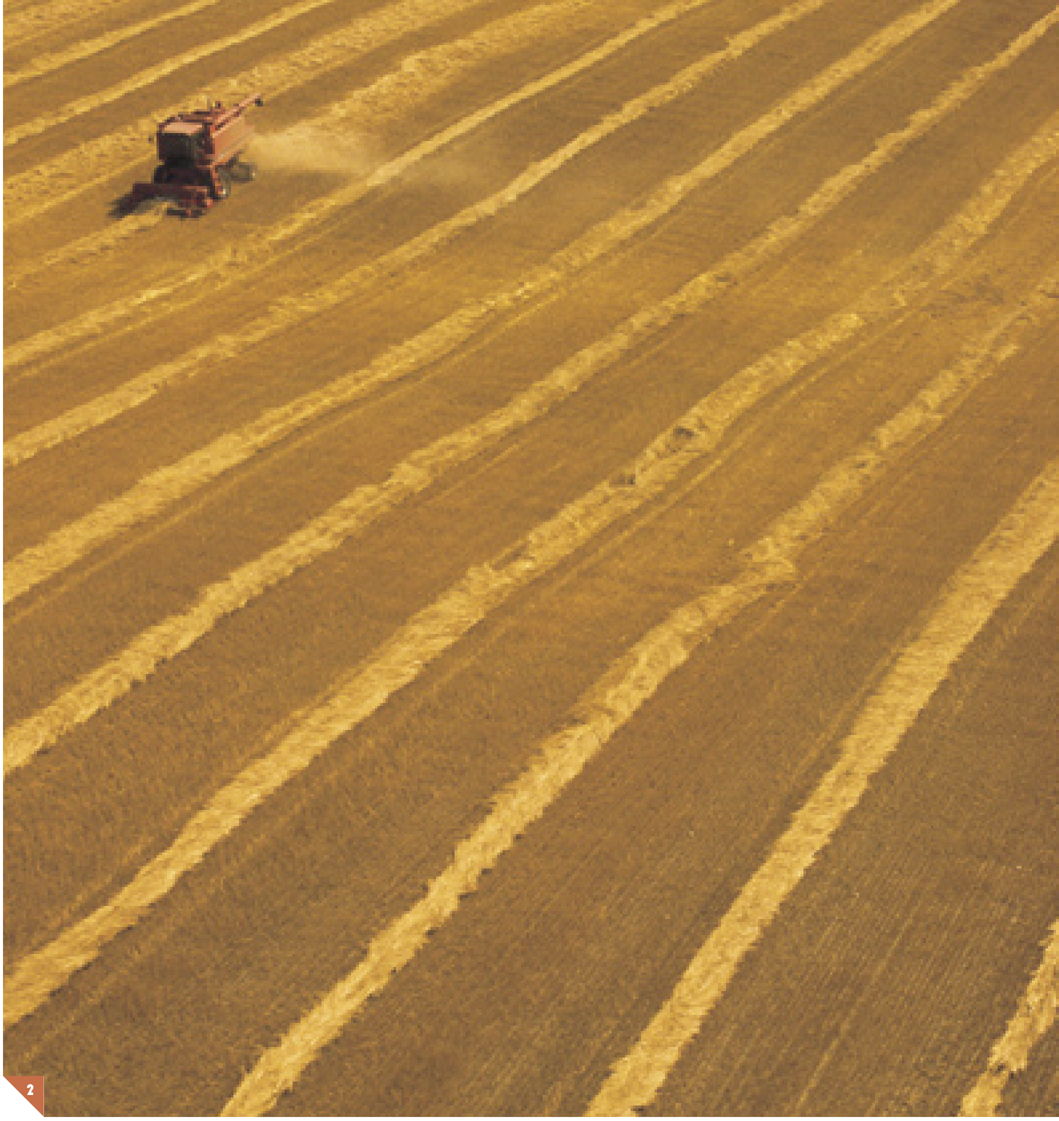
Maximizing the Power of Precision Agriculture

MapShots provides crop management solutions for growers, crop consultants, crop insurance agents, independent fertilizer and chemical retailers, and farm supply cooperatives throughout the United States of America. MapShots understands a variety of field operation needs, providing the framework documenting the full spectrum of user needs, from those without technology to those implementing the most advanced technology. MapShots customers include Southern States Cooperative, John Deere's AMS and Agri Services groups and DuPont Pioneer Hi-Bred. Specifically, MapShots provides those in the agriculture industry the tools necessary for better crop planning, recordkeeping and GIS/Precision Ag functionality.

MapShots ensures that field operations data are openly exchanged among all systems employed in agricultural production. Fertilizer has increased in price much the same way oil has in the past few years. For Southern States Cooperative, fertilizer dealers are scattered across the East Coast. MapShots' agriculture precision technology enables this company to manage these farmers' services remotely, with analytical understanding of the quantity yielded and sold to customers. See ***Figures 1-3***.



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▲**FIGURE 2**
Farmers working in precision agriculture use computers to integrate layers of data, including soil conditions and fertilizer needs for better prediction of crop yield.

Recently, MapShots began exploring options for expanding their services through web mapping. Previously, customers utilizing MapShot's EASi Suite GIS software package operated entirely in the desktop environment. Providing their customers with massive amounts of USDA imagery, MapShots was regularly updating and delivering this data to their customers by DVD. Their customers then copied the imagery onto their desktop, using EASi Suite to run the necessary processes and analytics on their areas of interest. By adding the option of a web mapping application, MapShots hoped to offer customers the added means to access and serve their imagery over the Internet, without abandoning desktop.

After exploring a number of web mapping applications, MapShots chose to implement ERDAS Image Web Server, a high-speed, specialized server application that efficiently distributes large volumes of geospatial image data. ERDAS Image Web Server solves the infrastructure congestion problems associated with deploying large amounts of image data, enabling users to access quickly the information they need.

Several of the other solutions MapShots considered had problematic and expensive licensing issues and restrictions. Many farmers produce books of their maps each year, and the restrictive licensing practices of other applications did not allow this. Other options available to MapShots also forced the use of the imagery they provide, which is of low quality and/or older for rural areas. The quality of imagery was paramount to MapShots customers. ERDAS Image Web Server allowed MapShots to control their environment and quality of content by hosting their own imagery. MapShots could then maintain and update this information for all their customers regularly.

An added benefit of ERDAS Image Web Server is that it does not require an SQL server database. ERDAS Image Web Server seamlessly connects to MapShots' existing business applications, and is interoperable with their GIS-based core product. With

Web Mapping Services (WMS, the standard set by the Open Geospatial Consortium), ERDAS Image Web Server can call the GIS server, render maps in the GIS engine, and then serve these maps as part of a total image solution.

Ted Macy, President of MapShots, commented, "Our customers are eager to implement the technology that ERDAS Image Web Server provides. By offering such fast web serving capabilities for massive amounts of imagery, ERDAS Image Web Server has also opened doors to a number of new potential customers eager to further advance their investment in precision agriculture."

Ultimately, the speed and performance that ERDAS Image Web Server provides MapShots will enhance their customers' ability to access the most up-to-date imagery on demand. This faster access, combined with MapShots' EASi Suite software, ensures better precision agriculture, maximizing the potential of our Earth's resources and the ability to cultivate the land to meet the needs of our ever-increasing population.

▲**FIGURE 3.**
Laptops are new essential tools for farmers in the field.

Delivering a County's Geospatial Information

In Florida, the Lee County Property Appraiser's Office maintains a large amount of geospatial and business information. This includes the sale of ownership maps; property record cards and ownership data; sales data books; header strap identification books; copies of the tax roll; and locators for hotels, motels, apartment buildings, mobile home parks and condominiums. The office also provides property ownership verification for, and locates properties on, ownership maps. The Lee County Property Appraiser's assessment is used by various governmental agencies to set their tax levies.

Because of the vast amount of data maintained, businesses, organizations and individuals alike had diverse interests in Lee County's information. Developers, property owners, and other government agencies wanted unified access to cadastral data and aerial photography to provide additional, vital information to the cadastre.

The State of Florida's Department of Revenue also requires that mass reappraisals verify/establish market values for the tax roll. New construction and agricultural classified properties are also reviewed throughout the year. Lee County has over 500 gigabytes of raster imagery, including aerial photography coverage from 1998, 2001, 2002, 2005, 2006 and 2007. Delivering this imagery quickly to the large number of land stakeholders presented a performance problem for traditional GIS technologies.

Lee County continues to use its existing GIS infrastructure to serve the cadastral information. The imagery, however, is now served using ERDAS Image Web Server. This tandem approach allows the original GIS to perform as it was intended – serving vector information. ERDAS Image Web Server takes the load of serving 500 GB of image data.

The unified cadastral/aerial photography view presents a complete land information picture to the user. There is no time-consuming 'application swapping,' as all necessary information is presented within a single application window. Combining aerial photography from different years into a single browser interface lets users efficiently determine areas that have changed over time. This solution has overcome slow performance, costly hard disk and processor requirements, and other infrastructure bottlenecks.

Serving Imagery Statewide: Oregon

State governments maintain a tremendous amount of geospatial information. Because these data are important to different departments and organizations associated with the government, it is necessary that they be easy to deliver and readily accessible.

Previously, in Oregon, users who needed to utilize statewide imagery coverage of any reasonable resolution needed to move data sets via CD/DVD, portable hard disks and FTP sites. As the state's imagery needs have continued to grow, the job of distributing and storing these data has become more challenging. Professionals in Oregon realized the need for a more efficient distribu-

▲**FIGURE 4.**
State of Oregon's Imagery Explorer digital library portal

tion mechanism, enabling users to acquire digital datasets via a Web-based library/ portal system.

In 2006, the Oregon Orthoimagery Framework Implementation Team (OFIT) directed the State of Oregon to contract with Oregon State University to create an imagery distribution/provisioning Web portal that could be integrated with the current Oregon Explorer Natural Resource digital library portal. This new portal provides datasets to federal, state and local agencies and to institutions of higher education, allowing users to select an area of interest and then extract/download the data in the appropriate format and projection to the client's site.

The portal also serves as a tool for ingesting and storing imagery files via a library, as well as providing a service to clients with applications that can access imagery via a WMS service. ERDAS Image Web Server stores terabytes of Oregon's imagery data that can be served to Web clients. See ***Figure 4***. ERDAS Image Integration Framework provides the user interface and ERDAS Image Extraction Engine extracts image subsets. The user interface manages the services independently, so that data are displayed as soon as available.

With an increasing amount of high-resolution imagery available, non-traditional businesses and governments worldwide are recognizing the value that geospatial imagery provides. For organizations that maintain large amounts of imagery, there is often a need to deliver this information efficiently via the Internet. ERDAS Image Web Server's advanced technology overcomes the obstacles associated with serving large file types, quickly providing access to any organization's imagery. ≪

Cloud Power

AGI AND GEOEYE GAIN AGILITY AND EFFICIENCY

BY BOB LOZANO
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▲**FIGURE 1**
The Hoover Dam is in the Black Canyon on the Colorado River, located about 30 miles southeast of Las Vegas, on the Nevada-Arizona border. This image is courtesy of GeoEye, and was captured by GeoEye-1 on Jan. 10, 2009.

ISN'T IT INTERESTING THAT THE data applications that today might rely most heavily on cloud computing are distinctly focused on Earth, but from the bird's eye view? That's the idea with clouds—you need to back up, sometimes miles, to get perspective.

Geospatial leaders all over the industry are doing just that, taking a few giant steps back and really looking at how they're doing business. They have seen that they've been asking amazingly talented algorithm engineers and developers to also take on parallel and distributed computing—and they're saying, "Hold it. This is inefficient. Let's figure out something else."

When these decision-makers stick to their core competencies, they accomplish two purposes.

- They let their developers focus on what they're really good at, creating a less complex, more efficient, and more agile working environment.
- They begin to use all the little pieces at their disposal, which means they begin to develop applications in a much more elegant, correct way–instead of the BIG, data-hungry way. They become mean and lean–specialized.

Frugality often drives innovation. And the fabric-based cloud technology many geo companies are using has allowed for all of this to be easy–the drudgery computing that they could do, but that isn't a core competency, can be handled by the cloud (the Internet).

These are times for backing up to gain perspective, no doubt. Organizations are taking many steps in reverse to get the bird's eye view, the big picture. It is believed to be Socrates who said, "Man must rise above the clouds and look back upon the Earth. Only then can he truly understand the nature of things." That statement still rings true today.

GeoEye Uses the Cloud to Stick to Its Core

GeoEye (Dulles, Va.) is one company with this changing world view. They are a premier provider of commercial satellite imagery to the Department of Defense and intelligence communities. The company also provides satellite and aerial geospatial information to government intelligence, national security, and military organizations, as well as to commercial customers, including Google Earth.

As part of the $500-million NextView contract from NGA awarded to GeoEye in 2004, GeoEye launched its GeoEye-1 satellite from Vandenberg Air Force Base in California in September 2008. From an orbit of 423 miles (681 kilometers) above Earth, GeoEye-1 has a ground resolution of 0.41 meters, or about 16 inches. The satellite also provides 1.65-meter resolution multispectral imagery. Due to current U.S. government licensing restrictions, non-U.S. government customers will have access to GeoEye-1 imagery that has been re-sampled to .5-meter ground resolution. GeoEye-1 is able to collect some 700,000 sq. kilometers of panchromatic imagery each day—an area equivalent to the size of Texas. It collects about half that in the multispectral mode. See ***Figures 1-3***.

Talk about volumes of data and massive computational demands! From sharpening and compression to geocorrection, GeoEye's ingest applications perform a variety of processing steps using that massive amount of raw image data.

A launch like GeoEye-1 can change everything—and without the cloud, there would have been the daunting challenge of generating more capital fast for the multi-processor supercomputers necessary to muscle through this next-gen milestone.

Before GeoEye-1 was launched, GeoEye's leaders had taken those steps back and considered the cost and complexity issues associated with doing business as usual:

a. Infrastructure costs

Between the initial price tag in the millions and recur-

▼ **FIGURE 3**
This image of ocean ice flow around Vladavostok, Russia was taken on Jan. 5, 2009. This is Russia's largest port city on the Pacific Ocean. It is situated at the head of the Golden Horn Bay, not far from Russia's border with China and North Korea. Vladavostok is the home port of the Russian Pacific Fleet. Image is courtesy of GeoEye.

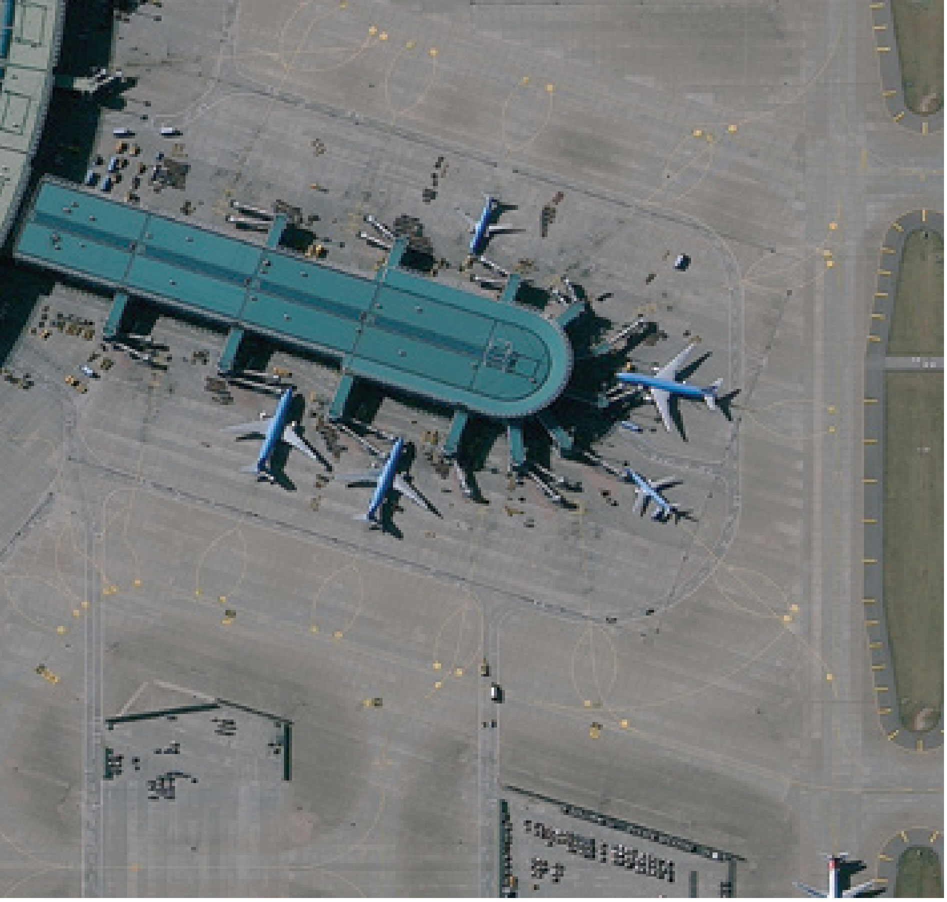
▶ **FIGURE 2**
Seoul-Inchon Airport, Seoul, South Korea, taken by GeoEye-1 on Oct. 29, 2008. Image courtesy of GeoEye.

ring maintenance fees in the hundreds of thousands, purchasing high-end multi-processor servers just would not work.

b. Hardware obsolescence GeoEye's applications are typically deployed longer than the hardware on which they are originally designed to run, so system obsolescence—and the potential need to re-design a deployed application when vendor support for the hardware platform ends—was a real concern.

c. Application development complexity and risks for multi-processor environments Programming for symmetric multiprocessing (SMP) servers requires specialized development skills and prolonged development efforts. GeoEye could put its best mind to this task, but realized its skills were better spent focusing on the company's core value.

d. Platform rigidity Expensive, high-end servers require accurate, upfront forecasting of capability and scalability needs, a requirement that is neither flexible nor realistic.



e. **Innovation limitation** Once GeoEye's images are ingested, they are exploited by downstream applications that turn the images into actionable information. As with improving ingest applications, the high-end server approach creates barriers to GeoEye's ability to innovate new exploitation applications. Developers were forced to conceive of and design applications within the constraints of the infrastructure's limitations, stifling the company's agility.

GeoEye is using the cloud computing Appistry Enterprise Application Fabric (EAF) solution to build its next-generation platform for geospatial intelligence applications. EAF provides the following to GeoEye applications:

- **Application-level fault tolerance** Fabric-based applications derive their dependability from the fabric itself, rather than from the hardware on which they run;
- **Automated management** Application fabrics dynamically discover and assimilate new hardware and software, minimizing administrative and operational overhead; and
- **Scale-out virtualization** Application fabrics can easily scale out across tens, hundreds, or even thousands of commodity computers, yet are viewed and managed as a single system by developers and administrators.

AGI Uses Cloud to Analyze the Situation in Space

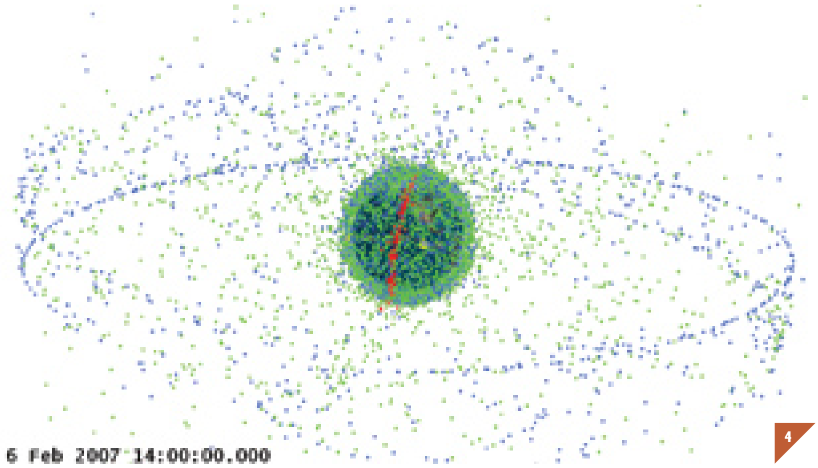
Analytical Graphics, Inc. (AGI) also recently reaped the benefits of the cloud together with Appistry when it took its data-intensive libraries out of a singular group on the desktop and split them into multiple libraries. AGI develops commercial off-the-shelf (COTS) analysis software for land, sea, air, and space that is relied upon by the national security and space communities in more than 35,000 worldwide installations; it is a premier provider of space situational analysis.

For a vivid example: satellites can collide in space, creating debris of all sizes—and AGI handles the precise calculations to determine when that can happen. See ***Figures 4*** and ***5***. Some of the calculations that are involved include satellite orbit determination, navigational accuracy calculations, and dilution of precision (calculating where the navigational data may have lost its accuracy in transfer). AGI and Appistry partnered to create custom and COTS applications based on AGI's Dynamic Geometry Library; these are easily scaled to meet the real-time needs of the applications.

In lifting their application out of the desktop and separating it into more easily usable, more efficient pieces, AGI looked for ways to distribute this code among a range of machines to support it. The pieces are distributed across the fabric, which gives AGI's customers the ability to provision their systems only as needed, and also opens up an opportunity to reduce their reliance on those high-end multi-processor servers that they had previously needed.

Appistry was asked to provide a proof-of-concept, working with AGI tools to create the user interface, back-end processing, and necessary algorithms to be cloud-supported. AGI has found that their calculations now get back to the user more quickly, and their system boasts better fault-tolerance. If one machine fails, there's always a back-up.

AGI's customers are in the environment today where occasionally they may need the massive processor, but in the next five days they may need only a



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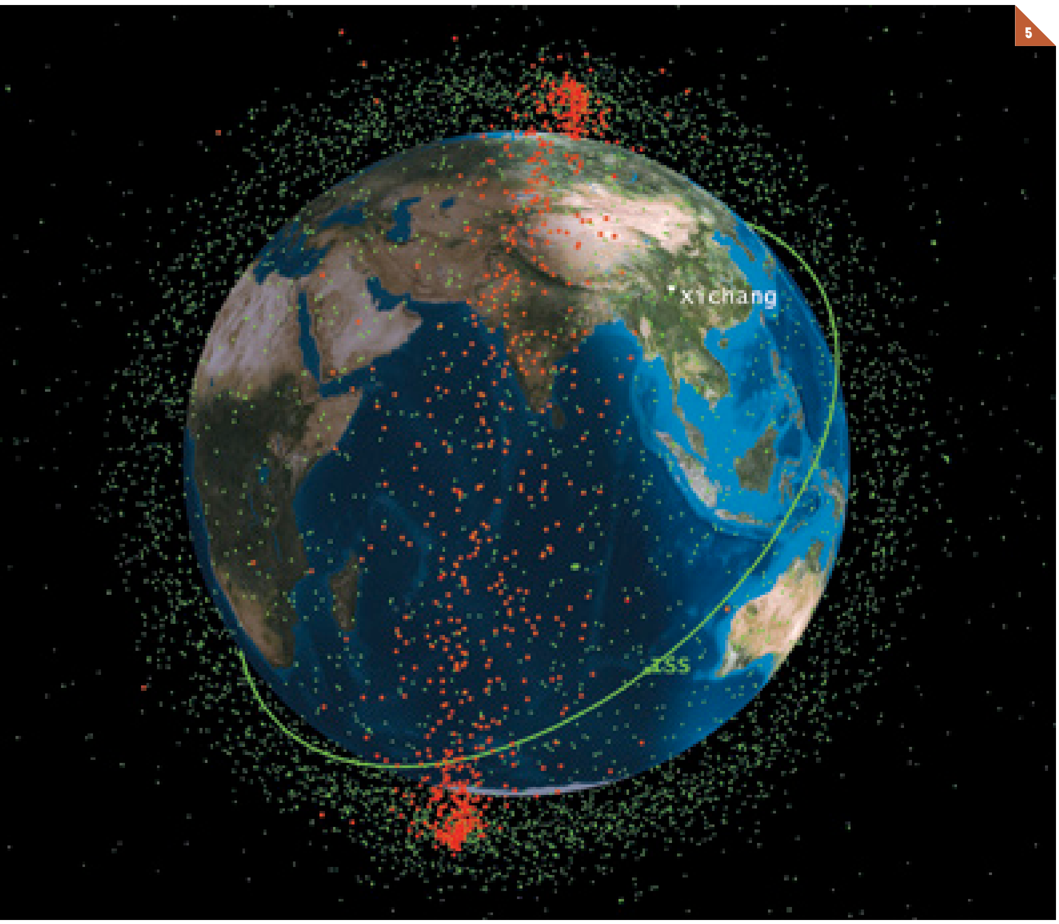
◀ **FIGURE 4**
AGI software assesses potential collisions of all space objects simultaneously. Image courtesy of Analytical Graphics, Inc.



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▼ **FIGURE 5**
This screen shot from an AGI viewer file shows a view of low Earth orbit satellites (green) and the space debris ring (red) from the Chinese satellite that they destroyed on January 11, 2007. The Xichang Space Center is also shown. This STK-generated image is courtesy of CSSI (www.centerforspace.com), and also appeared in our Summer 2007 issue in the article, Code Red: China's Threat to EO Sats from Space Debris.

little of it. The fabric helps AGI's customers conserve resources when it's not necessary to have them; it also knows when something needs more resources and it provides those right away. Using cloud computing allows delivery of the technology on any platform and in any form factor.

Next stop: space debris—a bigger universe for sure. Will more machines be needed for processing? Yes—and AGI can just plug them into the cloud.

THE BIRD'S-EYE VIEW REVEALS A FUTURE OF OPPORTUNITIES

Key benefits of cloud computing include effortless scaling of the environment with no changes to the application's code base, enhanced reliability because hardware failures never impact completion of in-process application tasks, and reduced hardware and maintenance costs, with estimates showing that a single high-resolution image processing application running on cloud computing will save 88% in hardware and software acquisition costs and 58% in three-year recurring costs.

In addition, greater simplicity of development allows developers to focus on honing algorithms rather than on programming structure, and hardware obsolescence is eliminated with the machine-independent nature of cloud computing.

Using cloud computing, AGI and GeoEye may have created a "future-proof" environment. GeoEye and AGI not only can serve current customers better and more profitably, but also can grow their business in new directions with the only limitation being the companies' imaginations about how they can exploit their assets. With cloud computing, the sky's not even the limit. The limit hasn't been located yet, and we don't recommend breath-holding. ⪡

NOTE See also Next-Gen Mapping (Fall 2008), *Nuages: Innovations in the Clouds: A New Geo Marketplace* at www.imagingnotes.com/archive.

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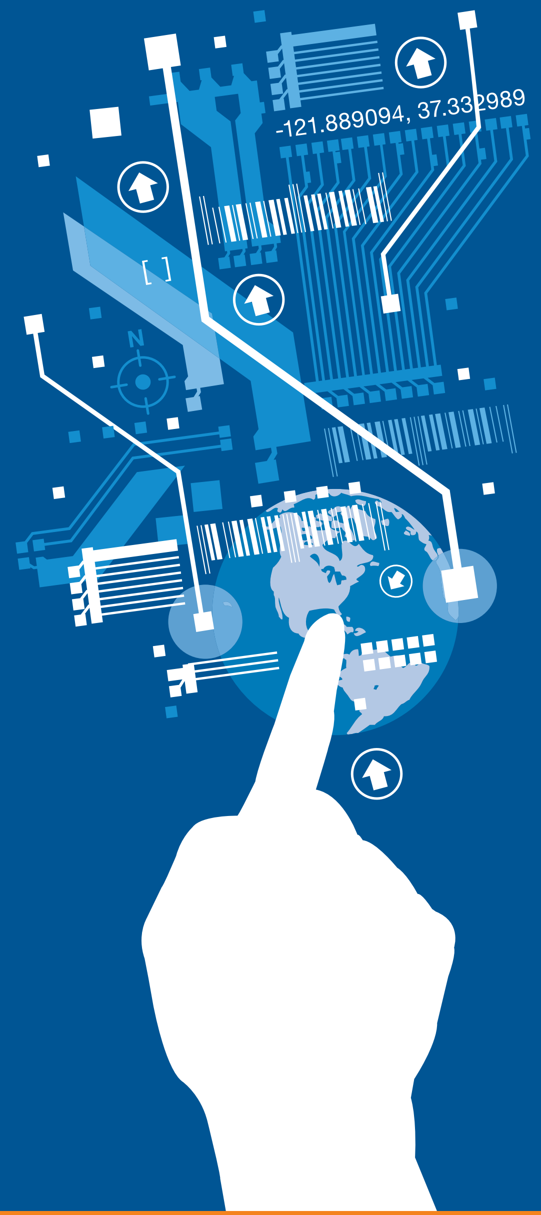

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Web Services for Imaging Workflow "Chaining"

GEOPROCESSING TECHNOLOGY STAKEHOLDERS ARE WORKING TOGETHER IN the OGC and other standards development organizations to create an open Web standards framework for discovering, evaluating, accessing, processing and displaying imagery and other kinds of geodata. Despite the complexity of Earth imaging, "service chaining" that involves Earth imaging is moving forward rapidly and is being exercised and demonstrated in multiple projects.

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What is "Image Service Chaining"?

Web services are the latest, most complete realization of the idea that "the network is the computer." Actions that previously took place only inside a computer across the computer's motherboard or backplane can now be programmed to take place across the Internet. Almost all designers and developers of major enterprise information systems are implementing or planning "service oriented architectures" (SOA) that use the public Web and/or enterprise intranets for communicating between distributed clients and servers.

Think of the old paradigm as file-based computing and the new paradigm as Web service-based computing. In the old paradigm, we pass large data files and load them in their entirety into standalone software systems. In the new paradigm, we pass queries that return the results of services that execute on remote Web servers.

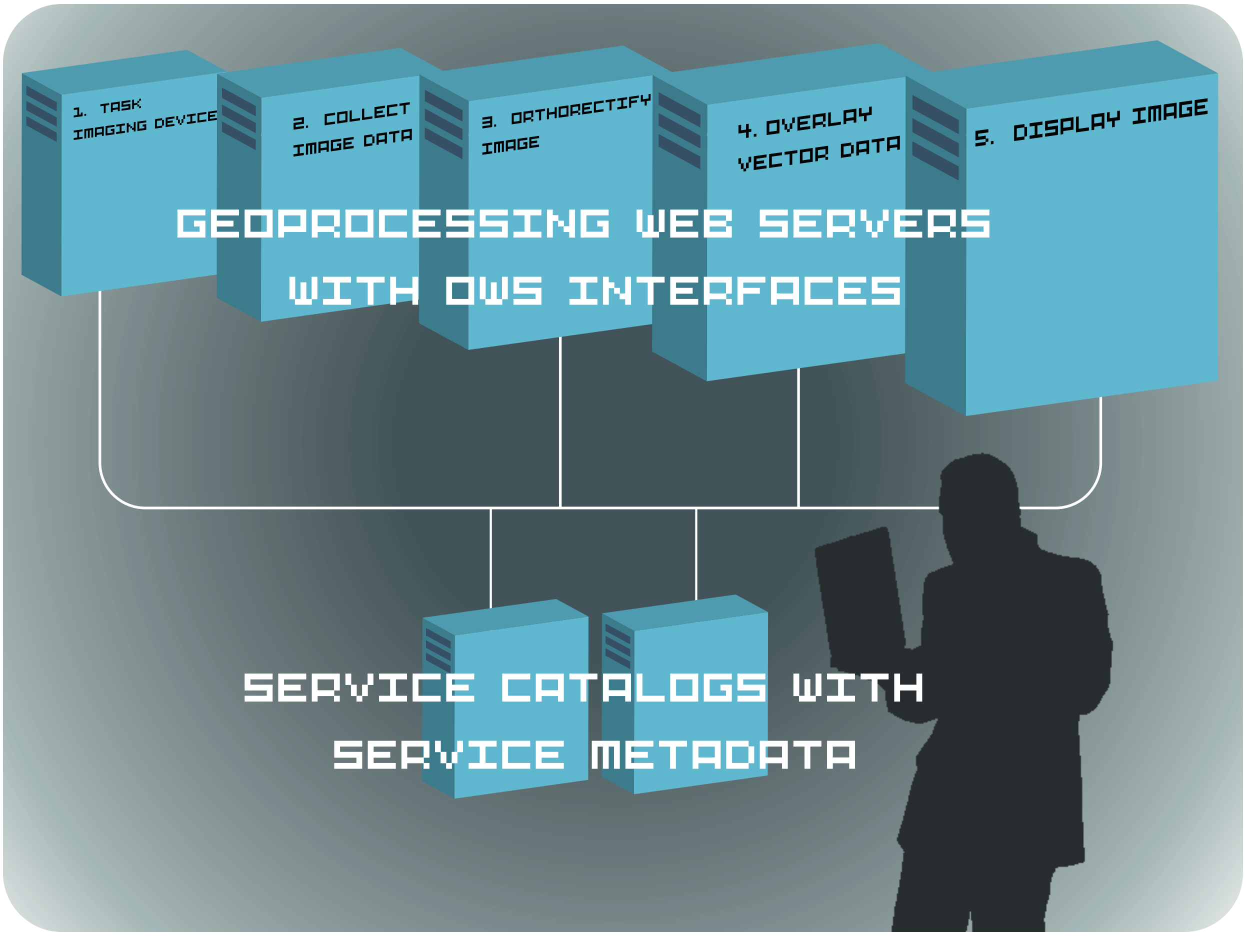
In the old paradigm, we use the Internet (or LAN or physically transported storage media) to obtain a large data file from which we then painstakingly extract information. In the new paradigm, we reach across the Web to get just the information we request. For example, Earth browsers enable anyone with a Web browser to access huge spatial databases to get a particular result—typically a map view—without downloading the whole database. The user gets an answer, not a file.

"Service chaining," one of the key benefits of the new paradigm, involves Web services that invoke other Web services. In the old paradigm, software programs invoke subroutines to provide particular kinds of processing on the local host. Interfaces are important: The subroutines must be called in a specific way, provide certain kinds of data in a list of parameters, and return certain kinds of data in a list of parameters. Subroutines can invoke other subroutines.

In the new paradigm, a software program that is a Web client calls a Web service that's available at a particular URL. Interfaces are important here, too: The Web-based query must be done in a specific way, and the Web service must be provided with certain data in a list of parameters. The invoked Web service might call another Web service, just as one subroutine can call another, except that, if the interfaces are open, the Web services do not all have to be provided by the same software vendor, as they do in the old paradigm.

Web services, like stand-alone software packages and their libraries of subroutines, can be completely proprietary, with unpublished interfaces that let the software provider control who can "play" in the bounded environment of that software product or Web service "walled garden." But proprietary interfaces are part of the old paradigm. Open interfaces make full use of the potentials of the new paradigm. Each Web service can be a "black box" running proprietary algorithms, and yet, through open interfaces, that service can be accessed by anyone or any remote client with permission to use it.

Geoprocessing service chaining involves Web services that perform processes that include any algorithm, calculation or model that operates on spatially referenced data. These are tasks that we normally associate with GIS, remote sensing, location services, navigation, etc. These Web services usually depend on OGC Web Services (OWS) standards and Sensor Web Enablement (SWE) standards developed in the OGC's consensus process in collaboration with other standards organizations



▲**FIGURE 1**
In this example of geoprocessing Web servers with OWS interfaces, five chained services reside on five different servers.

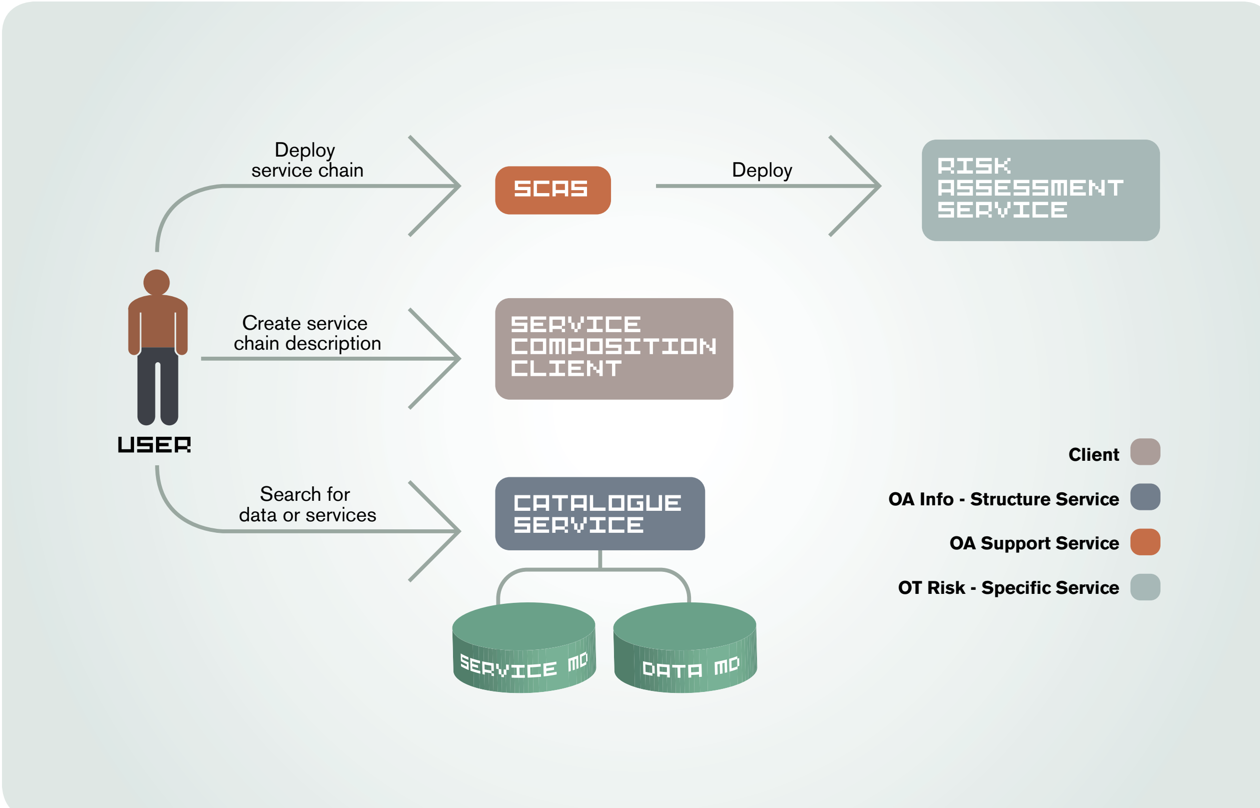
such as ISO (International Organization for Standardization), W3C (World Wide Web Consortium) and OASIS (Organization for the Advancement of Structured Information Standards). OWS and SWE standards specify interfaces, encodings and best practices for open geoprocessing Web services. Image service chaining is usually service chaining that involves image-related OWS and SWE standards.

Many of the vector and raster geoprocessing service chaining activities to date involve the OpenGIS Web Processing Service (WPS) Interface Standard. WPS defines a standardized interface that facilitates the publishing of geospatial processes and the discovery of and binding to those processes by clients. Publishing means making available machine-readable binding information, as well as human-readable metadata that allows service discovery and use. WPS provides mechanisms to identify the spatially referenced data required by the calculation, initiate the calculation, and manage the output from the calculation so that the client can access it. The WPS specification is designed to allow a service provider to expose a web-accessible process in a way that allows clients to input data and execute the process with no specialized knowledge of the underlying process. The WPS interface standardizes the way processes and their inputs/outputs are described, how a client can request the execution of a process, and how the output from a process is handled.

A user or a user's application finds appropriate Web services via a catalog and then chains the Web services to perform a repeatable multi-step operation. See ***Figure 1***.

An ORCHESTRA Geoprocessing Service Chaining Example

ORCHESTRA, a major European "integrated project" under IST-FP6, was undertaken to improve technical interoperability for risk management. The project developed a service-oriented architecture for risk management based on open standards, together with a software infrastructure for enabling risk management services. The ORCHESTRA architecture is a platform-neutral (abstract) specification based on Web service specifications of the ISO, OGC, W3C and OASIS. Three Orchestra pilots were organized to provide practical tests and demonstrations of what could be accomplished using this architecture. One goal was to define workflows



▲**FIGURE 2**

In one ORCHESTRA scenario, a user first finds data and services by means of a Catalog Service containing metadata about available data and services, then creates a service chain and deploys it to a Service Chain Access Service (SCAS), which deploys the service chain as multi-component Risk Assessment Service.

that combine several services into one value-added service chain that achieves a certain goal, as shown in ***Figure 2***.

OWS-6 Testbed Activity

Some OWS standards, such as the OpenGIS® Web Map Service (WMS) and Web Feature Service (WFS) interface standards, are implemented in hundreds of products. Others, including those focused on service chaining, are currently implemented mainly in experimental settings, such as the OGC Web Services - 6 (OWS-6) testbed activity. OWS-6 includes a Geoprocessing Workflow thread that involves service chaining with particular emphasis on ensuring authenticity, integrity, quality and confidentiality of services and information in OWS service chains. Conflation and Grid processing use cases are being explored.

EC08 OGC Pilot

The recent Empire Challenge 08 (EC08) OGC Pilot was a multivendor demonstration of workflow that demonstrated the “chaining” of Web services in an Intelligence, Surveillance and Reconnaissance (ISR) scenario. The demonstration involved off-the-shelf software that implemented standard interfaces and encodings to task and control an airborne or spaceborne imaging device, collect the data, orthorectify it, and display it in a single frame, all in near-real time.

Ocean Observation Community

In January 2007, members of the OGC launched the Ocean Science OGC Interoperability Experiment (Oceans IE) (http://www.opengeospatial.org/projects/initiatives/oceansie) to study implementations of OWS standards and SWE standards (and complementary standards from organizations including the ISO, IEEE, and OASIS) being used by the international ocean-observing community. More than a dozen ocean observation initiatives are using these standards, including regional application-oriented organizations such as the Gulf of Maine Ocean Observing System (GoMOOS) (www.gomoos.org/), the open-source, community-oriented OOSTethys (www.oostethys.org/) initiative, and others such as:

- In the US, the NOAA IOOS program made a recent decision to leverage the OGC's Sensor Web Enablement (SWE) standards as the basis for interoperability of sensors (http://ioos.noaa.gov).

- SURA Coastal Ocean Observing and Prediction (SCOOP - http://scoop.sura.org/) and the related community initiative: www.openioos.org.
- Interoperable GMES Services for Environmental Risk Management in Marine and Coastal Areas of Europe (InterRisk - http://interrisk.nersc.no/).

GEOSS

The Global Earth Observing System of Systems (GEOSS) is being developed by the Group on Earth Observations (GEO) (www.earthobservations.org), a partnership of 126 governments and international organizations. Through agreements on technical standards and through institutional coordination on policies, the governments are making available on Web servers a very large collection of geospatial data, including live sensor data and stored geodata of many kinds. The goal is to improve understanding and capacity in dealing with challenges involving disasters, health, energy, climate, water, weather, ecosystems, agriculture and biodiversity. OGC is leading the GEOSS Architecture Implementation Pilot.

GEOSS and the service chaining it will support are attractive to scientists because the Earth itself is a system of systems, and modelers increasingly seek to "couple" systems to see how Earth systems interact with one another. Governments look forward to decision support systems that will be able to draw on a rich collection of data and processing resources.

Image Georeferencing: A Key but Complicated Link in Imaging Service Chains

In many cases, it is important to compare extracted ground positions to positions that were previously or subsequently measured in other images or that were obtained by cadastral surveys or GPS. Georeferencing is the process of assigning, or reassigning, geographic coordinates to an image. Georeferencing simplifies both the comparison of overlapping and adjacent images and the measurement and comparison of ground positions. Initial georeferencing coordinate transformations often need improvement to increase ground position accuracy and to reduce position differences between overlapping and adjacent images.

Remote sensing practitioners also perform image georectification (or orthorectification) using georeferencing coordinate transformation. This involves shifting pixel locations to remove distortion. Often the process of georectification includes georeferencing, because one can both shift the pixels to remove distortion and assign coordinates to those pixels at the same time.

OGC Web Service standards and Sensor Web Enablement standards offer several ways to accomplish these tasks, although not all of the relevant standards have been adopted yet by the OGC members, and there are competing ideas among Technical Committee participants regarding best approaches.

Georectification can be performed by the relatively new OpenGIS Web Coverage Service (WCS) Interface Standard 1.1. New extensions of WCS 1.1 include:

1. the transaction extension (WCTS), which allows input of new images, and
2. a new processing extension for subsequent retrieval, georectification, and processing of image parts that allows modification of retrieved pixel values, such as for image enhancement or classification of ground cover.

Georeferencing coordinate transformations can be defined by the OpenGIS Geography Markup Language (GML) Encoding Standard (in accordance with ISO 19111) or by the OpenGIS Sensor Model Language (SensorML) Encoding Standard. SensorML specifies an XML encoding framework within which the geometric, dynamic, and observational characteristics of all types of sensors and sensor systems can be defined, from simple visual thermometers to complex earth-observing satellites. Most of the experiments on image service chaining have utilized SensorML and other approaches such as Business Process Execution Language (BPEL).

A proposed Image Georeferencing Service (IGS) standard in the OGC improves georeferencing coordinate transformations by triangulation and uses georeferencing coordinate transformations defined by an Image Georeferencing Metadata (IGM) application profile of GML. The proposed IGS and IGM standards came close to adoption in 2008, but they are now being improved before re-consideration. OGC members are in the process of introducing a SWE version of WPS that will be in harmony with SWE and could provide a more harmonious and common foundation for image processing services. The SWE-WPS would support service chaining of sensor data, including georectification and other data.

Though work remains in finalizing the georeferencing approaches, this is a major step forward for Web-based processing of Earth images.

Many of the manual tasks involved in Earth imaging can be accomplished by Web services working together in an automated fashion to provide information requested directly by users or by computer models or decision support systems. All of the standards in the "OGC Baseline," or collection of OGC standards (www.opengeospatial.org/standards), can provide links in these Web service chains.

Looking ahead, service chaining will support workflows that involve geospatial rights management, Earth browsers, data preservation, data quality, geosemantics and other concerns. These are all elements in the foundation that is being built for a new era in which Web-based geoprocessing, including chained Web services that operate on images, will be the norm. «

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USGS announced that all Landsat data now can be downloaded for free from the archive. Go to http://glovis.usgs.gov or http://earthexplorer.usgs.gov.

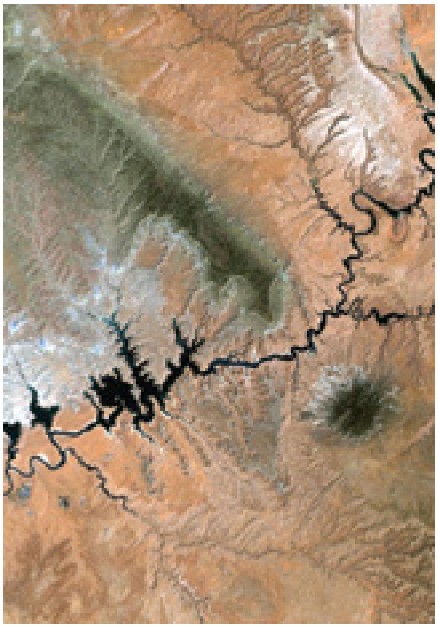
multi-temporal Landsat scenes allow scientists to discover and highlight environmental security issues associated with phenomena such as desertification and deforestation, and those stemming from changes in land use and fresh water resources. Many technical papers were presented highlighting these applications, which of course is the main purpose of the symposium. The celebrations were just a plus this year.

I personally, through the Landsat Legacy Project – a project dedicated to writing the history of the Landsat program as seen through the lenses of technology change and the evolution of the satellite concept into a true global observing system – was elated to interview a few of the early pioneers of the ERTS program, capturing their oral histories on video for posterity and future historians. Those interviewed included past Pecora Award winners such as John DeNoyer, Al Watkins, and Vince Salomonson, and instrument engineer Virginia Norwood, whose 'banging mirror' design has proven to be the on-orbit workhorse of the Landsat program. The programmatic struggles and technical innovations and risks that marked the ERTS era provide a backdrop for the lessons being learned today for LDCM and the future of land imaging.

The 25th anniversary celebration for Landsat 5 on the final evening included, not just symposium attendees, but also the operations teams, and engineers from then General Electric, now Lockheed Martin, who came to celebrate the engineering marvel that Landsat 5 has become. Albeit, one can also point to Landsat 5's longevity as a contributing factor to the indecision about launching LDCM. This indecision will, more than likely, break the continuity of the program, since it will take a few years for LDCM to be launched and operable, and meanwhile, the currently operating Landsat satellites could become inoperable at any time.

Decision makers tend to look at Landsat 5's on-orbit life with the expectation that others will match it, rather than recognizing it for the exceptional engineering feat that it is. Still, you could feel the pride in the room, and it was well earned. «

▲FIGURE 1
Belize, South America, taken by Landsat 5. Image courtesy of USGS.



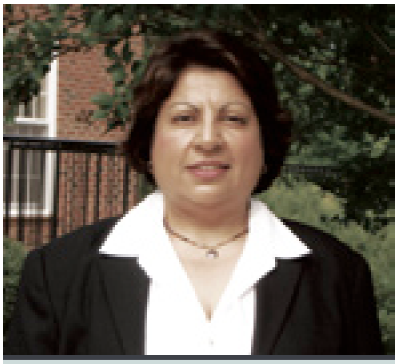
▲FIGURE 2
Lake Powell, Utah, taken by Landsat 7. Image courtesy of USGS.

Finally, A Bright Future for Landsat

A PECORA SYMPOSIUM SUMMARY

HINDSIGHT GUEST EDITORIAL

In November 2008, I attended one of the most positive land remote sensing symposia conducted in years. The pall that had fallen over the community since 2003 and the fog of uncertainty over the future of the program are finally lifting. There is a new spirit of optimism in the air for land remote sensing and it was evident at the 17th William T. Pecora Memorial Remote Sensing Symposium that took place in Denver, Colorado. From the opening session, which celebrated the vision of William Pecora and Stewart Udall in a poignant video entitled *An Idea That Worked*, to the technical sessions describing the expected improved performance of the Landsat Data Continuity Mission (LDCM) over that of Landsat 7, the positive energy was palpable.



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Some of the excitement stemmed from the celebratory looks to the past honoring the visionaries who initiated the civilian land remote sensing program, and from the technological achievement of Landsat 5 reaching its 25th year of continuous on-orbit operations and observations. The rest of the excitement came from looking forward. After many years of indecision about the next Landsat mission – first looking at a commercial data buy, then a public-private partnership, then a Landsat instrument on an NPOESS platform – we now finally have a funded, free-flying satellite mission that is being developed and looking quite promising. The 'cherry on top' for the week, which delighted me and many other users of Landsat data, was the announcement by the U.S. Geological Survey (USGS), that all Landsat data now can be downloaded for free from the archive. From the inception of this program on Oct. 1, 2008 through Jan. 9, 2009, over 225,000 scenes have been downloaded from the Landsat 7 archive.

In looking back and honoring the work of the pioneers in the field, one realizes that the ideas of the visionaries have come to fruition through not just hard work, but also perseverance in the face of almost constant programmatic turmoil. The symposium is named after Dr. Pecora who, along with Secretary of Interior Stewart Udall, envisioned a civilian Earth observing system that in 1966 was announced as Project EROS – Earth Resources Observation Satellites. They imagined government-funded satellites carrying remote sensing instruments as a public good, the data from which would be openly distributed and used to gather facts about the natural resources of our planet.

The 1966 announcement stimulated a partnership between NASA, the Department of Interior, and USGS, that resulted in the 1972 launch of the first Earth Resources Technology Satellite (ERTS), later named Landsat 1. The first Pecora Award was presented in 1974, two years after William Pecora's untimely death at age 59, just a few days before the launch of the first ERTS.

It was both in looking back at the contributions of many and in looking toward the future of land imaging that so much optimism and good will were generated by symposium attendees. The week-long event reflected a pride that comes from a program celebrating 40 years of success and a future bright with a new satellite development effort, new data distribution policies, and plenty of new applications.

It is through such longevity that applications have continued to flourish in areas related to human security. USDA's crop monitoring program and Foreign Agricultural Service (FAS) continue to generate crop predictions that focus policy makers and aid agencies on issues of food security. USAID uses their crop predictions for the African continent to anticipate famine when crop yields are low, allowing food aid to be planned and sent in a timely manner.

Climate change researchers also benefit from the continuity of the program and its long-term archive. Direct change techniques comparing