Imaging NOTES

Summer 2009
Vol. 24 >> No. 3

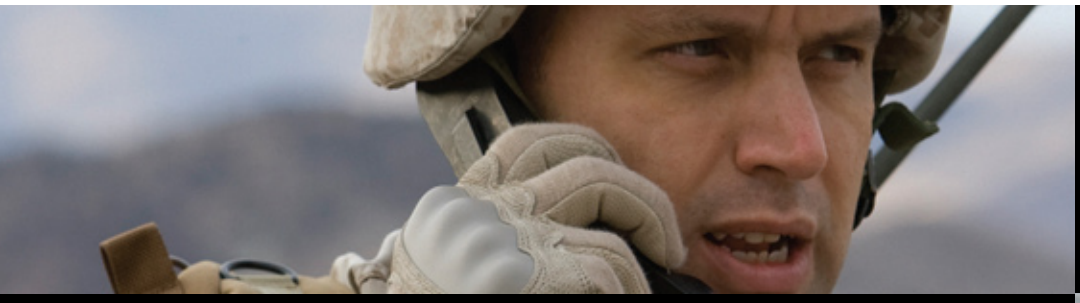
EARTH REMOTE SENSING
FOR SECURITY
ENERGY AND
THE ENVIRONMENT

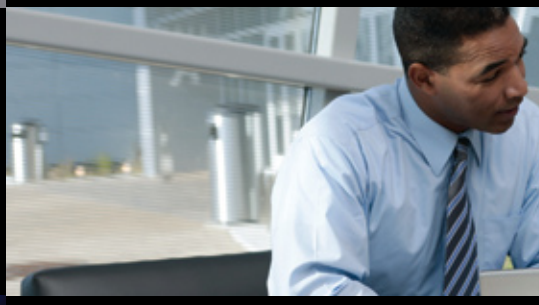
Voluntary Carbon Markets

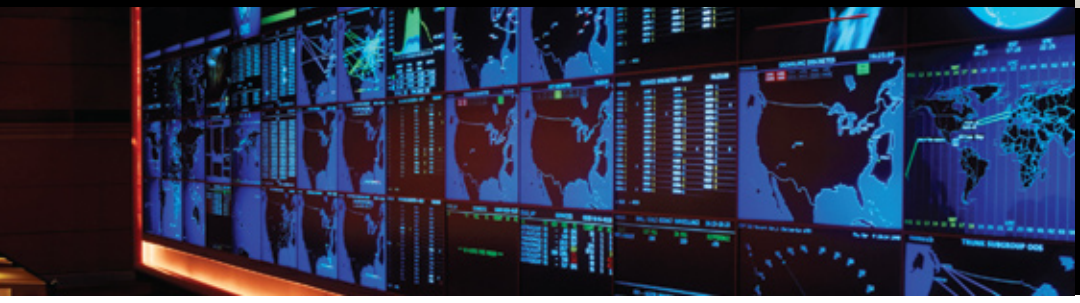
3D ROI

TRANSPARENCY

U.N. USE OF EO







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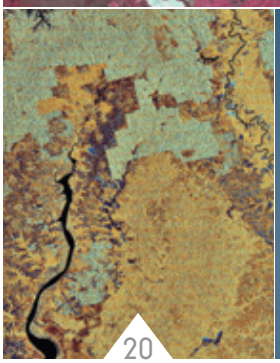

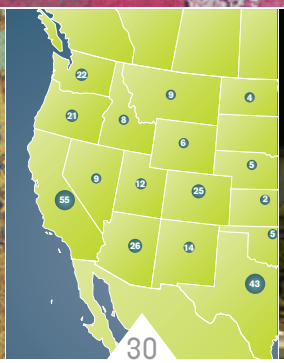

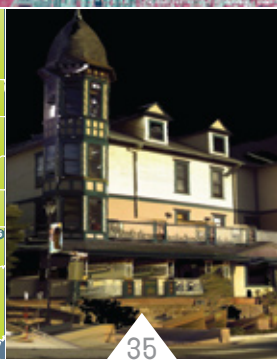

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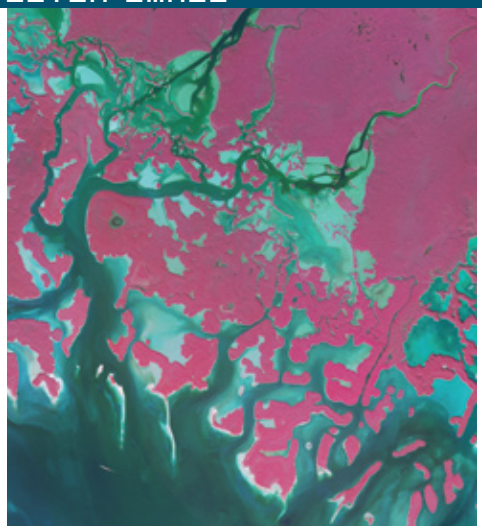
South Florida from the Air

COVER IMAGE



This color infra-red orthoimage of the Royal Palm Hammock quadrangle is located a few miles west of the Everglades National Park, in Collier County on the Gulf coast of Florida. The image was collected at a 1-meter pixel resolution in December 2004, using a Leica ADS40 airborne digital imaging sensor, as part of the statewide mapping program for Florida covering approximately 54,000 square miles. This image is provided courtesy of the South Florida Water Management District and the USGS. It was acquired and processed by Fugro EarthData.

This program was sponsored by an alliance of the state's water management districts and the USGS. At the time, it was one of the nation's first large-scale acquisition efforts that took advantage of the ADS40 sensor's ability to generate both natural color and false color renditions simultaneously. To accommodate the full range of data products requested, a total 16,800 individual map tiles were produced. A total of more than 3 terabytes of image data were delivered to the USGS and the five water management districts.

The water modeling article on page 26 includes this project.

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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).

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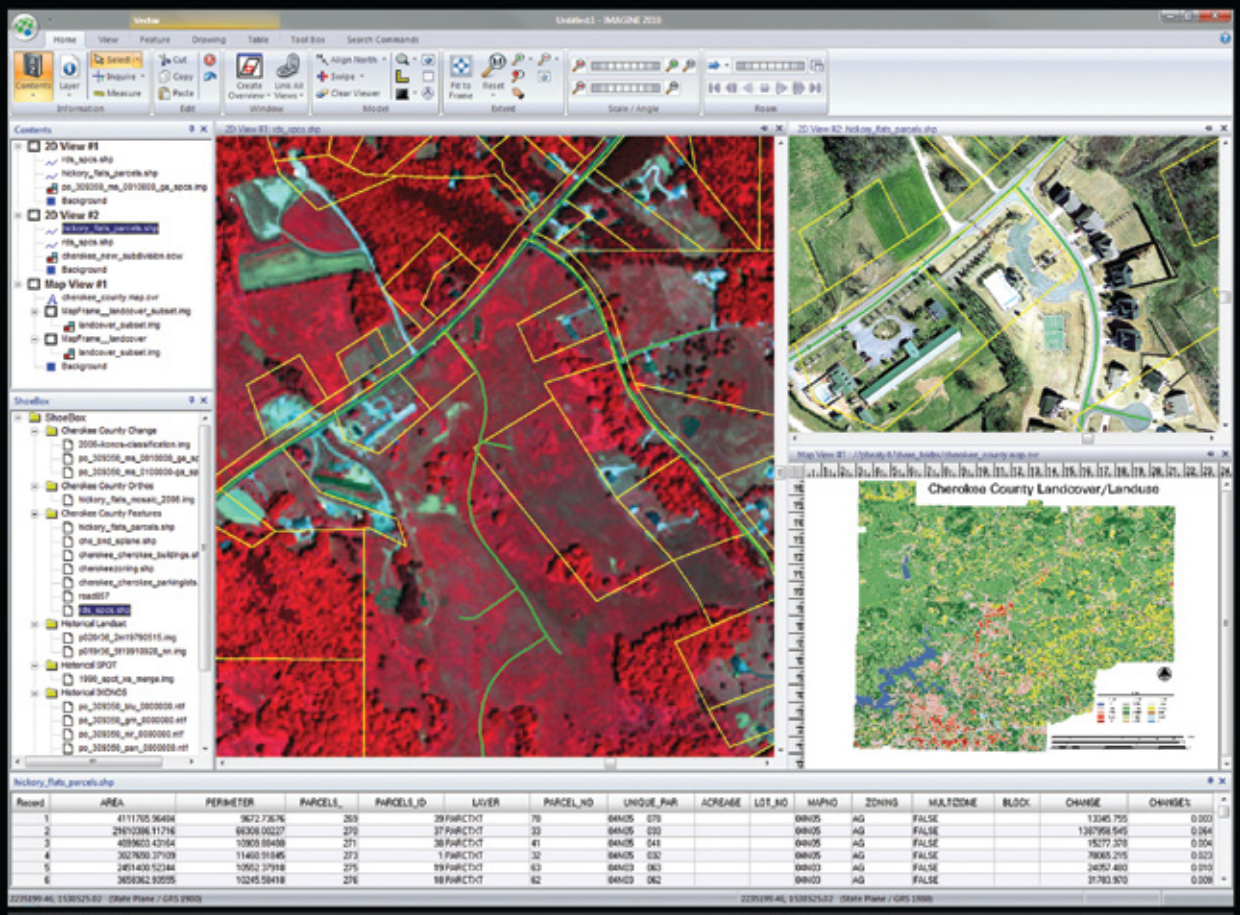

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LOCATION IN THE LANGUAGE OF BUSINESS

Dear Remote Sensing Professionals,

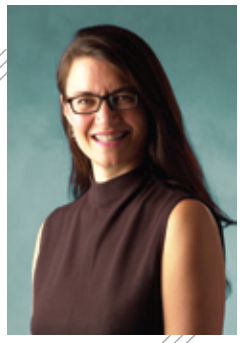
The *Imaging Notes* team is thrilled to provide you with a complimentary copy of our launch issue of our spin-off publication, *LBx Journal*: Location in the Language of Business. Enjoy this copy, and pass it along to someone who is the ideal reader: Business leaders who are exploring the untapped business potential of location intelligence, and geospatial professionals who are seeking that new business customer.

LBx is a multi-media resource about location intelligence for the business user. We launched in print at Where 2.0 (an O'Reilly Conference on all things digital mapping) and online at the ESRI User Conference! Our website is rich and interactive, with many new opportunities to share your business needs and wants, from posting marketing materials and white papers to actually connecting with customers via our *LBx* Network and Virtual RFP process. Subscribe and join our community at www.lbxjournal.com.

In this issue of *Imaging Notes*, our Next-Gen Mapping column asks questions about transparency and its effect on business. This article will also be interesting to the *LBx Journal* reader, with its commercial applications.

Meanwhile, *Imaging Notes* is still committed to the geospatial and remote sensing professionals. We will continue to provide all original content for each issue—a feat that most major newspapers cannot perform these days. We do not reprint any material from any other source; every story is written for *Imaging Notes* exclusively.

Two of those original articles in this issue come from the perspective of the United Nations. One is about voluntary carbon markets versus those that are Kyoto-compliant, by Anna Burzykowska of the YGT European Space Agency. The other is the Secure World Foundation Forum, where editor Ray Williamson shares that various U.N. Committees use Earth observations in more ways than you might expect.



Renew *Imaging Notes* now! It is still free of charge; do not lose your subscription. If you do not renew annually, you will not get the magazine.

Rod Franklin's report on justifying an investment in 3D from an ROI perspective is intriguing. We also provide an update on water modeling and mapping, an increasingly important issue as less fresh water is available globally. Finally, Karen Nozik does an in-depth report on education, reporting that universities are working hard to keep up with changing technologies, and that the workforce needs people who can think spatially, and who can really understand what can be done with all that data!

Join us at GeoWeb in Vancouver, and at the Symposium on Digital Earth in Beijing. With so many geospatial technologies and applications moving to the Web, from cloud computing to the Sensor Web, to SaaS (software as a service) making it less expensive, both gatherings promise serious intellectual stimulation and high-level contacts.

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As always, thanks for reading.

–Myrna James Yoo
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Remote Sensing Capacity Building and the United Nations

SECURE WORLD FOUNDATION FORUM

This June, I spent nearly two weeks at the meeting of the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS), which meets in Vienna, Austria annually. In that meeting and the associated Scientific and Technical (S&T) Subcommittee and Legal Subcommittee meetings held earlier in February and March, respectively, delegates from 69 States met to share information, work out cooperative programs, and study legal problems that arise in the exploration and use of outer space.

In 1967, COPUOS, which was set up by the U.N. General Assembly 50 years ago, worked out the international treaty that provides the legal underpinnings of all space activity, the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, otherwise known as the Outer Space Treaty (OST). This is the treaty that makes remote sensing of Earth's environment and human activity on the planet truly useful.

The first two articles of the treaty contain the following key statements:

- **Article I:** Outer space, including the moon and other celestial bodies, shall be free for exploration and use by all States without discrimination of any kind, on a basis of equality and in accordance with international law, and there shall be free access to all areas of celestial bodies.
- **Article II:** Outer space, including the moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means.

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 (http://www.SecureWorldFoundation.org).

Although States still cannot agree on precisely where air space ends and outer space begins, all are nevertheless bound by the treaty, which entered into force at the time of its inception in 1967, and no State can successfully claim jurisdiction over parts of orbits that pass over its territory. This provision helped keep the peace during the depths of the Cold War by allowing U.S. and Soviet satellites to pass unhindered over each other's territories, providing verification of the number and placement of ballistic missiles in each country. This same provision, of course, makes possible the operation of the many different types of Earth observing satellites that countries and private companies operate today.

This year, during both the S&T Subcommittee meeting in February and the plenary meeting in June, I was struck especially by the frequent mention of Earth observations and the benefits they provide. According to statements offered at these meetings, many member States make enormous use of Earth observations data to support different aspects of human and environmental security needs. Others, however, spend more time focused on the need to build capacity for employing the data effectively.

What might surprise many readers is the fact that the United Nations itself employs the data gathered by different countries to support public needs, from tracking the spread of vector-borne disease to responding to natural disasters. According to the United Nations, about 24 U.N. entities make routine use of space applications, mostly employing information derived from Earth observations data. Investigating these uses in detail takes one into a dizzying array of acronyms, all beginning with the letters U.N.

U.N. HIGH COMMISSION FOR REFUGEES (UNHCR)

The United Nations' broad use of Earth observations follows from the broad scope of the United Nations' mandate, which covers most human and environmental needs, with a special emphasis on the needs of citizens within developing States. For example, this year the offices of the UNHCR began a pilot project on the use of aerial and satellite imagery for studying human migration, which is most often seen in internal displacements such as has taken place recently in Pakistan as serious fighting began between the Pakistan Army and the Taliban insurgents in the Swat Valley of Pakistan.

The UNHCR study will compare current and past satellite images, mapping

▲ FIGURE 1
U.N. building in Vienna, Austria. Photo credit: Agnieszka Lukaszczyk.

changes in land use and determining patterns of natural resource extraction. The organization will also map refugee camps in order to facilitate delivery of humanitarian aid to the inhabitants. Mass population dislocations can exact a considerable toll on the environment. Such studies can be enormously useful in helping UNHCR to develop appropriate methodologies for finding appropriate sites for refugee camps, in addition to aiding the delivery of food, water, and services to refugees.

Refugees in urban settings pose a particular challenge to aid agencies because of the density of habitation. UNHCR has used satellite imagery to help map refugee populations in the sprawling cities of Cairo, Damascus and Nairobi.

U.N. OPERATIONAL SATELLITE APPLICATIONS PROGRAMME (UNOSAT)

Another element of the United Nations is the U.N. Institute for Training and Research (UNITAR) Operational Satellite Applications Programme (UNOSAT). Since its inception, UNOSAT has developed more than 900 operational maps and associated analyses to assist human security and humanitarian assistance. UNITAR provides applications training related to peacekeeping and preventive diplomacy and also supports training for local authorities in disaster prevention and vulnerability reduction.

U.N. FOOD AND AGRICULTURAL ORGANIZATION (FAO)

In addition to these efforts, the U.N. Food and Agricultural Organization (FAO) makes extensive use of NOAA's National Polar-orbiting Operational Environmental Satellite (NPOES) imagery to warn farmers in Sub-Saharan Africa of impending drought or rainy seasons.

MAJOR NEED OF CAPACITY BUILDING

In making effective use of Earth observations data, developing countries face the severe difficulties of a lack of training in the effective use of satellite data and of appropriate computer hardware to operate the necessary analytical software—in other words, they need training in capacity building. Hence, in the past two decades, the United Nations has created or assisted in the development of a number of U.N.-affiliated organizations to provide training. For example, the U.N. Office of Outer Space Affairs (UNOOSA), which also serves as the secretariat for COPUOS, holds a series of training seminars and conferences each year in developing countries.

Finally, the United Nations was instrumental in setting up training centers for space science and applications in Africa, Asia, and Latin America. These affiliated training centers offer a variety of courses in order to strengthen the space capabilities of their regions. Africa hosts two regional education centers, the African Regional Center for Space Science and Technology Education, one in French in Rabat, Morocco, and one in English in Lagos, Nigeria. Between them,

▼ **FIGURE 2**
A COPUOS session meeting at the U.N. being led by current Chairman of the Committee, Ambassador Ciro Arévalo of Colombia. Photo credit: Ray Williamson.

2

these two centers serve respectively the Francophone north and the largely English-speaking south of Africa.

The single Asian Center for Space Science and Technology Education in Asia and the Pacific is located in the campus of the Indian Institute of Remote Sensing, Dehradun. In Latin America, the Regional Centre for Space Science and Technology Education in Latin America and the Caribbean boasts two locations: one in Puebla, Mexico, on the campus of the National Institute of Astrophysics, Optics and Electronics, and another in Santa Maria, Rio Grande do Sul, Brazil, in the facilities of the National Institute for Space Research. All of these centers provide, among other courses, significant training opportunities in the processing and interpretation of Earth observations data, centered on the regions they serve.

The organizations that I have highlighted provide only a partial view of the extensive use of satellite Earth observations data and information that the United Nations as a whole applies to its work on behalf of the developing world. Nevertheless, this list illustrates just how embedded these capabilities are in the U.N. system. It also illustrates just how far we have come since NASA launched its first electro-optical satellite, Landsat-1 (originally called Earth Resources Technology Satellite, or ERTS) in 1972. Although at the time some U.N. officials could see the promise of the technology for development and for managing Earth's resources, I suspect that few imagined that Earth observations technologies would evolve into these U.N. workhorses. Nevertheless, there is still a deep need to build the capacity for making effective use of the data, and the United Nations has taken that need to heart.

For further information please consult the many reports that can be found at: www.oosa.unvienna.org/oosa/en/COPUOS/copuos.html.

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The Age of Transparency

THE EFFECT ON BUSINESS

NEXT-GEN MAPPING

A transparent world is a frictionless world of information. In this world, almost any piece of information can be connected instantaneously and made visible to the public by various people, ranging from those who are simply curious and bored to those who have a clear mission. Satellite imagery and global transparency relative to government accountability and international security have been discussed for years, including the role of satellite imagery in news reporting.

In addition, satellite imagery in the context of competitive intelligence for businesses has been raised by the Society of Competitive Intelligence Professionals on occasion in the past but has not garnered much attention recently. Our editor Ray Williamson and others have talked about imagery activists since the advent of commercial satellite imagery. Google Earth and other virtual globes have democratized the use of satellite imagery to extend its use to multiple groups, from kids looking for the closest Starbucks and tracking their friends to activist groups exposing corporate misconduct and environmental degradation. Satellite imagery continues to be viewed as the ultimate reconnaissance tool, because it is unrestricted (for the most part) by jurisdiction and national boundaries.

TRANSPARENCY IS A RELATIVE TERM:

- **It can mean availability of information, meaning that a company or government agency has invested in acquiring a piece of information, for example, the toxic elements in drinking water.**
- **It can mean accessibility, meaning that a company or individual can purchase information available from another source, or a taxpayer can request information in the government domain through a Freedom of Information Act request.**
- **It can mean visibility, meaning that the information is widely distributed and easily understandable, for example through a news broadcast, or interactive map available on Google Earth. A map of data points can convey more visual information than a 20-page detailed report.**
- **It can mean the ability to take action, meaning to file a petition, engage in a protest, or compile a viral Internet campaign.**

What tools enable all four of these elements? The ubiquitous availability of satellite imagery, combined with radical cartography, social networks and multimedia platforms is creating a new source of open intelligence that is not managed by the original creators of the data.

OPEN SOURCE INTELLIGENCE

Traditionally, "intelligence gathering" has been the domain of the military, intelligence agencies, and private investigators. The intelligence community has coined the term open source intelligence (OSINT) to mean a form of intelligence collection management that involves finding, selecting, and acquiring information from publicly available sources and analyzing it to produce actionable intelligence. Military, government and private investigators were once responsible for "intelligence." It is now in the hands of anyone with the ability to do a mashup. Radical Cartography, renovated cartography, neogeography, outlaw cartography, corporate cartography, political cartography, and so on, can be more than disruptive–they can be used to persuade, enlighten, or expose practices that used to be managed behind corporate communication firewalls.

There are no shortages of examples of the use of imagery and mashup to advance environmental and sustainability initiatives. But what about the advance of business? Businesses are just beginning to explore the power of location intelligence for improved performance and decision making. But what has not been discussed is the impact of unmanaged transparency of information on operations, management, marketing, financials and regulatory compliance.

TRANSPARENCY IN BUSINESS

What if a mashup of publicly available market data, economic data, transportation routes and imagery provides more insight on the health of a company than the diligently managed 10Ks, 10Qs, 8Ks and financial analyst reports produced

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. Natasha is also editor of the new spin-off publication, *LBx Journal*.

by armies of accountants, lawyers, and financial analysts? The financial scandals of the early 2000s, such as Enron, Worldcom and Healthsouth, and today's financial crisis demonstrate that those carefully produced reports designed to ensure transparency (at least by the Securities Act of 1934) and an efficient financial market could not be trusted. Will new corporate positions emerge, such as the now familiar "Twitter correspondent" and "blogmaster," for companies to respond to unmanaged transparency?

> The ubiquitous availability of satellite imagery, combined with radical cartography, social networks and multimedia platforms is creating a new source of open intelligence that is not managed by the original creators of the data.

Traditional maps have been storytellers of moments in history. Today's interactive maps are no longer mere snapshots, and tomorrow's maps, which will encompass realtime data feeds from an extensive SensorWeb, will be realtime audits of corporate, government and human activity. Can marketing and communications budgets compete with this realtime storytelling?

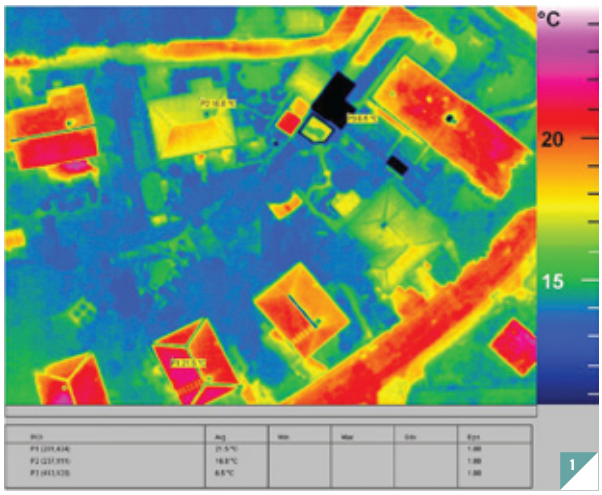
What should be the corporate response to material generated by "Radical Cartography" and its ilk? Two of the unplanned offshoots of ubiquitous satellite imagery and web availability are decentralized activism and open source intelligence, supported by imagery. Anyone can now be their own journalist, private investigator, intelligence analyst, and media platform. With imagery freely available and accessible, and when bundled with multi-platform media, companies have a real issue to address. Despite the securities regulations, the financial markets have never been transparent. In fact, profit often times results from "mystery." What happens in a transparent world?

"The Age of Transparency" is still unfolding, but clearly imagery and GIS have been enlisted as tools to present points of view faster, better, and cheaper than ever before. Don't be surprised at the mashup as an increasingly powerful corporate and government monitoring tool. We anticipate a variety of corporate responses to yet another digital media onslaught (for example peer-to-peer file sharing, blogs, YouTube). This transparency offers an opportunity for companies to leverage this new age of transparency, and to respond more maturely than the music industry did to Napster. (For those of you who may not recall, Napster was the peer-to-peer file sharing program that led to illegal transferring of music files. The music industry's response was to sue mostly teenagers and students. After close to five years of this litigious strategy, the music industry decided in December 2008 to stop such lawsuits.) «

Thermal Infrared Applications for Hot Markets

Green jobs are just kicking off in this nation, with Vice President Joe Biden holding the standard as the most visible of the administration spokespersons. Van Jones, the green collar guru, has been recruited into the White House, demonstrating further support for this societal transition to all things green and sustainable. The ship of state is large, however, and even with the stimulus, our national agenda is turning ever so slowly towards energy conservation and greener lifestyles. More money has been spent on ads by the energy companies touting their green credentials than has actually be spent on green investments, but the sentiment is there in the marketing/PR departments and that in itself is a harbinger for change.

Perhaps a revisit to the classic I Ching text offering metaphorical guidance through life's seasons of change is appropriate for us now. Energy issues are reaching all Americans, as tracked



▶ **FIGURE 1**
Airborne Thermal IR of homes, depicting energy loss differences with 25-cm ground resolution at 1000-meter altitude (courtesy of Jenoptik).

▶ **FIGURE 2**
Hand-held thermal IR sensor image depicting energy loss areas, especially glazing surfaces in homes (image courtesy of FLIR Systems, Inc.).

▶ **FIGURE 3**
Hand-held thermal IR sensor for energy audits and building inspections (image courtesy of FLIR Systems, Inc.).

by media headlines. As of this writing, Congress is wrestling with the American Clean Energy and Security Act of 2009, which addresses a litany of issues from creation of a 'cap-and-trade' system to electric and hybrid cars to energy efficiency in homes and buildings. The fossil fuel companies are lobbying a tug-of-war with environmental and consumer groups, with consensus that coal will come out a winner for the foreseeable future. Energy efficiency, however, is being codified for building ordinances and is adding momentum to current programs by states and municipalities to measure and monitor the carbon footprints of their jurisdictions.

Carbon calculators are becoming mandated throughout country and were a hot topic at the National League of Cities (NLC) "Green Cities" conference held in Portland, Oregon, in April 2009. The International Council for Local Environmental Initiatives (ICLEI, www.iclei.org), with over 500 city members, is leading the parade of carbon calculators and garnering the market share by forging ties with NLC and the U.S. Green Building Council. In my state of Maryland, the governor has established a special task force to perform energy audits for all state buildings, with the goal of quantifying the state energy efficiency. Government managers throughout the nation are becoming occupied by the new trends for carbon accountability and are eagerly repositioning priorities to address the deluge of weatherization funds stimulated from our nation's Capitol. All of these actions and policies should be viewed

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as good news for the remote sensing community, due to the intrinsic need to apply technology into this fray.

Thermal infrared (IR) remote sensing technology represents both low hanging fruit and a potential market stimulator for *Imaging Notes* readership. It is still early in the game, with many elements of legal instruments still remaining to make this topic interesting, but clearly, thermal IR holds great promise and utility in the energy conservation arena. First, we can think of applying thermal IR data collection over-flights for whole communities or cities as a precursor to establishing a baseline for the energy efficiency of homes and buildings.

It would seem logical that, if states, counties, and cities are going to expend millions of dollars for calculating carbon, a baseline quantification would be prudent. (Note: Current carbon calculators are spreadsheet-based approximations lacking any scientific calibration.) Large amounts of money will be distributed based on targeting goals for energy reduction, and baselines are requisite to this process. Thermal IR has been well demonstrated for its capacity to quantify temperature differences (one degree Kelvin) for surface objects ***(Figure 1)***.

Delineating the relative differences for energy loss in buildings and homes is straightforward and can be overlain for georeference with municipal GIS databases. County and city administrators can work with utility providers to link the energy loss data with customer billings to create a robust energy conservation profile for their jurisdictions. While privacy issues may be raised, the only winners will likely be plaintiffs' lawyers, due to the forensic history in remote sensing.

The boost in small and large firms hawking their services is evidence that energy audits of homes are increasing. On a house-to-house basis, hand-held thermal IR offers a great way to assess energy heat losses in a building ***(Figures 2 and 3)***. Hand-held thermal IR sensors provide answers to the hidden clues regarding glazing losses, insulation gaps, empty wall cavities, and seam or joint leaks. This information is critical for the weatherization retrofit construction work that can most effectively address remediation of heat loss and thereby lower the building owner's utility bill. Because there is a direct link between professionally executed weatherization and lowering of energy bills (estimates range from $500 to $1000 per year for the average home along the mid-Atlantic region), the impetus to market thermal IR to a larger but disaggregated customer base should be improving.

Is our industry paying attention to the energy conservation trend? At the March 2009 ASPRS meeting in Baltimore, a survey of the industry demonstrated only anecdotal evidence of interest in thermal IR sensors. No company represented there offered the services to the commercial market. Thermal IR sensors have held fast to the market needs of the Department of Defense and have not ventured out to the energy security of our nation. Perhaps, with the advent of the American Clean Energy and Security Act of 2009, the remote sensing industry will shift gears and make forays into the rapidly expanding market for home and community energy audits and into the longer term requirements for monitoring our nation's buildings for ever-increasing energy efficiencies. We might start by introducing our technological prowess to the leading architectural and engineering firms and mayor's offices.

3

GeoWeb101 Workshop

A DIGITAL NERVOUS SYSTEM FOR THE PLANET

The GeoWeb 2009 Conference in Vancouver offers a new GeoWeb101 workshop by these visionaries. Following are their definitions of the GeoWeb:

The Geospatial Web is not just a bunch of mash-ups or even the hundreds of SDI's that have been successfully deployed. The Geospatial Web is about the complete integration and use of location at all levels of the Internet and the Web. This integration will often be invisible to the user. But at the end of the day, the ubiquitous permeation of location into the infrastructure of the Internet and the Web is being built on standards.

—DR. CARL REED, CTO, OPEN GEOSPATIAL CONSORTIUM

The GeoWeb is more than virtual globes. Today, and for the near term, it is the set of local systems sometimes called Spatial Data Infrastructures (SDIs) that provide access to information for decision making and support collaboration among organizations. In the future, the GeoWeb will represent the integration of all business processes that relate to the world around us. It will serve as the foundation for decision making in government, in industry and in our private lives. It will present us, in a multitude of ways, the state of the world.

—RON LAKE, CEO, GALDOS SYSTEMS

The GeoWeb is an interconnectedness of information and services that extends the connectedness we already experience on the Web with a set of applications and protocols to exploit information at an unprecedented level.

—MICHAEL P. GERLECK, DIRECTOR OF ENGINEERING, LIZARDTECH

Three different perspectives from leading visionaries on the definition of the GeoWeb all bring one common foundation concept—the GeoWeb is the platform for the aggregation and integration for geospatial information and services related to life on the planet. Ron Lake has also referred to the GeoWeb as the "digital nervous system" for the planet. With rising data input levels, including real-time information from sensors around the world, this appears to be an apt image of the role of the GeoWeb.

Now that we have some views of what the GeoWeb means, what about its history, what are the important components, and why does it matter? These questions will be discussed in a new workshop at the GeoWeb2009 conference titled GeoWeb101. The three quoted visionaries above will teach the workshop. Here's a brief overview of what you can expect in the workshop.

Evolution of the GeoWeb:

The GeoWeb's evolution has tracked that of the Web, moving from Web 1.0 to 2.0, and 3.0. However, the GeoWeb has not been awarded such clear distinctions. Instead, the evolution of the GeoWeb has been described as essentially moving from the ability to form simple queries, such as "show me the location of a restaurant on a map," to complex temporal modeling scenarios such as "show me the effects of weather on rice production over the last year, or over the next ten years."

What is meant by geo?

Traditionally, geo has been narrowly defined to mean GIS data, imagery, GPS data—grids, points, lines and polygons. However, any measurement that pertains to the physical world should fall under the term of geodata. Real-time traffic feeds, weather data, sensor feeds from buildings and utilities, business intelligence data about performance of companies, economic and demographic data, are all examples of data that reflect day-to-day activities in the world, and that have not been traditionally defined as geographic data.

What are the most important aspects of the GeoWeb from a technology perspective?

↘ **Data discovery and discovery of dynamic services is still a challenge. For example, Google has a web crawler that works well for static content. But what about dynamic services? For instance, find archives of imagery of**

Seattle between 2000 and 2005. There could be multiple owners of that data; therefore, find me all the possible organizations that can serve me this data. Then find me a service that will aggregate the data from these sources and provide me with the highest quality images. How is that solved? Standards!

Regarding geographic data, Google Earth provides a baseline of imagery, but where does that data come from? How automatically does it get to Google Earth? When a municipality adds a new road, is there a means for that to be automatically reflected in the base data of Google Maps or Microsoft Virtual Earth (now Bing)?

- Interoperability is required to deliver seamless services and content to the user so that the user doesn't need to worry about multiple formats. For example, find the best imagery of Seattle and find floodplain data, and then display a map of the areas at risk for 100-year floods. If NGA has the best aerial imagery and FEMA has the best floodplain database, and both are in well-known and standardized formats, then it is much easier to implement the service combining the two datasets and furthermore the user doesn't even have to be aware of the different underlying formats at all. How is this solved? Standards!

  Even where organizations use the same data formats and vendor technology, information sharing is not trivial. Each organization looks at the world differently and hence uses different schemas (data models). Standards and the infrastructure based on these standards must enable data to be shared in spite of such model differences.

- Business process integration of geospatial content is critical. Many GeoWeb technologies are solutions looking for problems to solve and many national mapping programs focus on the aggregation of data that is not particularly useful to solving specific business and public policy problems. Maturing of the GeoWeb will require the development of an information infrastructure that integrates business processes, and that is driven from a business requirements perspective.

  Therefore understanding the lifecycle and workflow of data in the enterprise context is critical. For example, the building permitting process requires a developer to submit plans for the building for the purpose of getting approval. Those plans are currently not integrated with law enforcement, urban planning, and utility providers, for example for the purposes of crime analysis and city design. How can these problems be solved? Standards!

> Geospatial becomes a value multiplier from a business and public policy perspective.

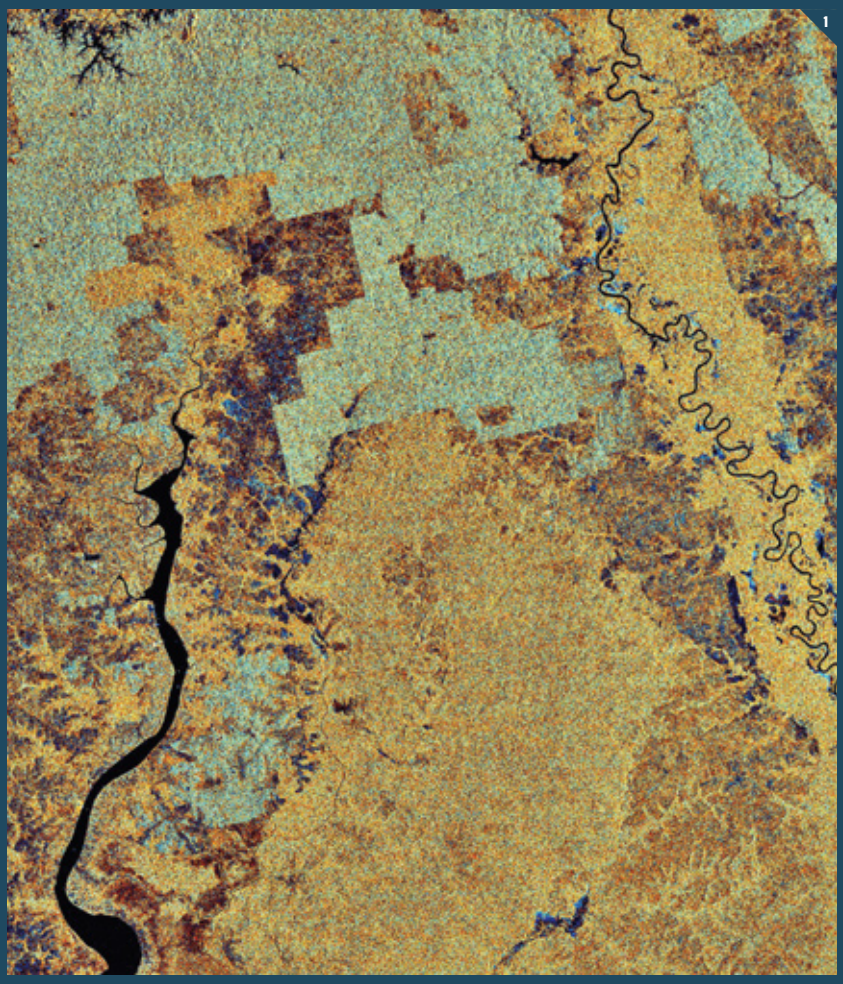
> Maturing of the GeoWeb will require the development of an information infrastructure that integrates business processes, and that is driven from a business requirements perspective.

Standards in the above examples include not just interface or encoding standards but also institutional agreements, process standards, and rights of use.

Why does the GeoWeb matter?

The GeoWeb allows extraction of a deeper level of information and knowledge than ever before. As a result, geospatial becomes a value multiplier from a business and public policy perspective. The ability to gain unprecedented insight into the day-to-day activities we conduct, from business to government, and from emergency response, to social interactions, to travel will raise the level of information for everyone and create a platform for innovation of new products and services.

Although taking advantage of the GeoWeb does not require formal geospatial training or expertise, understanding the technology challenges and the history, social, business, and government issues is critical to its continued growth and maturity. The GeoWeb 101 workshop is a must for those new to the GeoWeb geospatial experience, as well as for those who are technically geo-savvy but looking to better understand the business, governmental, and policy issues involved in expanding the GeoWeb. For everything you ever wanted to know about the GeoWeb—from its history, definition, and business issues to applications, architecture, and standards—don't miss the GeoWeb 101 workshop on Monday, July 27, 2009.



Voluntary Carbon Markets from Space

THE PRACTICAL MANAGEMENT OF KYOTO-COMPLIANCE

Within the glossary of terms, bodies and working groups associated with the United Nations Framework Convention on Climate Change (UNFCCC) negotiations is a well-known reference to satellite Earth Observations. The UNFCCC Subsidiary Body for Scientific and Technological Advice (SBSTA) annually endorses the goal of cooperation in "systematic observation" of the climate system

to identify causes and effects of global change. The Global Climate Observing System (GCOS) secretariat of the World Meteorological Organization (WMO) and other specialized agencies and organizations participating in WMO's Climate Agenda are in charge of on-going research and implementation of "Essential Climate Variables" needed for climate monitoring and prediction, many taken from Earth observations.

The role of Earth Observations in the process is no less important to practical management of statutory and emerging voluntary "carbon markets." This is because effective mapping and monitoring of carbon stored in land-based ecosystems is key to any mechanism that compensates countries for reducing their greenhouse gas (GHG) emissions through land use and forestry.

The UNFCCC negotiation block called LULUCF (land use, land use change and forestry), which treats forests and other types of vegetation as global carbon stocks, provides for a wide array of activities that could mitigate carbon emissions. Because the international finance sector has established certified carbon emissions reductions as a traded commodity, those activities can also generate carbon credits to be further exchanged in the international carbon market.

As much as one quarter of the CO_2 mitigation potential may lie in afforestation and reforestation, preventing deforestation and forest degradation, cropland management, grazing land management, revegetation, grasslands and agroforestry. Therefore, it is widely expected that future arrangements on climate change will maximize the role of LULUCF in the climate agenda by providing "large, stable, predictable and long-term financial flows" to the carbon market stakeholders; hence, a "large, stable, predictable and long-term" marketplace for geo-referenced data is also forthcoming.

The necessity to use the remote sensing techniques and other geospatial tools to help shape carbon markets has been clearly reflected within the framework of the UNFCCC process. The International Panel on Climate Change (IPCC) Guidelines for Agriculture, Forestry and Other Land Uses (AFOLU) of 2003 is the most important and widely recognized material developed to assist in the implementation of carbon sequestration and carbon conservation projects. The specific methodologies based on those guidelines are developed under the UNFCCC mechanism compliant to Kyoto Protocol through the Clean Development Mechanism (CDM) and Joint Implementation (JI)), and within the voluntary carbon markets outside Kyoto Protocol, especially through the strategy usually referred to as "Reducing Emissions from Deforestation and Forests Degradation" or REDD.

Despite developing dedicated instruments, procedures and methods, the volume of transactions in this area is relatively small. The parties to the Kyoto Protocol limited their certified CO_2 emissions reductions to projects pertaining to afforestation and reforestation (A/R) only, thus excluding carbon sequestration in soils, non-forest biomass and agricultural land use, or carbon conservation through avoided deforestation. Moreover, the Kyoto-compliance carbon market for LULUCF is marginal—under the Protocol it does not exceed 1% of the total carbon credits traded within the market.

The change for the LULUCF negotiation block is, however, forthcoming, and it is expected from three directions. First, a variety of the land-based carbon credits are welcomed in the voluntary carbon market. Second, the learning-by-doing experience from design, monitoring and verification of the forestry CDM/JI projects is growing. Third, innovative carbon financing can really make a difference to the least-developed countries in achieving their abatement potential, especially if it will help them reform the CDM/JI system.

The Role of the Voluntary Carbon Market

The international finance sector has established certified carbon emissions reductions—carbon credits—as internationally traded commodities. As such, carbon transactions take place in the "Kyoto-compliance" and "voluntary" carbon markets. Currently most of the LULUCF-related credits are outside the Kyoto Protocol, mostly because land use and forestry are barred from the EU Emissions Trading System. Therefore, the credits and offsets from the LULUCF projects are traded primarily in the voluntary market, which initially emerged as an idea for "corporate and social responsibility" for climate change mitigation actions, but slowly turned into an alternative to Kyoto regulations.

The voluntary carbon market represents only 2.9% of the total volume of the carbon market and 0.6% of its value ($700 million USD in 2008); however, despite the relatively small volume, the array of activities producing carbon credits is quite extensive. The emissions reductions based on the avoided deforestation and forests degradation (REDD) has been, for example, firmly established there. Soil carbon sequestration has been included in the biggest U.S.-based international voluntary emission trading system, the Chicago Climate Exchange

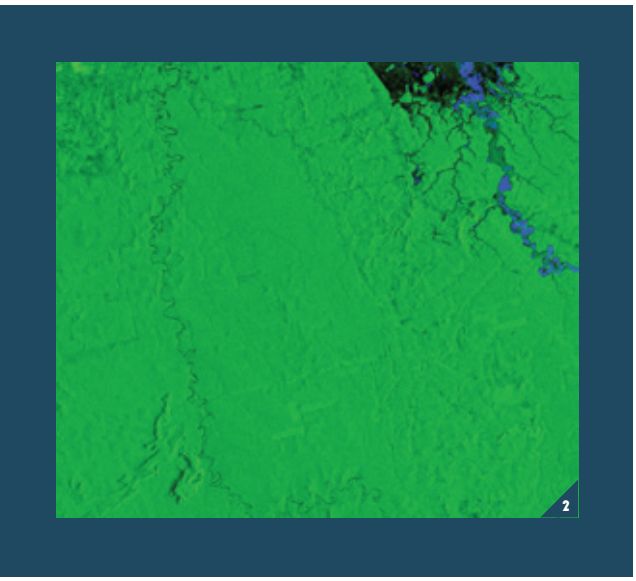
◀ **FIGURE 1**

This radar Envisat acquisition highlights Indonesia's Kalimantan region in the southern part of tropical Borneo in Southeast Asia. Borneo, the world's third largest island, was once covered in dense rainforests. However, in the 1980-1990s, these forests were cleared for their timber at an alarming rate. Soon after, the global demand for palm oil increased and what was left of Borneo's forests started being cleared for palm plantations (visible as square green patches). This image was acquired on April 23, 2009, by Envisat's Advanced Synthetic Aperture Radar (ASAR) instrument. Credit: ESA Envisat www.esa.int.

ANNA BURZYKOWSKA, LL.M.
YGT European Space Agency
Washington D.C.
www.esa.int

(CCX), and the California Action Reserve—the regional carbon offset market in the Western United States—comprises project types from agriculture to forestry. In 2004, as much as one-third of the voluntary market transactions were in the land-based sector, mainly within forestry. The volume of transactions fell in 2007 and 2008 to 16% and 11% respectively, but the market grew in size (it doubled in 2008) and the amount of certified emissions reductions, as well as the number of registered projects, has increased.

This trend will be further reinforced after the land use carbon credits are accepted under the future U.S. emissions trading scheme, the cap-and-trade system. The American Clean Energy and Security Act (formerly called the Waxman-Markey proposal) passed in the U.S. House of Representatives on June 26, 2009 and pending Senate's approval, calls for carbon offsets from afforestation, reforestation and other biological sequestration, including emissions reductions from forestry conservation in developing countries. As a result, it is likely that those voluntary markets will eventually pave the way to carbon sequestration/conservation in soils and forests as a part of the international carbon market in the post-Kyoto regime to be negotiated in Copenhagen.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Building up the voluntary carbon market capacity has other important advantages. The Kyoto system is very conservative in terms of LULUCF. It regards, for example, the REDD strategy as yet insufficiently developed to become extensively financed by market mechanisms. There are good reasons for this skepticism: the land-based CO_2 mitigation (sequestration) strategy has to deal with the problem of leakage (or displacement of emissions to another location to avoid regulation) and non-permanence of emissions reductions, as well as with fears of "flooding the market with cheap carbon credits," which would distract attention from regulating fossil fuel and other heavy industry sectors. Therefore, many LULUCF activities are simply not eligible for CDM financing under Kyoto. There is also little incentive to do the cumbersome research and preparations that are required for Kyoto-compliant CDM projects, which are generally regarded as expensive, too complicated and highly rigorous.

Voluntary market transactions, on the other hand, are much more inclusive when it comes to the types of supported activities, as well as much more flexible with regard to project design and implementation (although the carbon credits may be sometimes of a lesser value, depending on the type of activity). Therefore the voluntary carbon market grew not only as a place where the majority of interest in land-based carbon credits accumulated, but it consequently is also expected to contribute to the reduction of the complexity of the CDM methods. More so, the voluntary market has consequently become the best space for testing new products, services and methodologies in project design, monitoring and verification. The CCX, for example, has recently approved its first forestry carbon offset plan using innovative remote sensing monitoring techniques: aerial LIDAR and CIR remote sensing imagery. In effect, if the market potential of LULUCF is going to be shaped by an increasing confidence in emissions reductions (largely achieved by new science, technology and innovative remote sensing applications), these are the voluntary markets that will yield important results for the inclusion or exclusion of new methodologies and protocols for LULUCF projects implementation.

The most recent 2009 assessment of the CDM, the World Bank's annual report on state and trends of carbon markets, has explicitly mentioned that the know-how from the U.S. voluntary domestic emission reduction schemes—especially under the California Climate Action Reserve (C-CAR) or the Voluntary Carbon Standard (VCS)—is seen as a guideline for addressing the problems of the permanence of emissions reductions in soils and biomass, and of simplifying the methodology for Kyoto-compliance transactions in the forestry sector.

Learning-by-doing Experience

The most recent UNFCCC SBSTA meeting in Bonn, June 1-12, 2009, noted that the experience from real-life forestry projects is paramount for the REDD strategy to be included as an outcome of 2009 UNFCCC talks in Copenhagen. Significant progress in using remote sensing methods has been possible thanks to the lessons learned from the REDD projects run by, among others, the World Bank BioCarbon Fund, GOFC-GOLD, Tropical Forest Group and national forest research organizations, to name a few. The World Bank's BioCarbon Fund (BCF), for instance, submitted to SBSTA a review of the methodology developed for the project in Madagascar dedicated to estimating and monitoring GHG emissions from mosaic deforestation. The Institute of Applied Ecology in its report to UNFCCC indicated improvements in using Earth observation technologies in forestry projects implemented in Peru, Congo, Madagascar, Indonesia, and Papua, New Guinea, but pointed to poor historical data for many tropical countries (of which India and Brazil are prominent exceptions) and to problems with time series consistency between the data from different satellites and sensors over time.

The lessons learned within the Kyoto market, on the other hand, are at least twofold. The CDM/JI projects assessment by the UNDP (U.N. Development Programme) revealed that the costs of forestry projects monitoring and verification can be very high, in some cases up to 25% of project cost. This is because the accuracy levels are very high and the approach toward potential deficiencies in data is conservative.

In terms of CDM/JI projects planning, by August 2008 over 90% of the approved afforestation/reforestation projects were based on the historical land use data for estimation of land eligibility and the emissions reduction baseline. As a result, the Global Environment Facility (GEF) – the financial mechanism of the UNFCCC governed by the World Bank – indicated the need for wider accessibility of scientific research and GIS for the CDM/JI decisions planning.

The 2008 release of the historical Landsat imagery has been a major breakthrough in addressing those needs; nevertheless the basic information on land categorization for potential carbon stocks is still lacking in developing countries, especially in Africa, because the evidence of historical land use is often not available to them or is difficult to obtain, especially over tropical regions with a heavy cloud cover. It is expected that only the upcoming FAO Forest Resource Assessment (FRA 2010) will provide the first consistent global time-series of satellite data using imagery from MODIS (at 250-m resolution) and Landsat satellites from 1975, 1990, 2000 and 2005.

◀ **FIGURE 2**

Satellite image showing deforestation in Northwest Brazil (Rondonia) is an example of a multi-temporal product extract based on the combination of two ERS acquisitions (April 1996) showing radar backscatter (green) and radar backscatter changes over time (blue) over a region of active deforestation. Deforestation patterns are clearly visible from the structure and texture of the backscatter image layer in the Southeast portion of the image extract. This product extract has been designed and processed by Gamma Remote Sensing (CH). Credit: ESA/Gamma Remote Sensing.

▲ **FIGURE 3**

One of Russia's largest reservoirs, the Tsimlyansk, is highlighted in this Envisat image acquired on September 27, 2008, over southern Russia. The reservoir is located at the great bend of the Don River near the town of Tsimlyansk in the province of Rostov. Many agricultural crops can be seen growing along the river, including wheat, rice, cotton, alfalfa, grapes and other fruits and vegetables. The darker brown areas around the reservoir indicate where crops have already been harvested. Earth observation satellites are used in agricultural monitoring for mapping and classifying land use, crop type, crop health, change detection, irrigated landscape mapping and crop area mapping. Credit: ESA.

Innovative Carbon Markets Financing in Developing and Least-developed Countries

The UNFCCC has repeatedly raised the concern that between one-half and one-third of carbon abatement spending between 2000 and 2050 must occur in developing countries, but the immaturity of their carbon markets—the poor supply of offset credits under the CDM—poses a problem in achieving their mitigation potential. To overcome that difficulty, in 2007 the World Bank and its Carbon Finance Unit (CFU) introduced innovative financing mechanisms, which in the short term are aimed to buffer the low confidence in carbon transactions with those countries, help them to overcome barriers for CDM project development and implementation, and enable transfer of technologies and know-how.

The vehicles for those transactions are carbon funds managed by the World Bank, such as Prototype Carbon Fund, Netherlands JI and Netherlands CDM Facilities, Community Development Carbon Fund, BioCarbon Fund, Italian Carbon Fund, Spanish Carbon Fund, Danish Carbon Fund, the Umbrella Carbon Facility, Carbon Fund for Europe, the Forest Carbon Partnership Facility, and the

Carbon Partnership Facility (CPF).

The CFU uses resources from those funds to set up projects within the CDM/JI framework, which would not normally be eligible for loans or commercial lending due to high transaction risks. Then the World Bank purchases carbon credits on behalf of the fund contributor, becoming a source of carbon market revenues in developing countries.

> The most recent 2009 assessment of the CDM has explicitly mentioned that the know-how from the U.S. voluntary domestic emission reduction schemes is seen as a guideline for addressing the problems of the permanence of emissions reductions in soils and biomass, and of simplifying the methodology for Kyoto-compliance transactions in the forestry sector.

The Bank's Carbon Finance Unit also has a role in capacity building. The Forest Carbon Partnership Facility, for example, dedicated $185 million USD to establish "readiness mechanism" for three purposes: reference scenarios for avoiding deforestation in 37 developing countries; national monitoring, reporting and verification systems for emissions and emission reductions; and national REDD strategy.

The CFU, in addition to that, also "systematically observes the CDM regulatory process and contributes to bottom-up rulemaking for CDM by interpreting regulatory decisions, providing input, and developing new methodologies, thus bridging the gap between general guidelines and methodologies with their application to real-world projects." The openness of the CFU to new methodologies can generate a significant potential for the GIS community and facilitate a number of practical contributions of the remote sensing technology to the UNFCCC process, especially if it delivers novel but universal results to tweak the nuts and bolts of the Kyoto system.

New Science – New Opening for Carbon Markets

There is a growing dedication on behalf of space agencies around the world to introduce new science and technology and new global-scale research projects dedicated to land use and forestry, which will eventually allow more transactions in carbon markets with higher certainty of emissions reduction. The new remote sensing products and applications are forthcoming specifically to tackle the need for global, regional, and project-wise carbon accounting identified through the LULUCF negotiation block.

For example, in 2008 ESA released its GlobCover application, which provides the first global land cover map for 2004-2006 updated bi-monthly and based on ENVISAT MERIS data with 300-meter resolution. Currently developed forestry projects such as ESA/JRC TREES3, FAO FRA 2010 or NASA Landsat Pathfinder Humid Tropical Deforestation Project will be a novel and highly anticipated source of data on global emissions from deforestation, but no sooner than in 2010.

In terms of new sensors being developed, after 2013 the high-resolution hyperspectral, SAR and LIDAR satellites will open new chapters for remote sensing carbon accounting from space (due to NASA-planned decadal survey missions (DESDynI, HyspIRI and LIST), and a candidate ESA Earth Explorer Mission (BIOMASS) dedicated to taking global measurements of forest and land biomass). In terms of using the existing SAR imagery for land use and forestry applications, which is still uncommon, the ESA Climate Change Initiative of 2008 proposed research towards measurement of forest biomass by a combination of SAR and LIDAR measurements from ERS, ENVISAT, RADARSAT and JERS satellites, with the aim of reaching continental or even global scale forestry maps. See ***Figures 1-3***.

The results of this study will be important, because these kinds of data have not yet been available with global coverage, and because there is little experience with using radar imagery for forest monitoring as an alternative observation method. If the mass market for forestry and land biomass applications indeed emerges, it will be the result of enhanced confidence in and improvements of optical satellite observations: multiplication and internationalization of satellite missions, lower price for high resolution imagery, and automatization of observations.

Yet before these new developments will deliver data, the current mitigation commitment will be provided by the existing systems such as Landsat (U.S.), CBRES (China-Brazil), TerraASTER (US-Japan), IRS (India), SPOT (France), DMC (Algeria-China-Nigeria-Turkey-UK), ERS, ENVISAT (ESA), mostly because the same methods for reference scenarios, monitoring and verification have to be used within one crediting period. New sensors will open the possibility for establishing new baselines and contribute with new monitoring and verification methods when the Kyoto second commitment period, from 2013 onwards, will be well advanced. «

NOTE

The author was a member of the Task Force to Poland's Special Envoy/Climate Ambassador for the 2008 UNFCCC COP14 in Poznan, Poland. The views expressed here should not be attributed to any of those organizations.

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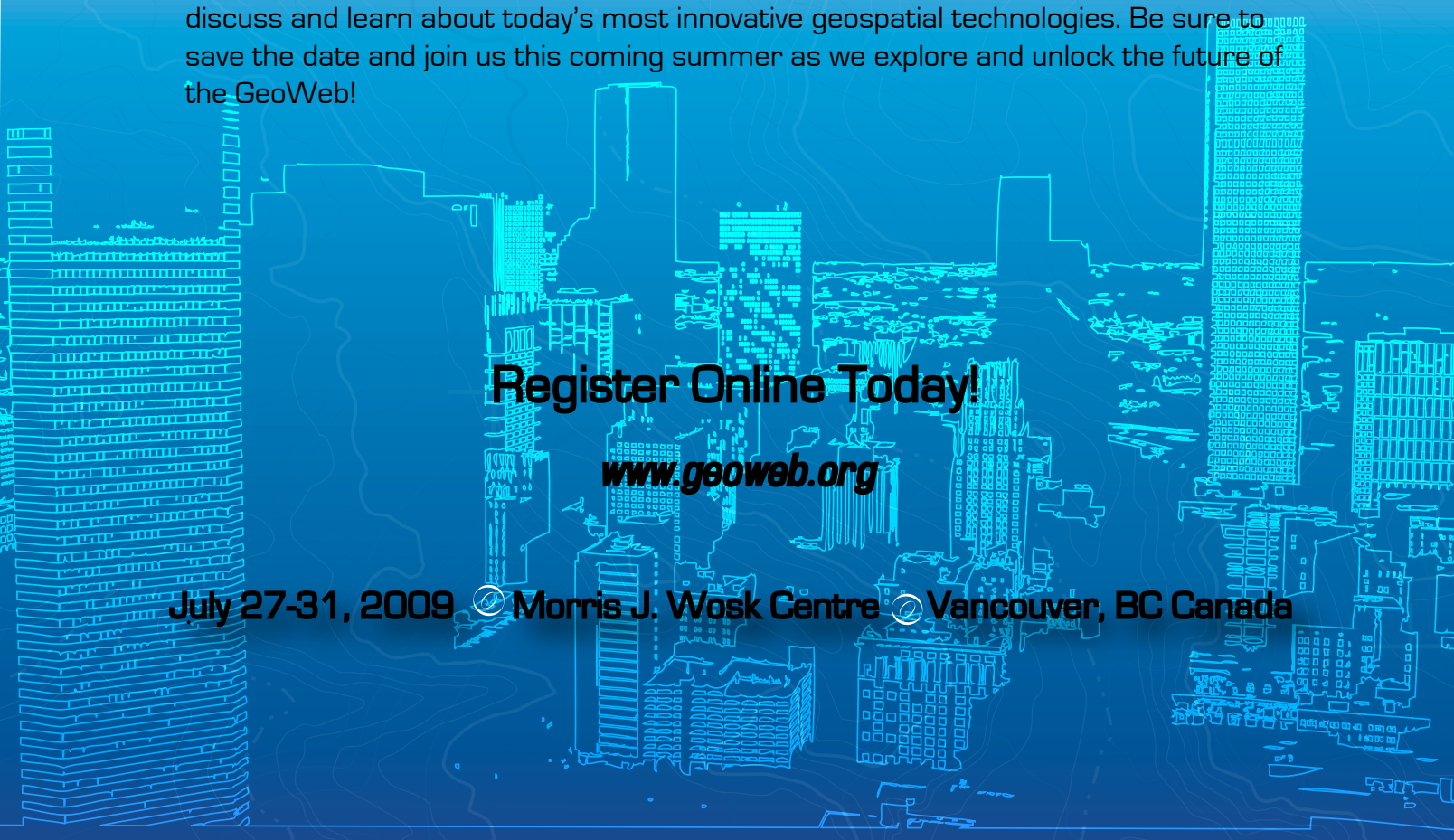
Everything is Connected tm

GeoWeb 2009

GeoWeb conferences focus exclusively on geographic information systems, the Internet, and the economic potential associated with their convergence. GeoWeb 2009 will continue the tradition of focusing on the reciprocal impact of the Web and Geographic Information as well as the ever-increasing need for collaboration in light of global economic and environmental concerns. GeoWeb 2009 is for everyone!

Representatives from both public and private organizations are invited to meet, discuss and learn about today's most innovative geospatial technologies. Be sure to save the date and join us this coming summer as we explore and unlock the future of the GeoWeb!



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Water Modeling

MAPPING AND MANAGEMENT

The modeling of natural and manmade water systems encompasses one of the more established uses of remotely-sensed imagery and applied GIS. But where exactly does this sector stand as of mid-2009? How far has it come?

On a foundational level, water mapping practitioners continue to make product choices that refine the boundaries of engagement for modeling environments, software interfaces and standards. Without question, the industry has achieved a certain level of maturity: Showcase projects feature geodatabase technology that, more than ever, help monitor the dynamic conditions of potable and non-potable water systems all over the world.

At the project level, each effort tends to be characterized by its own set of wild cards. Sometimes specific technical challenges stand at issue. In other cases, time factors are tightly woven into project objectives. But perhaps the most universal set of variables is encompassed by the myriad ways in which geographic and legacy data are mingled—juggled might be a better word—to produce visual solutions that are useful in the guidance of human decisions.

The Journal of the American Water Resources Association observed a few years ago that a rich variety of technical approaches to water modeling, driven in large part by competitive jockeying, has come to disaggregate the art. "Currently," it reported in a state-of-the-industry paper, "disparities in spatial scales, data accessibility, modeling software preferences, and computer resources availability prevent application of a universal interfacing approach."

Experts might agree that this fragmented status applies still. The industry, nevertheless, continues to put on new faces. Consolidation has changed up the vendor roster. With its purchase of Haestad Methods Water Solutions in 2004, and piqued by a national survey that it commissioned in 2007, Pennsylvania-based Bentley Systems has boldly staked its claim as the king of the water modeling hill.

ROD FRANKLIN
Reporter
Denver, Colo.

Surveys answered by more than 800 industry professionals indicate that the company's software leads in categories like distributions systems modeling, transient analysis, wastewater conveyance, storm water networks, and hydraulics calculation tools. In detention pond modeling, IntelliSolve Inc., a Cleveland company, emerged as the top innovator. Practitioners chose the U.S. Army Corps of Engineers as the preferred developer of floodplain management solutions. New solutions like Intermap's NEXTMap USA product may change that, with its high-resolution 3D digital elevation and terrain models.

As a fully integrated concept in water systems engineering, however, GIS appears to have hills yet to climb. Survey respondents said that its status as a framework for an idealized working environment plays third fiddle to their general desire for systemic interoperability with existing industry standards (EPANET, the storm water management model and LandXML, for example), and second fiddle to CAD systems. Water modeling engineers indicated their preference for tools such as AutoCAD and Bentley's MicroStation over solutions like MapInfo and ArcGIS, though MicroStation users can integrate data into ArcGIS. See ***Figure 1*** on page 28.

The directions water mapping has followed as an applied science seem to be limited by fewer bounds. Each year, ESRI's Special Achievement in GIS Awards (SAG) acknowledge local and regional water modeling campaigns all over the planet. Ceremonies in recent years have focused on projects in the U.S., Italy, Sweden, Norway, Costa Rica, Jamaica, Brazil, Uruguay, Peru, China, Sri Lanka and the Philippines. The company gave awards to seven water or wastewater projects in 2008, six in 2007, four in 2006, and six in 2005. These did not include SAG citations for water modeling efforts that may have been part of comprehensive projects initiated within the utilities, pipeline, forestry, government, engineering, environmental management and ESRI Conservation Program sectors.

City of Akron Public Utilities Bureau Centralization

One of the standout projects from last year's SAG was orchestrated by the City of Akron Public Utilities Bureau (APUB). This organization was in the midst of a decade-long records conversion process for its water and wastewater departments when the decision was made to install a centralized system to manage work and inventory for all assets above and below the ground. For nearly 100 years, APUB kept its records by means of hand drafting onto cloth paper and mylar. Now, a geodatabase synchronized with its new exterior records application helps reduce inefficiencies in water system data access.

Southern Nevada Water Authority Rebates for Xeriscaping

A star of the 2007 SAG ceremony was the Southern Nevada Water Authority (SNWA) Water Smart Landscape program, which offers rebates to Nevada residents and businesses that convert their water-dependant turf coverage to xeriscape design. Using six-inch airborne imagery provided by Digital Mapping Inc., SNWA has been able to identify grassy areas and potential program applicants. The solution employs ArcGIS from ESRI, ERDAS Imagine, and Feature Analyst from Overwatch Systems.

Managing Water Resources in Florida

Given Florida's richly tattooed water profile—it includes the Everglades and Intra-coastal Waterway, water supply canals, lakes, bays, estuaries and ports—managing water resources in the state is a complex issue, requiring accurate and up-to-date geospatial information. About five years ago, with existing data scarce or obsolete, mapping experts within the state were challenged to geographically isolate issues related to zoning, rights of way, engineering method, storm control, water quality, and the interests of wetlands and wildlife habitat versus those of sugarcane, sugar beet and citrus growers.

In order to fulfill their need for accurate and up-to-date geospatial information of their respective jurisdictions, the five water management districts in Florida teamed up with the USGS to collect high resolution digital airborne imagery of the entire state in 2004. The orthoimage mapping was completed by Maryland-based Fugro EarthData (formerly EarthData International). It was one of the nation's first large-scale acquisition efforts taking advantage of the Leica ADS40 sensor's ability to generate both natural color and false color renditions simultaneously. See ***Figures 2-3***.

For the South Florida Water Management District alone, a total 16,800 individual map tiles were produced in both

natural color and color-infrared rendition, and a total of more than 3 terabytes of image data was delivered. This dataset allowed the district to extract valuable information.

The state is currently involved in a statewide project to map the topography along the coastline using airborne LiDAR. The goal of this ambitious project is to allow state and local authorities to model the effects of sea-level rise on coastal communities. Fugro Earthdata is also involved in this project along with a number of other mapping companies.

Mapping Oyster Beds

Another project was initiated by the South Carolina Department of Natural Resources (DNR) for the purpose of identifying intertidal oyster beds. During low tide, the natural reefs that harbor this seafood delicacy tend to lie exposed above the state's coastal ocean water line. In 2003, the DNR and National Oceanic and Atmospheric Administration's Coastal Services Center determined that sub-meter spatial detail would be necessary to map adequately a targeted 1,500 square miles of reefs. Specialists also decided to use a combination of spectral and spatial data in distinguishing live oyster clusters from muddy, shell-covered reef substrate materials.

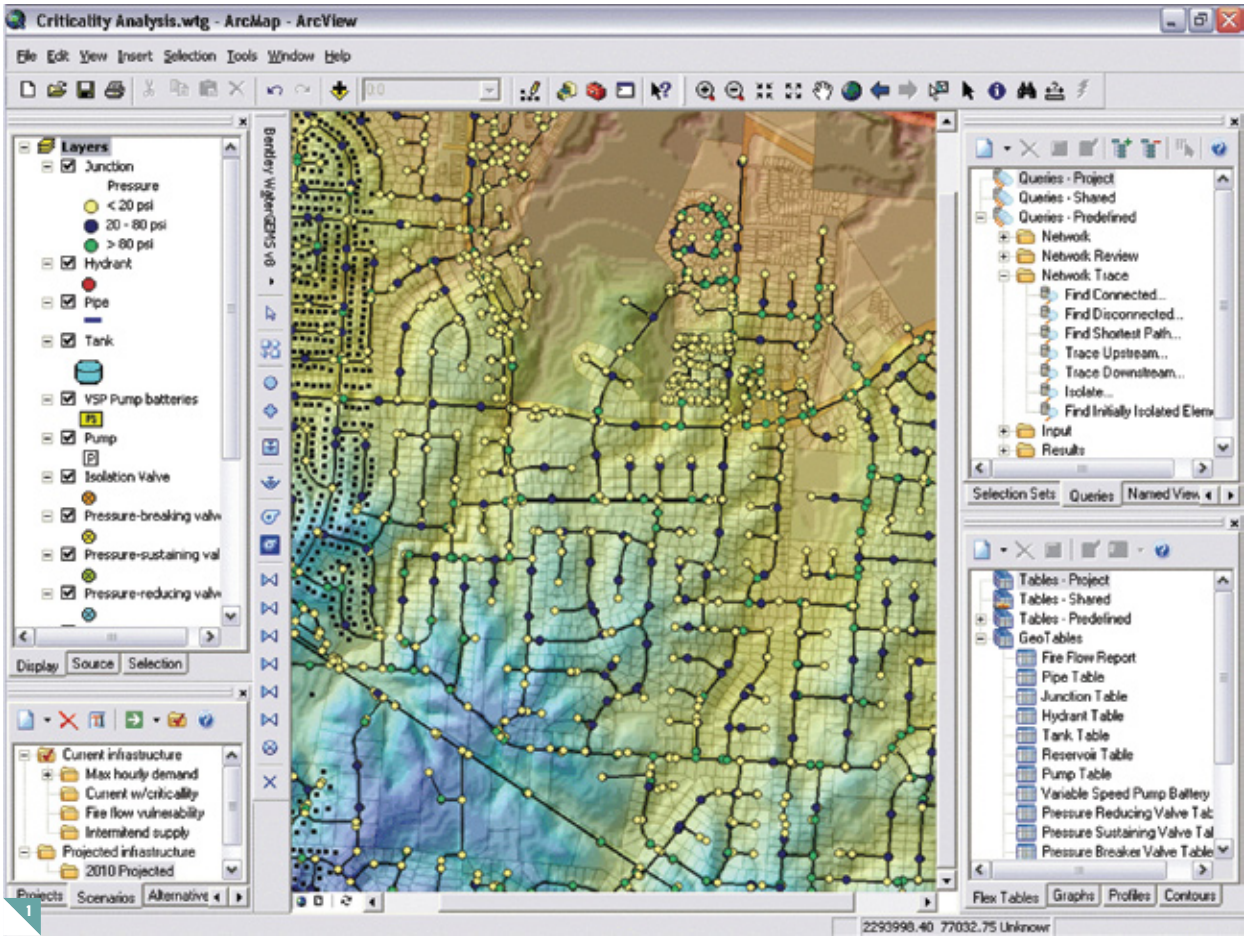
To achieve these goals, GeoVantage Inc. (Swampscott, Mass.) built 22 lightweight, high-resolution multispectral cameras that it dispatched in up to 10 planes per flight session. The acquired data helped commercial interests efficiently collect and sell more than $1 million of oysters annually.

Categories of Water Modeling

To those who follow the multi-jointed state of the water mapping art, 2003 may seem like an epoch ago. The fact is, some water models develop over a period of years into data-centric Godzillas. Bentley Systems features one project on its Website that shows how certain products are sometimes necessary to simplify these modular epics of data aggregation. Asset management staff in Toronto deployed WaterGEM's Skelebrator module to automate the skeletonization of the city's water system model without losing hydraulic equivalence information and network connectivity.

From a GIS and data perspective, it helps to think of water research in categorical terms. Disciplines can be divided into the very broad areas of watershed characterization and management, floodplain management and forecasting, water quality, and permitting.

- **Watershed management:** This multidisciplinary category includes terrain modeling, stream flow statistics and debris flow probability. The latter refers to flows of rock, earth, and other water-saturated debris that develop when the ground is rapidly soaked during heavy rainfall or snowmelt conditions. They can strike with little or no warning at avalanche speeds.
- **Floodplain management:** Imaging and modeling projects support a combination of corrective and preventive exercises. Some may require the integration of data from a variety of sources, including zoning, subdivision, or building requirements, as well



as those required by special purpose floodplain ordinances.

- **Water quality:** This work involves the constituent analysis of groundwater and the characterization of groundwater recharge areas and surface water. Because the relationship between surface water and groundwater is usually symbiotic, cross-contamination is an issue, and GIS becomes a useful ally in the calculation of chemical mass load impacts and of migrations between surface and subsurface waters. GIS also can be helpful in the monitoring of water quality changes within specific zones, such as rivers or bays.
- **Permitting:** Geographic information plays a key role in the determination of which businesses or activities are granted water rights or access to land in and around watersheds. Modeling with GIS facilitates permitting tasks in the areas of water quality monitoring, hazardous materials tracking, underground tank management and well log data management. It also applies in-site analysis, rights-of-way permitting and water flow analysis.

These applications have gotten top billing in some regions. The Pacific Northwest Regional Collaboratory (PNRC, a 2004 project of the U.S. Department of Agriculture) supported mapping exercises in the above areas throughout Idaho, Washington and Oregon. Its water resource forecasting projects sought to provide operational tools that could be used to improve estimates of streamflow in snow-dominated regions. Riparian analyses have focused on vegetated areas situated close enough to streams to influence the stream's conditions, or to be influenced by the presence of a stream. PNRC campaigns also have delved into near-shore habitat restoration studies that are candidates for assistance by remote sensing technologies.

Other GIS projects have tackled water systems analysis in areas that are anything but pastoral. The previously-mentioned EarthData has experience here. Its contribution in 1997 to a Con Edison energy loss inventory for Manhattan stands as one of the company's technical coups in urban water modeling. In a nutshell, EarthData achieved its goal of identifying a two percent reduction in total energy loss from steam fitting leaks within the city's heating system by using airborne thermal surveys, video, and existing natural color aerial photography.

International Projects

Using spatial data to map all that is wet has gained global momentum. In the Puglia region of Southern Italy, GIS applications now display networked workstation data for drinking water in real time. In Venice, complex mathematical models are being processed by MicroStation operators to keep the city from sinking into the lagoon upon which it was built 1,200 years ago. Bentley also has completed water resource showcase projects in Istanbul, Turkey and in southern Australia.

A few years ago, Australia was a mish-mash of unrealized GIS market potential. Intergraph Corporation (Huntsville, Ala.) was reporting its intent to use G/Technology as a means of streamlining operations at Melbourne's 1.3-million customer South East Water corporation. Around the same time, Tensing USA of Rockville, Maryland released news of its mobility solutions GIS contract with Sydney Water Corporation—the continent's largest water supplier and treatment company.

Consultants observed at the time that the sharing of spatial datasets between jurisdictions in Australia is not an assumed fact of life, at least in comparison with conditions in the United States. They also noted that imaging and GIS companies had begun to approach the Australian market more aggressively as talks advanced on a comprehensive national water policy. Those policy negotiations continue.

Some have said that the metropolitan regions of coastal Australia represent a GIS market that is at least as strong as that of North America. So there are new places that imaging and remote sensing can take those who devote themselves to watershed analysis, floodplain assessment, and storm water or sewage systems engineering. Even if water modeling has been around as long as GIS itself, there are yet miles to go.

◀ **FIGURE 1**
The WaterGEMS integration with ArcGIS allows users to analyze their network directly inside ArcGIS and to overlay model results in ArcGIS for presentation. Image courtesy of Bentley Systems, Inc.

▲ **FIGURES 2-3**
These orthoimages are of the Royal Palm Hammock quadrangle, which is located a few miles west of the Everglades National Park, in Collier County on the Gulf coast of Florida. The images were collected at a 1-m pixel resolution on December 3, 2004, using a Leica ADS40 airborne digital imaging sensor, as part of the statewide mapping program for Florida covering approximately 54,000 square miles. Images courtesy of the South Florida Water Management District and the USGS, and acquired and processed by Fugro EarthData.

Remote Sensing and GIS Education

UNIVERSITIES WORK TO KEEP PACE WITH THE INFORMATION REVOLUTION

THE STUDY OF LOCATION MAY BE AS OLD AS THE WOODS, BUT TODAY, THE WAY LOCATION IS STUDIED, AND WHY IT IS STUDIED, ARE changing drastically. To meet the challenges and to benefit from the tremendous opportunities of an information-based global economy, it pays to be both educated broadly and skilled technically. More and more, the information-based global economy is becoming a geospatial information-based economy. Aerial and satellite imagery and computerized geographic information systems (GIS) are revolutionizing the conduct of business, science, education and government. Consequently, people who can think spatially—where things are, in relation to other things—are in great demand.

According to the U.S. Bureau of Labor Statistics (BLS), the number of workers with the title "geographer" or "mapmaker" is small; there were fewer than 11,000 mapmakers and geographers in the United States in 2006. However, the BLS expects overall employment of surveyors, cartographers, photogrammetrists, and mapping technicians to increase by 21 percent from 2006 to 2016, a pace much faster than average for all occupations. See http://www.bls.gov/OCO/.

Need for Interdisciplinary Education

While this statistic is impressive, it hardly captures the interdisciplinary nature of an information-based global economy, nor industry's true demand for technically savvy employees who can think on their feet. In fact, the need may be greater than BLS's number suggests.

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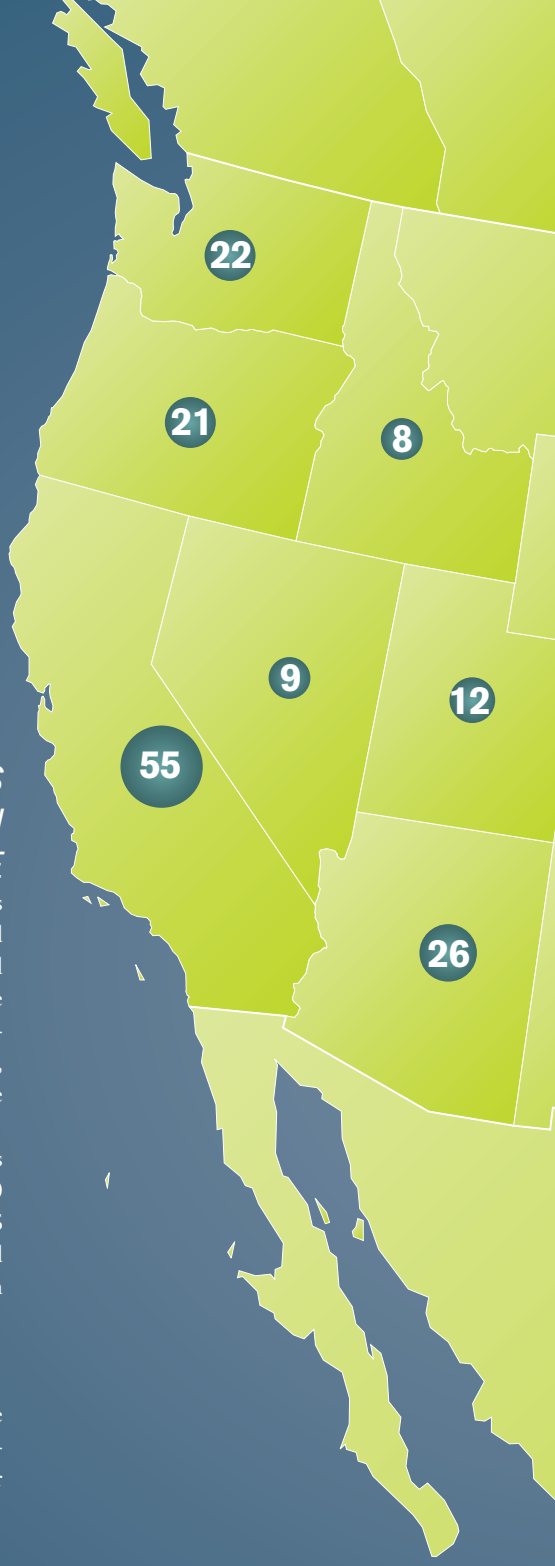
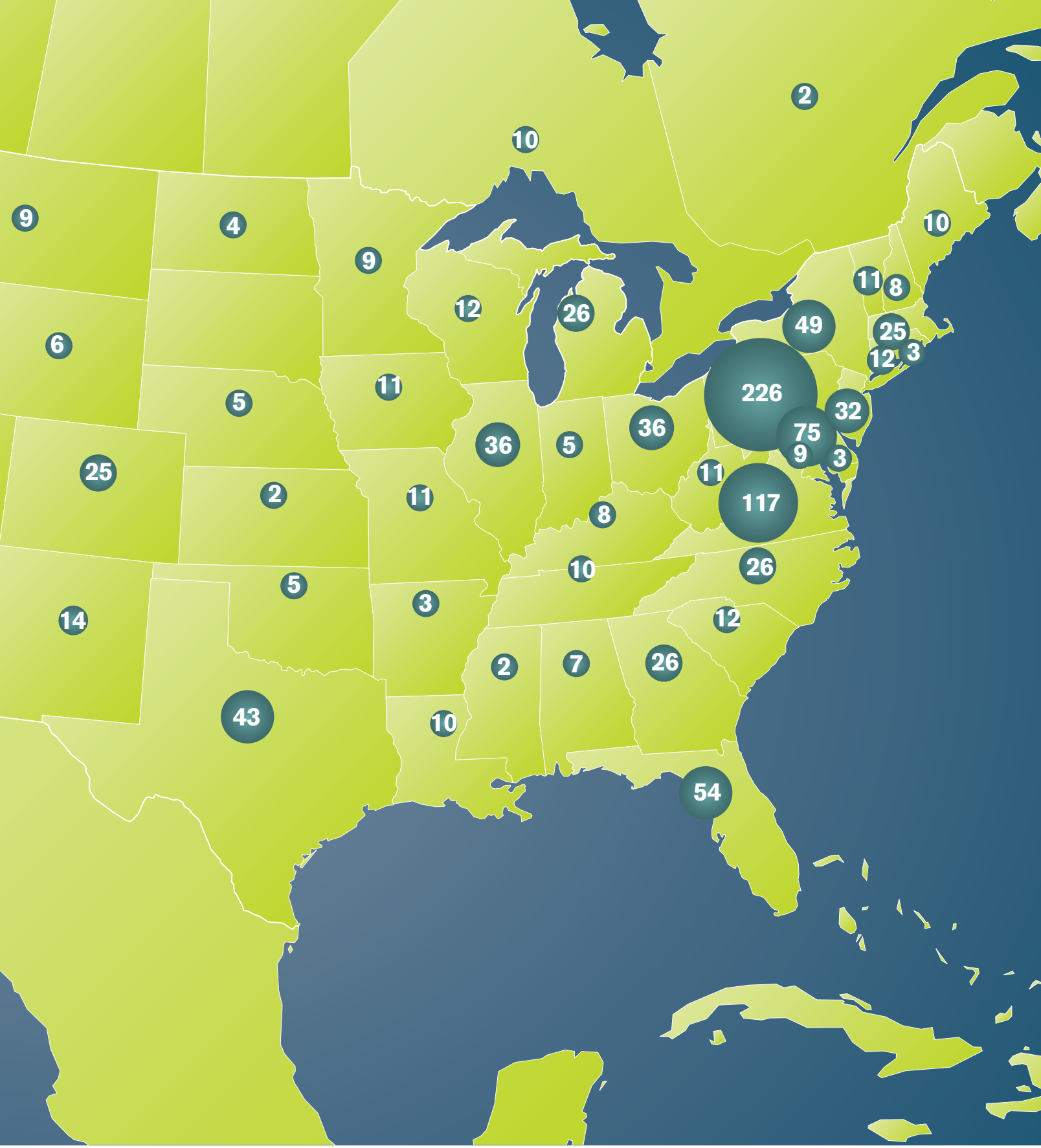


▶ **FIGURE 1**
Penn State offers three online programs of study in the area of geospatial technology. This map shows the locations of alumni from all three programs: the Certificate Program in GIS (1235 graduates), the Geospatial Intelligence Certificate Program (6 graduates) and the Master of GIS program (53).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> The current education method is like learning how to run a calculator without ever understanding math.

Jason San Souci, President and CEO of AFE Advisor, a GIS education company, agrees that demand for trained workers is out-pacing supply. Mr. San Souci, who is also the President and COO of NCDC Technical Services and active in numerous professional and scientific organizations, including the GIS Certification Institute (GISCI), URISA GISCorps, and American Society of Photogrammetry and Remote Sensing (ASPRS), said: "Undoubtedly we are making great progress, but there is still a big disconnect between GIS education and GIS application."

Victoria Provenza, CEO of the Colorado-based geospatial solutions company ProSpatial, concurs. Provenza says the question of whether educational institutions are adequately preparing students for future jobs is timely now that the industry is growing up beyond its first 20-30 years. "Ten years ago, it was all about certification programs and whether someone had a grasp of technology. But the power of GIS is being able to ask a big question, and then proving it using GIS technology. We can have all the data in the world. We still need humans to ask the right questions."

Provenza plans to hire 20-40 employees over the next year, depending on what her clients' contracts call for, and she is looking for employees with an ability to solve problems contextually, temporally, and spatially. "GIS is simply a decision tool—and the ability to collect data is ubiquitous. There is less need for "geo-techs" now, and more need for theorists," she said.

Restating a theme heard over and over again, Mike Beltz, CEO of GCS Research, an internationally-recognized award-winning leader in advanced geospatial information technology solutions in Missoula, Montana said, "There is definitely a need for industry to get more involved with educational curriculum. Students are being taught how to run software programs. Anybody can learn how to generate data. The need is for employees who can generate accurate data sets." The current educational method is like learning how to run a calculator without ever understanding math.

Calls for more critical thinking skills in GIS educational curricula are music to the ears of Doug Flewelling, Director of the Master of Science in GIS at the University of Redlands, California. He says that five years ago, it was all about the software. Technology has been changing so rapidly that it's been difficult for university faculty to keep up to speed. "They would have to go back and learn new commercial software every three years," Flewelling said. The small liberal arts university situated in the same town as ESRI emphasizes the interdisciplinary nature of emerging occupations. That emphasis is one of the reasons that the university does not offer on-line learning for its certificate program. "Not many on-line courses can get the nuances of spatial information the way living, learning proximity can. If industry is looking for critical thinking skills, then we are well-positioned to offer the why and the how of posing questions and solving problems."

Sue Kalweit, an expert in GIS and education for Booz Allen Hamilton, says that universities are in the business of educating students to go down one of two tracks: either to get a job, or to do research. It's a challenge for universities to stay current in such a technologically driven industry, and to understand what students need to learn in order to obtain or improve skills and competencies for the future. Kalweit has a saying that sums it up: "It's the data, stupid!" For clarity, she adds, "The great news is: there's a ton of data. The bad news is: there's a ton of data. Too few people really understand quality, accuracy, relevancy, and currency."

Certification and Licensure

Kalweit states that there is room for people of all technical backgrounds in the field. When considering GIS pedigrees, it helps to step back and delineate four categories: 1) professional certification; 2) professional licensure; 3) academic certification; and 4) accreditation of institutions.

There is a distinction between certification and licensure. ASPRS' website describes its certification this way:

...ASPRS certification is official recognition by one's colleagues and peers that an individual has demonstrated professional integrity and competence in their field. As such, the ASPRS voluntary certification program is considered "specialty certification." It is not a substitute for licensure as, for example, a Land Surveyor or Professional Engineer. Licensure is a legal act on the part of states to protect the public health, safety and welfare. It is a procedure by which various state and local governments require the licensing of certain professions, practices, trades, etc., under formal statutes and ordinances to protect the well-being of its citizens. Licensure may be required by your local state, county, etc., whether or not you secure certification.

Professional accreditation programs are also entirely voluntary. The GISCI describes its program this way:

The GIS Certification Institute (GISCI) is a tax-exempt not-for-profit organization that provides the geographic information systems community with a complete certification program. GISCI offers participants, from the first early years on the job until retirement, a positive method of developing value for professionals and employers in the GIS profession. A GISP is a certified Geographic Information Systems Professional who has met the minimum standards for ethical conduct and professional practice as established by the GIS Certification Institute (GISCI).

According to Karen Schuckman, past-president of ASPRS (and CP, PLS, MGIS, in the Department of Geography,

John A. Dutton e-Education Institute, College of Earth and Mineral Sciences at The Pennsylvania State University), in the last 10-15 years, during which licensing acts have been put into effect, some of the subdivisions within the industry require a professional license to conduct business. About 8-10 states actively enforce licensing acts that include photogrammetry and some GIS activities. Most professional licensure programs require a four-year degree.

Academic certificates are those offered at four-year academic institutions. GIS is often treated not as a minor, per se, but as a corollary to other majors such as Anthropology. For instance, Penn State offers on-line learning for its Geospatial Education Portfolio through its Penn State World Campus. Students have three Post-Baccalaureate programs to choose from: Certificate of GIS; Certificate of Geospatial Intelligence; and Master of GIS. The Certificate in GIS helps current and aspiring practitioners to become knowledgeable and skillful users of geospatial data and technologies.

> People who can think spatially-where things are, in relation to other things-are in great demand.

The Certificate in Geospatial Intelligence helps current and aspiring analysts to combine spatial thinking, information literacy, and geospatial technology skills with knowledge of cultural and political geography and a commitment to ethical practice. The Master of GIS is designed for experienced practitioners who aspire to leadership in the geographic information systems profession. ***Figure 1*** shows where graduates are now.

Finally, accreditation programs are in place when one organization, such as the USGIF Academy, accredits another institution. In this effort, the USGIF Academy appears to be zipping along as fast as the technology itself. Formed in 2004 by the United States Geospatial Intelligence Foundation to meet the demand for skilled GIS professionals, the Academy was created to support lifelong learning and professional development in the skills and competencies associated with Geospatial Intelligence.

Through relationships and programs with educational institutions, the Academy is working to develop at colleges and universities the USGIF accredited programs that lead to the awarding of the Geospatial Intelligence Certificate. Ultimately, the Academy aims to ensure the GEOINT tradecraft's continuance as a critical part of our country's homeland and national security.

Partnership: Education, Industry, and Government

Security has emerged as one direction the field is going. "We have had students in Egypt, S. Korea, Afghanistan, Bagdad—obviously people stationed in the military," says Schuckman, who adds that Penn State definitely worked to create its Geospatial Intelligence Certificate with the USGIF and a specific segment of the industry in mind. Penn State is in the process of developing an on-line program in Homeland Security to be rolled out in 2010. "More people are starting to be impacted by the technology at the personal level—Google Earth imagery is everywhere. People are starting to get an awareness of how individuals can become empowered to create virtual communities and locate things in time and space. This forever changes the way we solve problems. It offers a revolutionary way of solving a problem," she says.

Indeed it is challenging for universities to try to keep pace with the information revolution, particularly in new areas such as spatial statistics where there aren't very many people who understand the topic, let alone who can teach it. The term refers to a variety of techniques, many still in their early development, using different analytic approaches and applied in fields as diverse as astronomy and engineering. As it stands, spatial statistics currently is taught by only a very small group of experts within the (USGIF) Academy.

Diana Sinton, who teaches GIS to undergraduate students and faculty at the University of Redlands, suggests that gaps exist in the way GIS is taught—and learned—especially with regards to how experts appreciate how non-experts understand how software represents and models features and characteristics of the natural and social world. This gap complicates the idea of mastering a GIS education because it questions more fundamental standards of geographic education today.

"We are just beginning to understand how non-experts extract meaning from maps and images and to design cartographic techniques that can represent the uncertainty of spatial data," says Sinton. "Think of a city map that represents buildings along a street grid. Then think of the data set that represents the vast amount of information about the buildings, and what each XY coordinate represents on the map. One puts a whole lot of thought into designing the information that then gets reduced down to being a point on a map."

The emergence of Google Earth may be complicating the necessary understanding of critical thinking regarding spatial information. Google Earth allows one to compare images, but it cannot do anything with those images, nor does it provide an ability to do real analysis on the images.

To be sure, technology is creating new career opportunities related to economics, health, climate, urban planning, national defense, natural disasters, and homeland security, to name a few. All of these fields are becoming highly interdisciplinary, offering unique ways of looking at the world and solving problems. Going forward, it is clear that universities must be sure that they see the forest for the trees, and that industry must work hand in hand with governments and educational systems in order to prepare present and future skilled employees.

STATE of the WORLD FORUM

MOBILIZING TO SAVE CIVILIZATION:
A TEN YEAR PLAN TO ADDRESS CLIMATE CHANGE

FEBRUARY 28 - MARCH 3, 2010
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STATE *of the* WORLD FORUM

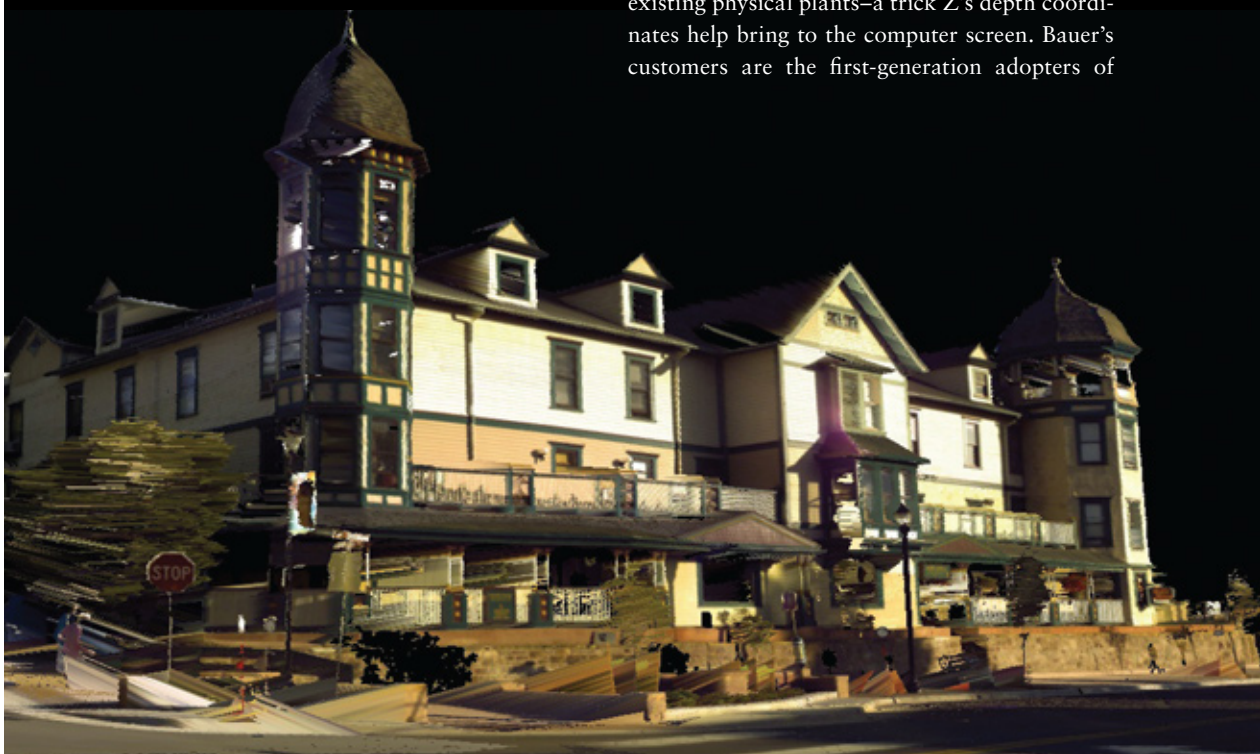
X, Y & Z: True 3D

AND TIES TO ROI

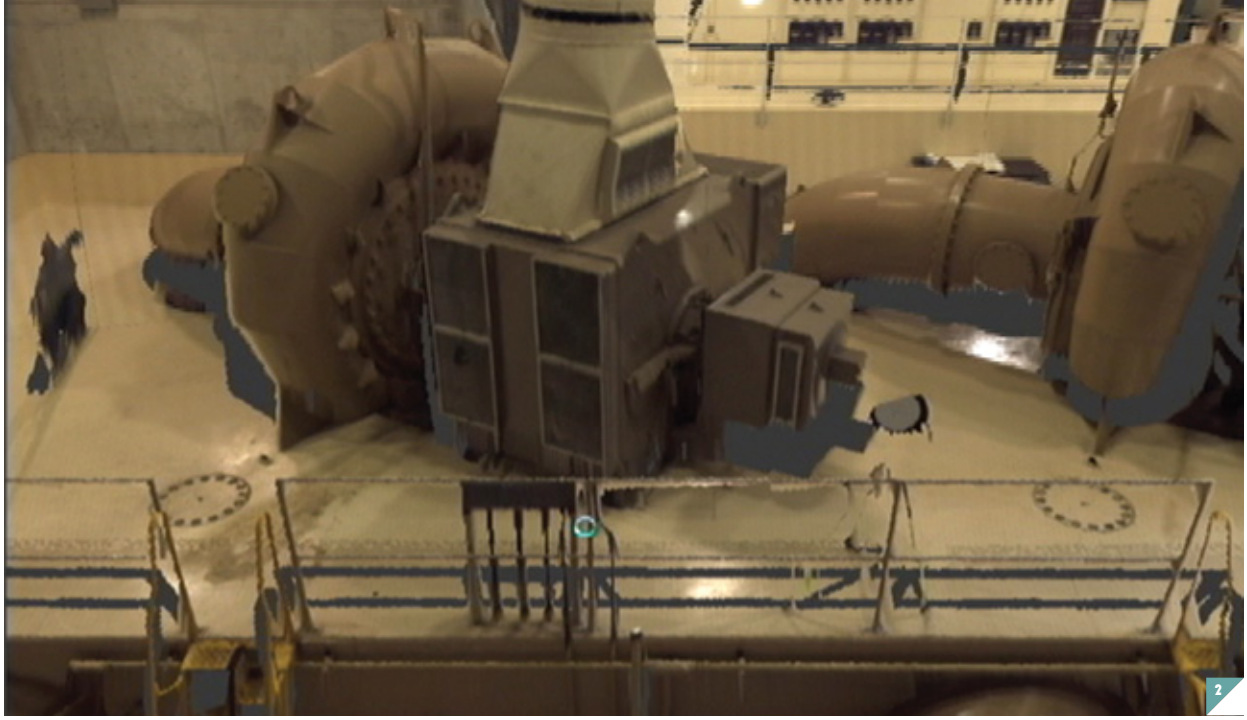
ROD FRANKLIN
Reporter
Denver, Colo.

There's a good chance you haven't met Z. He's easy to miss. In any room, Z tends to hang back. But George Bauer wants to introduce him to as many people as possible. Though Z's visualization skills may sound like fantasy, there is no magic in his depth coordinate—only practical, useable data.

As vice president of marketing for the Irvine, California company INOVx Solutions Inc., Bauer spends his days working the logistics of laser scanning and software configuration contracts for companies that want to give 3D form to their existing physical plants–a trick Z's depth coordinates help bring to the computer screen. Bauer's customers are the first-generation adopters of



▼FIGURE 1
This model from an InteliSum project in Manitou Springs, Colorado was created to verify how a new road design would affect the existing buildings on the street.



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high-definition 3D virtualization, and they're using the technology to trim maintenance routines, manage assets, heighten their awareness of surrounding danger, and catalyze knowledge transfer among the employee rank and file.

Players in the energy, chemical, food, construction and drug manufacturing sectors are crunching ledger numbers that make Z's presence look more and more like a worthy investment. As the oft-excluded member in the full trio of X (width), Y (height) and Z (depth) coordinates that must be present in any algorithm to synthesize visual space three dimensionally, Z can be integrated into an oil refinery's existing information systems at prices ranging from $400,000 to $500,000 for a single processing unit to several million for an entire plant, Bauer says.

Once Z is there, 2D pictures of coking units or heat exchangers morph into alternate cartoon realities. Z lives wherever the front of something turns gradually into the back of it–an essence that makes possible the study of components that previously remained hidden within complex mechanical environments. This capability is a benefit that can turn the cognitive intellect squarely on its ear. In fact, the overall result of Z's impact on industry promises to be a game-changing paradigm for those professional service categories in which visual acuity ranks high. Of these, engineering is probably the most natural beneficiary.

A central question for the potential 3D client is whether the technology can pull the weight of its own initial investment, and then some. If the answer is yes, a state transportation department might be interested in hiring a vendor like InteliSum Solutions Inc., another Irvine firm, which specializes in LiDAR-scanned 3D modeling primarily for highway contractors, plant operators, building managers and architects. Or, if the projected ROI looks solid for a utility, earthmine Inc. of Berkeley, California, might get the call to scan miles and miles of service area with its fleet of truck-mounted panoramic stereo cameras.

Promising returns on scanning investments have been easiest to justify in capital-intensive industries. Their physical plants stand as the icons of early adopter 3D success stories. INOVx has completed hundreds of scanning and software consultation projects, and counts among its clients giants like Shell Oil, Procter & Gamble, Dow, BP, Chevron and the U.S. Navy. Its literature cites the following ROI figures:

- **more than $1 million in corrosion monitoring savings for Shell Canada;**
- **productivity increases of 25 to 30 percent for thickness monitoring location inspection teams working at a joint venture refinery in Venezuela;**
- **a shorter engineering schedule and 50 percent reduction in reworks, due to improved design accuracy and efficiency, at a ConocoPhillips refinery that required new piping in a congested area;**
- **an estimated $10 million benefit in fire damage repairs at another plant after workers were able to complete the job two weeks faster than originally anticipated.**

Engineers assigned to the twisting mazes of pipe and pump that INOVx models for these organizations use a solution called RealityLINx to stoke their talents to a level that is at once both analytic and intuitive. The software

ties 3D visuals into existing enterprise management databases, operations and maintenance software, CAD, and document management systems. This merger helps an employee combine his data-intensive review of a factory subsystem with the more visceral act of seeing it, and at all possible angles–a technical mashup of the human analytic process.

The ability to "walk" through a plant from a workstation desktop, aided by visual procedures embedded in 3D models, can result in leaner inspection and maintenance routines. INOVx quotes studies showing that the combined effect of such benefits can greatly reduce the effort mechanics spend on maintenance planning and, in the process, can hike subcontractor wrench time from 30 to 55 percent. More time on the wrench leads to quicker turnarounds. Fast turnarounds translate into increased plant availability, which leads to higher profits.

> The overall result of Z's impact on industry promises to be a game-changing paradigm for those professional service categories in which visual acuity ranks high.

Building a business case for 3D versus the traditional 2D drawing and CAD approach actually begins on a basic level. Engineers at most plants should be able to list the top ten mechanical systems that are the most logical candidates for 3D modeling. These components would benefit from scanning for the simple reason that an open view of their back side is something that employees would like to see on a frequent basis.

When scoping out a plant for isolation points and clearance metrics, obstructed vision has always been a paramount issue. "It comes up a lot," Bauer says. "In this case you can go to the model query and say, 'show me the next available valve upstream.'"

Utility substations stand as another category that can fare well in this new working dimension. According to a 2005 paper by a Bentley Systems Inc. engineer, strong potential exists for cost improvements in areas like substation site selection, design alternative evaluation, design automation, virtual walk-throughs, commissioning, communication with neighbors, operations, and maintenance. Without Z, these cost benefits are but a pipe dream.

Figuring a leveraged ROI in support of virtualization has also been a fairly clear-cut chore for architects and transportation experts. InteliSum Inc. directs much of its attention toward these markets. Its LiDAR scanning services are based on the photo-mechanical properties of the InteliCamera, which is designed to capture information in a way that allows for the commingling of XYZ coordinates with RGB color values and GIS data inside individual pixels that have been rendered "intelligent." This commingling produces 3D pictures that double as three-tiered datasets. See ***Figure 1***.

Shana Lindsey, director of research and bridge operations for the Utah Department of Transportation, has lauded InteliSum's approach as an effective alternative to traditional surveying. When her department hired the firm to model a bridge badly in need of replacement, workers were able to build the structure miles from its target location, transport it and then install in a single weekend. Lindsey quoted a cost savings on the order of 75 to 90 percent, much of it owing to the higher accuracy of 3D over 2D drawings and consequent elimination of return trips to the field.

The accuracy of 3D LiDAR has made oil and gas customers as integral a part of InteliSum's client base as they are for INOVx. According to InteliSum media and marketing specialist Kirk Edwards, CAD wasn't enough for firms in Brazil that contract to work for Petrobras, the nationalized oil company. Modeling with LiDAR to produce LD3 files and Intelipixels that can be poured seamlessly into CAD systems has helped them reduce the margin of error inherent to the 2D drawing approach. See ***Figure 2***.

◀ FIGURE 2

This is a screenshot of the actual instant 3D model for a U.S. pumphouse that needed a scrubber replacement. By using the Instant 3D Model, the engineer at InteliSum was able to verify that the new scrubber would fit and connect correctly in the existing environment

Any ROI analysis engaged to weigh the 3D option should account for both short-term and long-term cost efficiencies. Frank Algarin, InteliSum's vice president of sales, says the initial expense for LiDAR scanning doesn't seem so dear to those clients who have seen how the InteliCamera can produce millions of reference points in the span of a day, as opposed to the 200 or 300 points recorded per shift in more traditional transit surveying.

According to Algarin, LiDAR's swifter modality costs about $75,000 for ten days of scanning–a fraction of the estimated $120,000 a company might spend for 30 days of conventional surveying, followed by three weeks of post-processing. This amount of scanning is sufficient to cover 100,000 square feet of a building or three to four stories of a 500-square meter oil platform. InteliSum's fee also pays for post-processing and a CAD deliverable.

However, the more permanent ROI is where virtualization makes its real play. "When you're looking back at ROI, it really gets back to more information and better information when you're conceiving your design," Algarin explained. "Then it starts to escalate geometrically after that, as far as the savings. Because once you collect your 3D drawings, they're done."

INOVx has quantified this impact over a one year period. Its subject of study was a 100,000-barrel-per-day refinery. Based on an annual cost of $100,000 per employee and a conservative guess of 12.5 percent improved productivity for each group of 60 operations and engineering staff members, the ROI equation yielded an estimated $750,000 in yearly cost savings.

Somewhere down the road, a company may trick out its 3D datasets to model "what-if" scenario planning and find itself drawing additional returns in the process. Bringing a company's procedural culture

◀ FIGURE 3
earthmine's mobile stereo panoramic collection system drives and scans hundreds of miles a day.

▼ FIGURE 4
An application built on earthmine's Flash Viewer API that provides mapping and measurement tools shows the ferry building in San Francisco with an inset satellite map.

to this point, naturally, will require the devotion of some front-end time in the interest of saving more later. "This is a disruptive technology," says Bauer. "You need to re-engineer your work processes and work in a different manner."

Benefits may compound, once staff members have learned the software. Virtualization can help a training professional transcend intellectual biases that for years have compelled him to declare that adult learning theory sits already at its theoretic apogee and isn't going anywhere new soon. Or experienced workers may use the models informally to convey knowledge in ways that are happily symbiotic with the bent of their younger colleagues, who have grown up in a world that barks its endorsement of the newest and glossiest technologies.

Another type of ROI analysis considers the value-added product factor. Earthmine Inc. has focused on the nascent market for large-area 3D mapping, using its panoramic stereo cameras to scan hundreds of miles daily at normal driving speeds for clients in government, utilities and online mapping. See ***Figures 3-4***. Because the firm offers an end-to-end solution for collecting, processing and delivering point cloud data, its licensing fees take into account the multiple ways a customer can use the information.

On earthmine's side of the transaction, ownership of the data remains intact and continues to draw revenue each time a new customer licenses it. "We want to build a large data library of street information that can be shared amongst many stakeholders," explains John Ristevski, one of the company's founders. "We're definitely going for the platform play." On the customer side, data purchased from the platform for a singular purpose will cost less than data being redeployed to many markets. With earthmine's application program interfaces (APIs), partners can produce a wide range of end user applications capable of pulling returns in their own right.

"If they're creating derivative products from our content, it's priced at one tier," Ristevski said. "If they are using it more as an interface, like in a local search Website, it is priced at another tier."

To varying degrees, the door is opening for some new 3D modeling markets. Some of the most promising of these lie in the realms of telecommunications, tax appraisal, public safety and emergency response. InteliSum has been devoting more time lately to building information modeling–that algorithmic hallucination where architects turn cartoon corners and descend cartoon staircases that aren't yet built–and reports a five-to-one ROI for its most recent project.

From an investment perspective, other applications of 3D visualization may be a little iffy. Because quick response planning tries to foresee the intangible, the technology could find itself positioned as hero in one modeled disaster scenario, but a false and costly prophet in another. For insurance companies, there's the question of who–underwriter or beneficiary–ultimately pays for the rendering process, and whether the increased transparency it provides should inspire a trend toward lower premiums or be used to clobber customers with higher costs. Finally, spokesmen for both InteliSum and INOVx say that the real estate sector, at least for now, views 3D modeling more as a nice-to-have than an essential.

Tired soldiers of the business wars will need to be convinced that 3D visualization should not be consigned to the throwaway status of mere eye candy. What will become more evident to them over the next few years is the continuing cascade of supercharged pixels into our working world.

To some, it does look a bit like fantasy. But those with down-to-earth experience in visualization should be able to reassure the would-be 3D customer that Walt Disney has left this particular room.

Z told them so.

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