APOGEO SPATIAL

ELEVATING GLOBAL AWARENESS

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"WorldView-3 will enable us to help our customers see through smoke, peer beneath the ocean's surface and determine the mineral and moisture content of the Earth below...all with unprecedented clarity."

– Jeffrey Tarr, CEO, DigitalGlobe p. 14

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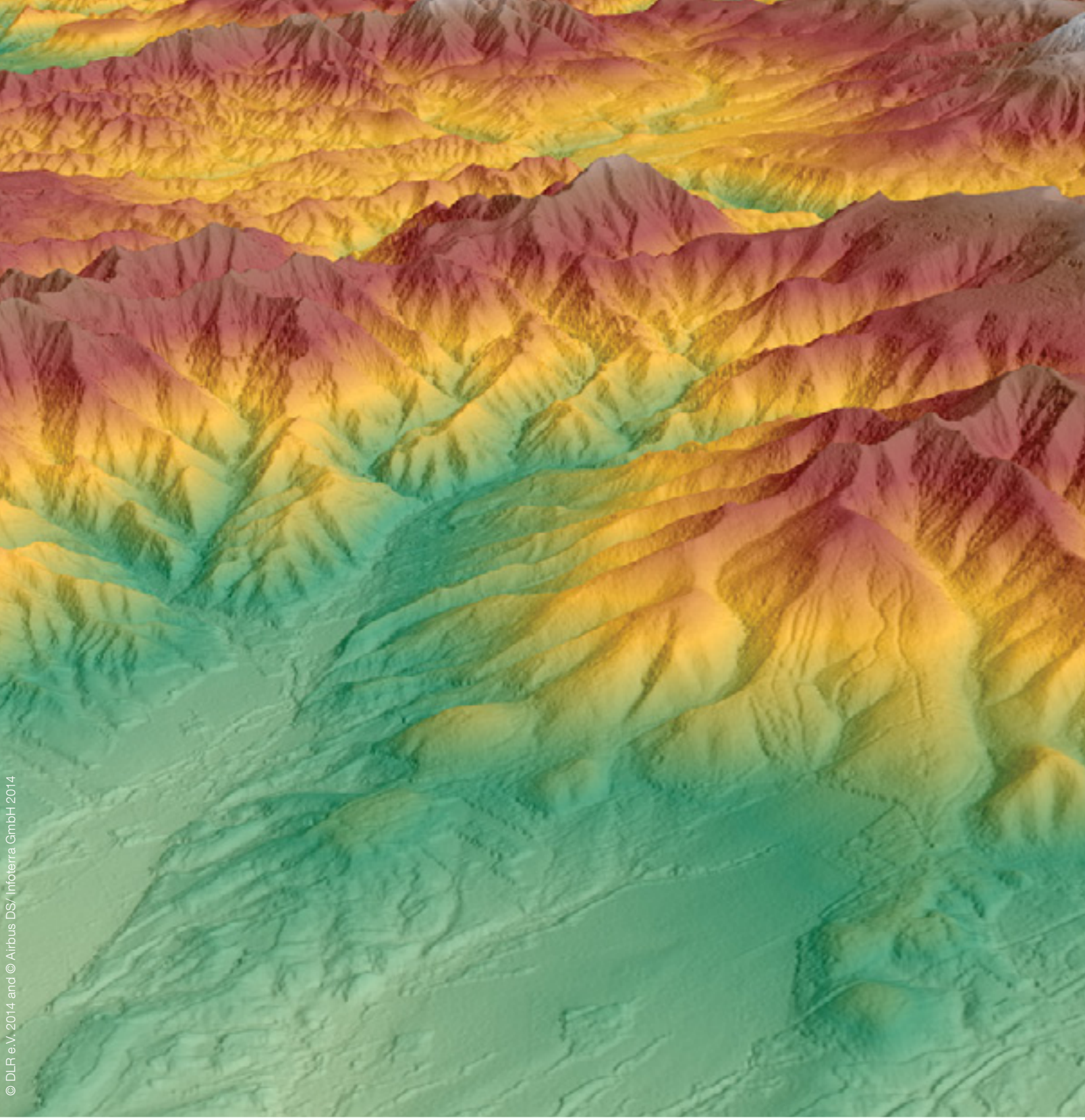
Fiji Islands, July 3, 2014, courtesy of Airbus Defence and Space. See page 6.

APOGEO SPATIAL

Apogeo Spatial communicates the power of geospatial tools and technologies in managing the world's environment and scarce resources, so that the global population has the security of water, food and energy.

APOGEO SPATIAL PROVIDES VISUAL INTELLIGENCE elevating global awareness for the long-term sustainability of the planet and people. Business, government and academic professionals find here the information–and inspiration–for using geospatial tools to build a more sustainable world. With the fresh, relevant insights from expert contributors, stunning visuals and clear examples of the technologies, those who make critical business and policy decisions about the world's resources will understand the visual power of remotely sensed data.

COLORADO RIVER DELTA
The Colorado River Delta is the region where the Colorado River flows into the Gulf of California (also known as the Sea of Cortez), in Mexico. CIR (color infrared) image captured on June 1, 2014, by RapidEye. Courtesy of BlackBridge.



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Columns

Features

COVER IMAGE

Fiji Islands

THE REPUBLIC OF FIJI IS AN ISLAND country in Melanesia in the South Pacific Ocean about 1,100 nautical miles (2,000 km; 1,300 mi) northeast of New Zealand's North Island. Its closest neighbors are Vanuatu to the west, New Caledonia to the southwest, New Zealand's Kermadec Islands to the southeast, Tonga to the east, the Samoa's to the northeast, and Tuvalu to the north.

Fiji's islands were formed through volcanic activity starting around 150 million years ago. Some geothermal activity still occurs on the islands of Vanua Levu and Taveuni.

The country comprises an archipelago of more than 332 islands, of which 110 are permanently inhabited, and more than 500 islets. The two major islands, Viti Levu and Vanua Levu, account for 87% of the population of almost 860,000. The capital and largest city, Suva, is on Viti Levu. About three-quarters of Fijians live on Viti Levu's coasts, either in Suva or in smaller urban centres like Nadi (tourism) or Lautoka (sugar cane industry).

This multispectral 6-meter image was taken July 3, 2014, by Spot 7. Copyright: Airbus DS/ Spot Image 2014. ∧♂

APOGEO SPATIAL

Formerly Imaging NOTES

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MISSION

Apogeo Spatial communicates the power of geospatial tools and technologies in managing the world's environment and scarce resources, so that the global population has the security of water, food, and energy.

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

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TOPCON

Big News for Imagery Access and "The Overview Effect"

Myrna James Yoo
Publisher and Managing Editor
Apogeo Spatial and *LBx Journal*
Owner
Blueline Publishing LLC

DEAR COLLEAGUES,

Dr. Ray Williamson has served as Editor of *Apogeo Spatial* since my company, Blueline Publishing LLC, acquired it in 2005 (then called *Imaging Notes* from then Space Imaging). He has recently retired from Secure World Foundation, where he was Executive Director, and most recently a Senior Advisor. I am thrilled to say that Ray has agreed to stay on as Editor, to be with us as we celebrate our 30th Anniversary in 2015!

In this issue, we focus on the newest commercial satellite launch from DigitalGlobe, WorldView-3, which for the first time will provide views into water, through smoke, and even into the Earth to determine moisture and mineral content of the soil. See page 16 for images showing fire through the smoke, taken just 15 days after the launch in August 2014. The super-spectral capabilities are being proven already.

Esri's ArcGIS Marketplace, launched in September 2013, provides their customers with easy access to a huge amount of content, from many companies. We provide a look at the imagery that is available there from BlackBridge's RapidEye, and the satellites of DigitalGlobe and Airbus Defence and Space. The news in July 2014 is that Airbus DS is allowing users to directly task their satellites, which is unprecedented, and quite exciting. Pricing starts at $1620. Read about it on page 20.

On the policy side, we hear from the Director of the UN Office for Outer Space Affairs (UNOOSA), Simonetta Di Pippo, about their commitment to capacity building in space technologies and to disaster response on page 28.

Our regular column, *On the Edge*, discusses a new book, *The Collapse of Western Civilization – A View from the Future*, by the esteemed authors of *Merchants of Doubt*, Naomi Oreskes and Erik M. Conway. It looks at, from the future, why our civilization collapses when we have the most advanced human intelligence and technologies in history. But author Hans-Peter Plag is optimistic that this will not happen. The story appears on page 36.

Of course, the issues of disasters and sustainability do not stop at our borders. The natural ecosystem is interconnected; rivers run through political boundaries. As we know, we cannot see national borders from space. One thing that we can see from space is the entire planet, all at once, from a new perspective—one that fundamentally changes our view of the world.

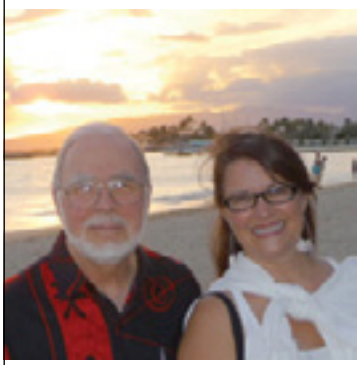
This change in perception has been called "The Overview Effect." Frank White in his book of the same name notes, "Nearly all astronauts report a lasting 'globalization' of awareness concerning environmental, political, and social issues." Astronaut Mark Garneau is quoted as saying, "You become more of a global citizen." And Edgar Mitchell, Apollo 14 astronaut who walked on the moon in 1971 sums it up, "We went to the moon as technicians. We returned as humanitarians."

I experienced something like this change in perspective, and perception years ago from traveling around the world solo for over a year. The world became a very small place, and I saw how everthing is interconnected. The beauty is overwhelming, and there is a sense of unity. Of course, it was not the same as seeing the Earth from space, but the way that it changed my perceptions about our fragile planet, and that we are all on it together, was very similar.

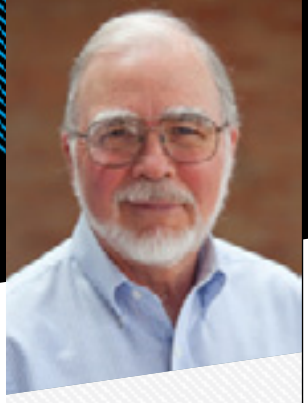
I believe if more people could experience this Overview Effect, whether by seeing the Earth from space, or studying the cosmos, or traveling the world, that conflict would decrease and more people would be aware of how we need to work together to take care of our planet and scarce resources. Perhaps space tourism will help!

As Hans-Peter Plag points out regularly in his column in this magazine, the science is clear that we must make changes for humanity to survive, as storms get worse and coastlines and entire islands disappear…

Share your own Overview Effect with us on social media.



Editor Ray Williamson and Myrna James Yoo at the IGARSS meeting in Hawaii, July 2010.



Building Geospatial Capacity in Mesoamerica

Ray A. Williamson, PhD
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Apogeo Spatial
Denver, Colo.
www.apogeospatial.com

EARTH OBSERVATION ANALYSTS FROM DEVELOPING COUNTRIES face several daunting challenges in pursuing their chosen profession. They have very limited budgets for data and software and they often have to work with hardware that is far from state-of-the-art. Further, local or national opportunities for training are often limited.

When Secure World Foundation (SWF) teamed up with the Regional Centre for Space Science and Technology Education for Latin America and the Caribbean (CRECTEALC), and the Mesoamerican Center for Theoretical Physics (MCTP) in November 2013 (see *Apogeo Spatial*, Winter 2014) to offer a training workshop for Mesoamerican Earth observation analysts and disaster management personnel, two of the persistent needs that workshop participants cited were for training in free, open-source software and guidance in locating sources of free or low-cost Earth observation (EO) data. We began the process of responding to these needs with the November workshop, but intensified the effort in May 2014 with a follow-on workshop in Tonantzintla, Mexico, the home of the Mexico Campus of CRECTEALC.

Here again, the focus was on building the capacity of Mesoamerican EO data analysts and disaster management professionals to mitigate the effects of natural disasters and to manage response effectively. This second workshop was held on the campus of the Instituto Nacional de Astrofísica, Óptica, y Electrónica (INAOE), which also houses CRECTEALC activities.

CRECTEALC, MCTP, and SWF supported travel and accommodations for those participants in need of assistance. Other partners included the U.S. National Oceanic and Atmospheric Administration (NOAA), the Group on Earth Observations (GEO), the Committee on Earth Observation Satellites (CEOS) and the Mexican Space Agency (AEM).

Workshop participants included representatives of civil protection organizations and regional GIS and remote sensing analysts from

Introducing CRECTEALC

The Regional Centre for Space Science and Technology Education in Latin America and the Caribbean (CRECTEALC) was established on 11 March 1997 through an Agreement signed by the Governments of Brazil and Mexico. At present, CRECTEALC is based on two campuses, located in Brazil and Mexico. In June 2003 the Center became affiliated to the United Nations.

The Center provides high-level education and training that develop skills and scientific knowledge in remote sensing and ancillary technologies, satellite communications, satellite meteorology and atmospheric sciences through 9- and 11-month education programs. CRECTEALC also organizes one-week workshops

◀ FIGURE 1.
Attendees at the Workshop on the Use of Open-Source Software and Satellite Data in the Prevention of, and Response to, Disasters in Mesoamerica, in Tonantzintla, Mexico, May 2014.

nine countries: Brazil, Colombia, Costa Rica, Dominican Republic, Guatemala, Honduras, Mexico, Panama and the United States. Participants from Costa Rica, Guatemala, Mexico and Panama presented their experiences with programs in disaster response analysis.

The workshop emphasized the wide range of free data and analytic tools available online. Representatives of NOAA, NASA, the World Meteorological Organization (WMO), and the Famine Early Warning System (FEWS) made virtual presentations about the data and analytic tools they have available. Table A provides links to these sources of information and tools.

We also devoted three days to hands-on training in the use of Q-GIS and TerraMA² by Dr. Scott Madry of the University of North Carolina and Dr. Laércio Nakigawa of the Brazilian National Institute of Space Research. The training was supplemented by digital manuals containing detailed instructions.

We chose to provide training in Q-GIS because it is widely used and supported in several languages, including Spanish. Also, it has a module for preparing responses to a natural disaster. We chose TerraMA² because it is a very powerful risk analysis software, suitable for most geospatially-related risk situations. As a testament to its practical utility, this software package is routinely used by municipalities throughout Brazil. Like Q-GIS, it is free and open-source, which means that individuals can add new modules or adapt the code to fit specific situations.

In discussion, several issues emerged that merit close attention. These issues extend beyond the workshop's agenda, but need addressing if we are to improve the use of geospatial tools for disaster risk reduction.

Disaster managers often find that introducing new tools such as EO data and GIS analysis into their workflow can be difficult and frustrating. Once they see that the capabilities of remotely sensed data and GIS can solve some of their pressing problems of timeliness, accuracy of information, and ability to assess risk, they then have to deal with the hard task of adjusting to the new tools and altering procedures to fit them. The GIS/image analysis community could assist that important process by focusing more effort on helping disaster managers to introduce their methods into workflows.

Participants noted the general lack of coordination and interaction among government agencies dealing with natural disasters. All too often government agencies with a role in disaster mitigation and response do not coordinate well, each going about its part of the effort independently of the others. Indeed, incompatible communications systems

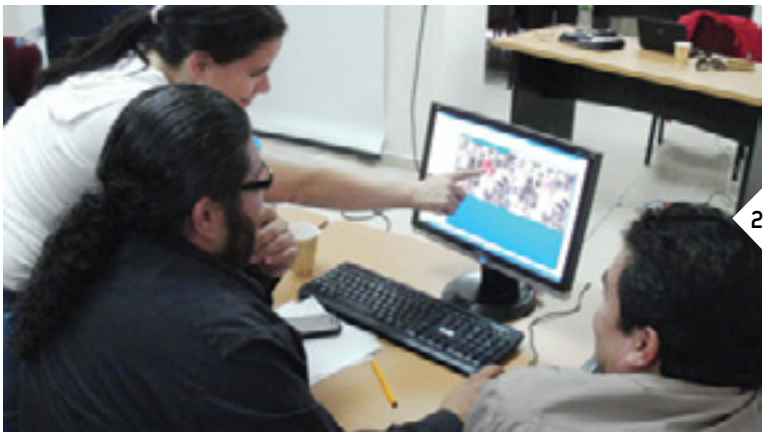
to promote regional cooperation and the strengthening of regional capacity in space policy, legislation and technical aspects of space applications.

The campus in Brazil benefits from the facilities made available to it by the National Institute for Space Research (INPE). Similar high quality facilities are found at the campus in Mexico which is hosted by the National Institute of Astrophysics, Optics and Electronics (INAOE). The languages of education of the Centre are Spanish, Portuguese and English.

In carrying out its activities, CRECTEALC collaborates in various forms with many other institutions. In 2013, CRECTEALC and Secure World Foundation signed a Memorandum of Understanding committing them to work together on projects of mutual interest.

may make coordination nearly impossible.

Recognizing this impediment to efficient and effective disaster mitigation and response, the Dominican Republic set up an inter-institutional group on geospatial information for decision making in risk management. Xavier Rodriguez of that country's Civil Defense and National Commission for Emergency Response, gave a compelling account of why and how that entity was established with commitments made by eleven state ministers. Importantly, the process had the backing of the president of the Dominican Republic, a fact that played a strong role in making sure the process carried through to completion.



▲ FIGURE 2. Training course for Mesoamerican countries on using radar images for flood mitigation, courtesy of UN-SPIDER.

Throughout the workshop, we urged the value of regional cooperation and suggested that participants create a Mesoamerican network of GIS professionals to help and support each other. In a surprise presentation during the last hour of the last day, workshop participants revealed that in the evenings they had been working on the creation of a new organization, entitled the Mesoamerican Open-Source Disaster Activities or MOSDA. For us, this was an exciting development. Among other things, this organization, if successful, will be able to provide timely and accurate information to decision makers. Unsurprisingly, this announcement put a big smile on every one of the organizers' faces.

It is of course much too early to say whether MOSDA will be successful, but it is an important step forward. We wish them well. It is now up to others in the region to help this fledgling group prosper and reach its goals, among which is a reduction in risk and the resulting losses from natural disasters.

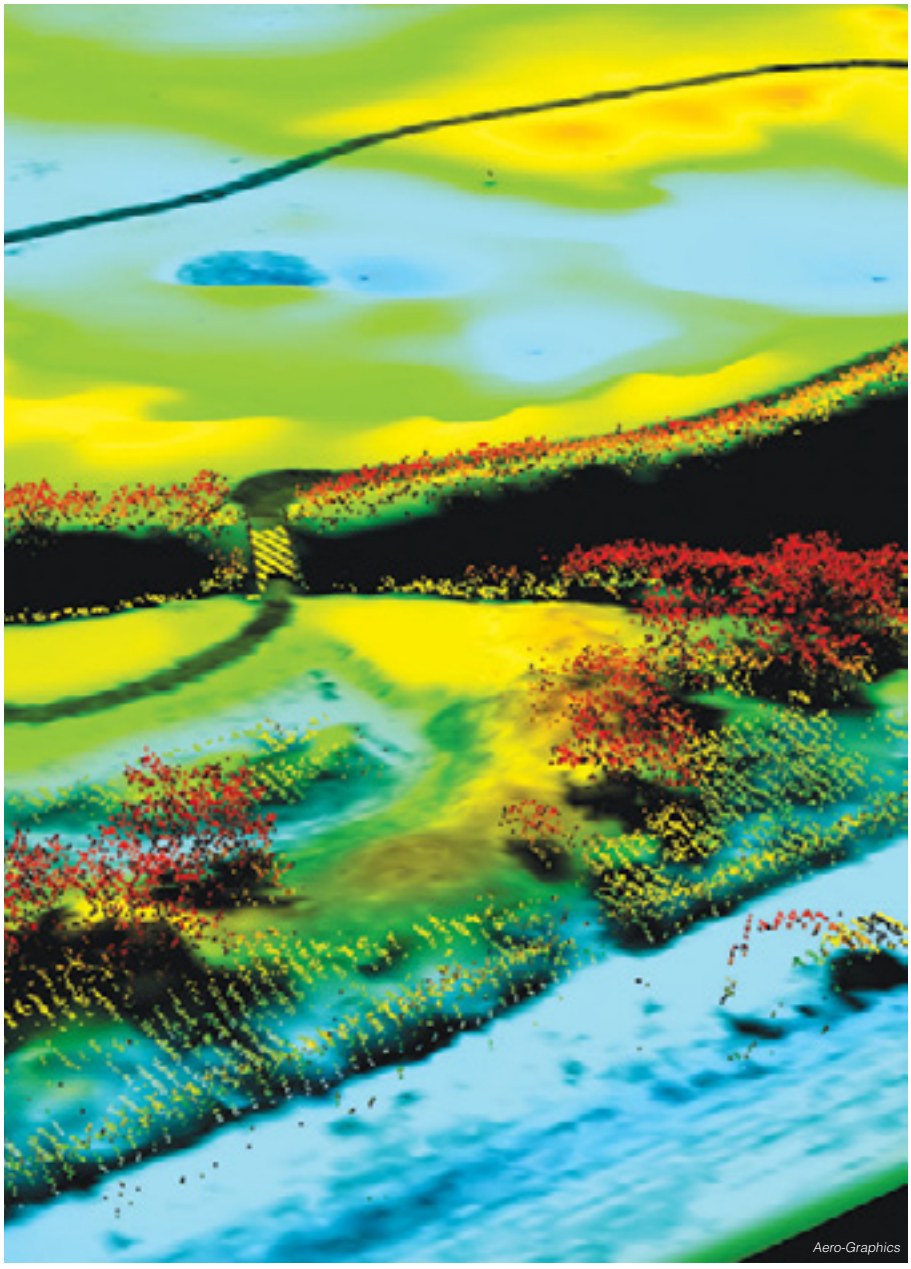
Funding agencies tend to focus their attention on the response phase of the disaster cycle. Nevertheless, disaster managers need a range of data tools to be fully effective during all phases of the disaster cycle—mitigating the effects of disasters by advance preparation. The disaster response phase garners the headlines, nationally and internationally. Yet the other phases of the disaster cycle are equally important to the long-term stability and productivity of society.

Finally, access to timely data at a variety of spatial, spectral and temporal resolutions and their conversion into useful information remain impediments to realizing the full benefits of geospatial information. Fortunately, as noted in several *Apogeo Spatial* issues, the new commercial systems, which are seen as disruptive to the EO data marketplace, may provide welcome relief to disaster mitigation and response agencies by making a wide variety of data available to civil protection agencies at very low cost. We can hope that they prove a very positive disruption for the geospatial community. ∧○

Table A. Useful Websites For Data, Information and Tools

- GEONETCast Americas: http://www.geonetcastamericas.noaa.gov
- Committee on Earth Observation Satellites: http://www.ceos.org
- CEOS COVE tools for free data acquisition: http://ceos-cove.org
- Famine Early Warning System Network: http://www.fews.net
- World Meteorological Organization-Coordination Group for Meteorological Satellites (WMO-CGMS) Virtual Laboratory for Education And Training In Satellite Meteorology: http://www.wmo-sat.info/vlab
- UN-SPIDER Knowledge Portal: http://www.un-spider.org
- SERVIR Disaster Assistance: https://servirglobal.net

International LiDAR Mapping Forum



International LiDAR Mapping Forum

is a technical conference & exhibition focused on data acquisition, fusion, processing & point clouds for airborne, terrestrial and underwater LiDAR used to support transport, urban modelling, coastal zone mapping, utility asset management and more.

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WorldView-3!

Seeing Through Smoke, Into Water and Earth

BY LEONARD DAVID / CONTRIBUTOR

1

2

There is a new, ultra-powerful eye in the sky with the liftoff of DigitalGlobe's WorldView-3 spacecraft, billed as the next generation remote sensing satellite. It can produce the most sophisticated images yet available for commercial applications.

Hurled spaceward from Vandenberg Air Force Base on August 13 into California-blue skies atop an Atlas V 401 rocket, WorldView-3 is now up and operating—and delivering on the pre-launch hopes of opening a new era in commercial Earth remote sensing.

WorldView-3 offers high spatial resolution, multispectral satellite imagery useful for civil government mapping, land-use planning, disaster relief, exploration, defense and intelligence, visualization and simulation environments, among others. But here's the eye-opening capability: seeing through smoke, and into water and Earth.

Among spacecraft superlatives, WorldView-3 will have an average revisit time to any desired imaging location of less than 1 day and is capable of collecting up to 680,000 sq km per day. WorldView-3 will

send a blistering 1.2 gigabytes of data back to Earth every second. Operating at an altitude of over 380 miles (617 kilometers), WorldView-3 will collect imagery as small as 1-foot (31 centimeters) across in resolution.

RESOLUTION RELAXATION

DigitalGlobe (Longmont, Colo.) recently received permission from the U.S. Department of Commerce to sell even higher resolution satellite imagery. Once fully operational, WorldView-3 will provide the commercial market images with significantly greater clarity and spectral depth than anything previously available. And as the sharpest-eyed commercial Earth-watching satellite ever built, WorldView-3 is on a mission to observe our planet in stunning detail.

Last June, the U.S. Department of Commerce relaxed satellite resolution restrictions, green-lighting permission for DigitalGlobe to collect and sell imagery at the best available commercial resolutions. Earlier limits curbed anything smaller than 50 centimeters from being shown on commercially-snapped satellite photos provided to non-U.S. government customers.

Regarding resolution licensing, Bill Baugh, research and development scientist within DigitalGlobe, told *Apogeo Spatial* the firm's previous license limited the company to releasing panchromatic imagery at 50-centimeter resolution. "Two existing sensors, GeoEye-1 and WorldView-2, could do better. They were capable of imaging in the 40-centimeter range. We had to degrade their resolution to 50 centimeters before releasing imagery," he said.

The license change earlier this year, Baugh said, reduced DigitalGlobe's restriction to 40-centimeters, "to allow us to sell at native resolution from the two sensors capable of imaging at better than 50-centimeters." In addition, he said that the license change allows for a further relaxation to a limit of releasing 25-centimeters panchromatic imagery six months after the launch of WorldView-3. "So, at the six month mark, we will be able to sell native 31-centimeter images from WorldView-3. The license will permit 25-centimeters, but the hardware will collect at 31-centimeters," Baugh said.

◀ **FIGURE 1.** WorldView-3 satellite before launch

▲ **FIGURE 2.** The launch, as imaged by WorldView-1

UNPRECEDENTED CLARITY

"It's all about seeing a better world," said Kumar Navulur, DigitalGlobe's director of next-generation products, prior to spacecraft liftoff. "We want to enable our customers to see the Earth clearly and in new ways, and make the Earth a better place."

Navulur said that, for example, highly precise images of our changing planet are important for decision makers managing Earth's natural resources. Via WorldView-3, DigitalGlobe can automatically distinguish different colors, textures and measure change over time which is important for the energy sector, conservationists, and governments.

Shortly after the satellite's boost spaceward, DigitalGlobe CEO Jeffrey Tarr said, "WorldView-3 will enable us to help our customers see through smoke, peer beneath the ocean's surface and determine the mineral and moisture content of the Earth below…all with unprecedented clarity."

DigitalGlobe announced July 31 that it plans to accelerate the launch of WorldView-4 (previously named GeoEye-2), to mid-2016. WorldView-4 is to offer "assured access" to 30-centimeter resolution imagery—the highest resolution imagery commercially available to customers.

CUTTING THROUGH HAZE, SMOKE AND DUST

WorldView-3 tips the scales at 6,200 lbs. (2,812 kilograms) and measures 19 feet tall and 23 feet wide (5.8 by

▼ **FIGURES 3-4.**
On August 28, 2014, just 15 days after launch, WorldView-3 captured images of the Happy Camp fire in California's Klamath National Forest. This is the first example of how WorldView-3 can use its shortwave infrared (SWIR) sensor to see through the dense smoke of an active fire to the ground beneath, and also locate the flame front and hot spots in the fire. The top shot is the same image but it was taken without the SWIR sensor. It's what you can see in the visible part of the spectrum, which is what a standard commercial imaging satellite would see. In the bottom image with the SWIR sensor, the smoke disappears, and the hot spots in the fire become visible.

3

4

7 meters) with its solar panels deployed. WorldView-3 is a lookalike, in many ways, to WorldView-2 (launched on October 8, 2009) in terms of its performance characteristics. But there are significant improvements including cost savings, risk reduction, and faster delivery of data for customers.

Built by Ball Aerospace & Technologies Corp. (Boulder, Colo.), WorldView-3's development leveraged expertise from the company's building of WorldView-1 and -2, QuickBird, QuikSCAT, ICESat, CloudSat, the National Polar-orbiting Operational Environmental Satellite System Preparatory Project (NPP), and Radarsat.

WorldView-3 is the fourth Ball-built satellite in the DigitalGlobe constellation. As with previous DigitalGlobe satellites, Ball was also responsible for development, integration and testing of the WorldView-3 satellite.

Jeff Dierks, Senior Program Manager, WorldView-3, Operational Space at Ball Aerospace, said WorldView-3 is built on the Ball Configurable Platform BCP 5000 spacecraft—a flexible, stable and highly accurate Earth remote sensing platform with a design life of more than seven years.

Furthermore, Dierks said, by using advanced Control Moment Gyroscopes (CMGs) on the spacecraft, WorldView-3 can be reoriented over a desired collection area in 4-5 seconds, compared to 30-45 seconds needed for traditional reaction wheels used on satellites.

New to WorldView-3, Dierks added, is a Ball-provided atmospheric instrument called CAVIS. That's short for Cloud, Aerosol, water Vapor, Ice, Snow. It's the duty of CAVIS to observe the atmosphere and provide correction data to improve WorldView-3's imagery when it pictures the Earth. In short, Dierks said, CAVIS boosts the color band of images, making it possible to target ground scenes through such image-restricting factors as haze, soot, smoke and dust.

LAYERS OF DATA

WorldView-3's sharp-shooting 31-centimeter resolution is made possible by a 1.1-meter aperture

▼ **FIGURE 5.**
Madrid Airport in Spain, at 40-cm resolution, captured Aug. 21, 2014, with WorldView-3

▶ FIGURE 6.
Sao Paulo, Brazil, captured Aug. 22, 2014, by WorldView-3

telescope and the primary visible/shortwave infrared (SWIR) sensor built by Exelis (Rochester, New York.)

The surface figure of that mirror is manufactured to an accuracy of 1/1000th of a human hair, said Rob Mitrevski, vice president and general manager of Exelis Geospatial Systems. Given WorldView-3's super-spectral capability, "layers of data" can be made available to users, he said, be it assessing vegetation health in trees to looking through smoke to spotting which section of vegetation is on fire.

WorldView-3 will enable us to help our customers see through smoke, peer beneath the ocean's surface and determine the mineral and moisture content of the Earth below...all with unprecedented clarity.

The spacecraft's SWIR sensor will multiply the value of WorldView-3 imagery by enabling the detection of specific mineral content and species of vegetation through signatures not identifiable with the naked eye.

Other imaging systems provided by Exelis include those on DigitalGlobe's IKONOS, QuickBird, WorldView-1, GeoEye-1 and WorldView-2 satellites. DigitalGlobe's WorldView-4 satellite, planned for launch in mid-2016, will also carry an Exelis-built imager.

INITIAL OPERATING CAPABILITY

On August 21, DigitalGlobe announced that they had completed focusing and achieved Initial Operational Capability (IOC) on the entire suite of WorldView-3's super-spectral bands.

DigitalGlobe formally notified the U.S. National Oceanic and Atmospheric Administration (NOAA) of WorldView-3's IOC, a step that means on February 21, 2015, the company plans to deliver 30-centimeter imagery to all of its customers. In the meantime, DigitalGlobe said it will make 40-centimeter panchromatic and 1.6-meter multispectral data available to their customers when WorldView-3 completes its validation and testing.

Data from the satellite's new shortwave infrared sensor will also be available to customers; however, the resolution of this data will be restricted to 7.5 meters while NOAA is conducting a six-month study of the capability.

Dierks of Ball Aerospace told *Apogeo Spatial* that WorldView-3's high-resolution space skills open up down-to-Earth markets. "You now are approaching what the aerial photography guys are doing. This satellite has a unique capability, basically imaging anywhere in the world within a day. That's tough to do with an airplane. And the aerial photography business right now is far larger than the space imagery business. So that's a potential market to go after," Dierks said.

change is in the air

ASPRS UAS Technical Demonstration and Symposium
October 21-22, 2014, Reno Nevada

Mapping with Unmanned Aircraft Systems (UAS)
In-flight demos and symposium
October 21-22, 2014
Reno Ballroom / Reno-Stead Airport
Visit the conference website:

uasreno.org

The American Society for Photogrammetry and Remote Sensing (ASPRS) is hosting a two-day symposium on mapping with unmanned aircraft systems (UAS) in Reno, NV on October 21-22, 2014. The purpose of the event is to assemble academia, UAS developers, survey and mapping companies, government agencies, and UAS enthusiasts, to share information, showcase new technologies and demonstrate UAS systems in action (in flight). The events will be held at the Reno Stead Airport, an FAA-designated UAS test site, as well as at the Reno Ballroom in downtown Reno. The mission is to advance knowledge and improve the understanding of UAS technologies and their safe and efficient introduction into our national airspace, government programs and business.

HIGHLIGHTS

- In-flight demonstrations of UAS technologies
- Collaboration opportunities among government, private sector and academia
- Exhibit floor
- Speakers and presentations on relevant UAS topics

Suggested attendees:

- Survey / mapping firms
- Companies developing UAS business plans
- Government agencies
- Government agencies driving UAS policy
- Software, hardware, system developers
- Academia and research institutions
- Geospatial professionals
- UAS technology enthusiasts

asprs

ASPRS – the imaging and geospatial information society – www.asprs.org

Imagery

Options for Esri Users

Esri's ArcGIS Marketplace

BY MATTEO LUCCIO / CONTRIBUTOR
PALE BLUE DOT LLC / PORTLAND, ORE. / WWW.PALEBLUEDOTLLC.COM

GIS users increasingly expect content to come with their platform, rather than be an add-on. To help meet this expectation, in September 2013 Esri launched ArcGIS Marketplace (https://marketplace.arcgis.com/). It allows ArcGIS Online subscribers to search for, browse, and download for use within their organization apps and data from Esri partners—such as DigitalGlobe, BlackBridge, Airbus Defence and Space, and AccuWeather—as well as apps created by Esri and its distributors and partners, such as Latitude Geographics, Azteca Systems, LizardTech, GISi, and con terra. All apps and data are built specifically to work with ArcGIS Online and can easily be shared with ArcGIS Online groups and users.

▶ **FIGURE 1.** ArcGIS Marketplace screenshot, copyright: 2014 Esri.

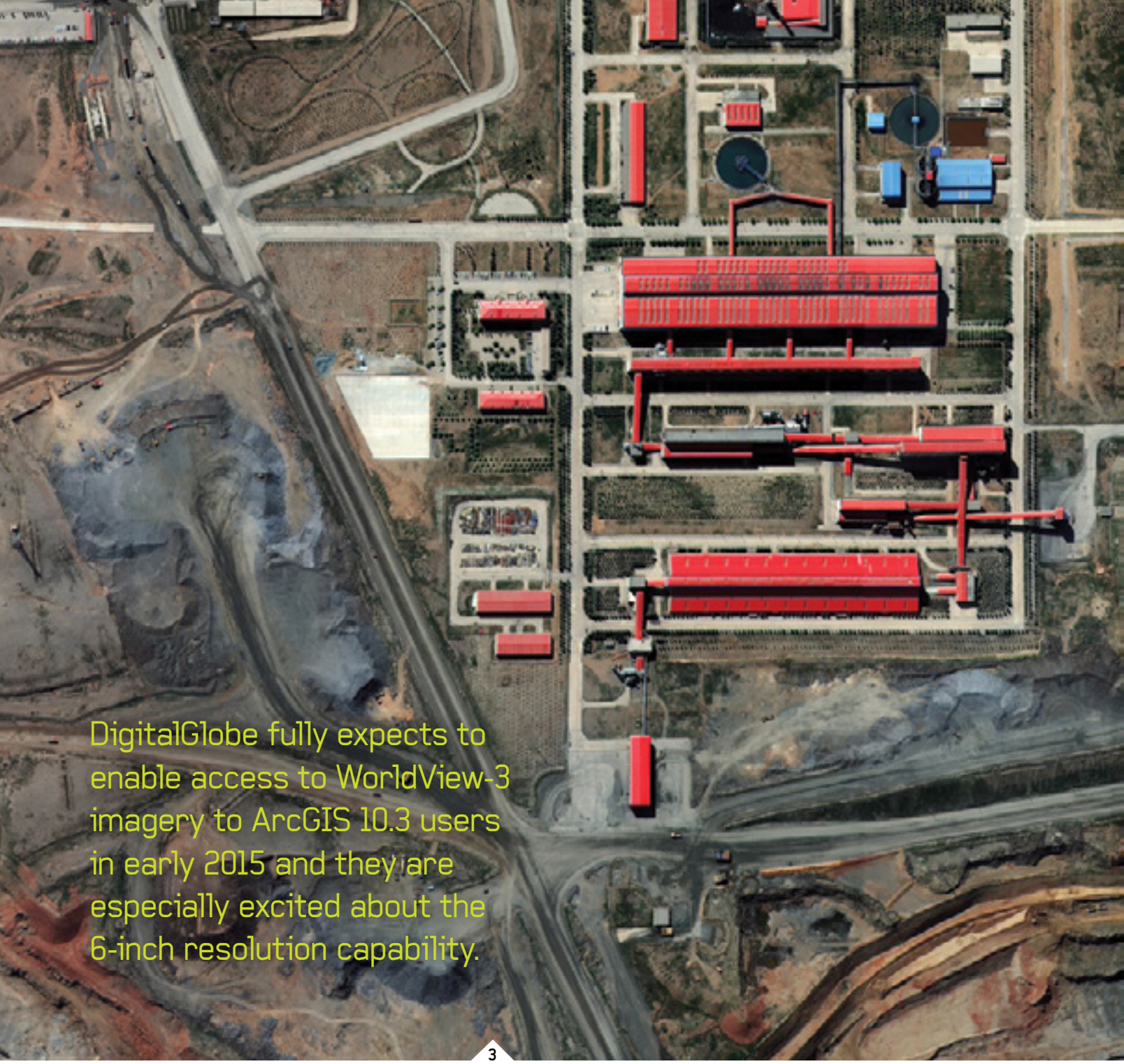
▶ **FIGURE 3.** This image from the new WorldView-3 satellite of a mine in China, captured on Aug. 23, 2014, is shown in 40-cm resolution, pending approval to release it at 30-cm resolution. Courtesy of DigitalGlobe.

Editor's Note:
Watch for articles about similar marketplace offerings of other companies, such as Trimble and Hexagon, in future issues.

While anyone can browse the listings in ArcGIS Marketplace, only ArcGIS Online subscribers can get free trials or make purchases. They can then access their organization's maps via the apps that they downloaded from the Marketplace and add to their basemap gallery or to other apps any data services that they acquired from it.

In addition, the Marketplace enables vendors of apps and data services to generate leads, provide free trials, grant access to listings, and manage subscriptions. All of the services in the Marketplace are subscription-based, but each is slightly different. The Marketplace serves as a gateway to services that are published by the vendors and are supplements to the ones that already come with ArcGIS Online. Some of them are offered by the vendors for free, as loss leaders.

"The valuable, authoritative content that users want to use is not only coming from Esri. It also has to be easy for us to make content available for users who are serving their own map services or map layers," says Christophe Charpentier, Product Manager Lead ArcGIS Content, at ESRI. "For many years, Esri partners have been building



DigitalGlobe fully expects to enable access to WorldView-3 imagery to ArcGIS 10.3 users in early 2015 and they are especially excited about the 6-inch resolution capability.

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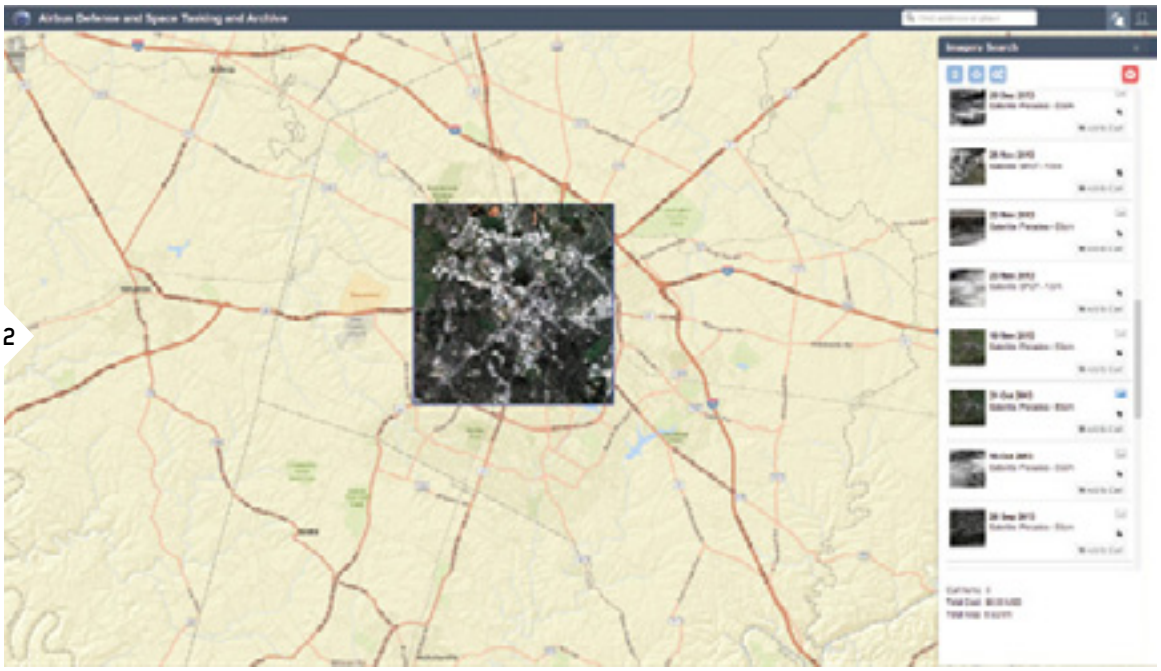
applications or extensions to the ArcGIS system. The translation of that to the system into the cloud, including content services, was about empowering our partners to be able to make their content-based services available to our users. As users discover the content, they can find the added use services that interest them."

Esri refers to the data and services on the ArcGIS Marketplace as Premium Content Services. To them, content can be imagery, it can be vector data, or other types of data. Premium content is content that users can purchase and use on top of what is already available in ArcGIS Online.

IMAGERY

Most of the ArcGIS Marketplace currently consists of imagery and imagery services. "We started with imagery vendors because we understand that there is a lot of value in imagery," says Charpentier.

Perhaps the most basic imagery on the Marketplace is the DigitalGlobe Global Basemap,



▶ **FIGURE 2.** Screenshot of the Satellite Tasking & Archive app, showing the app in action, with the AOI selected, and a list of tasking options displayed on the right hand side of the screen. Copyright: 2014 Esri. ArcGIS and ArcGIS Online are trademarks, service marks, or registered marks of Esri in the United States, the European Community, or certain other jurisdictions. All rights reserved.

which consists of cashed imagery, including some aerial imagery, and is updated yearly. "We also have multispectral imagery from DigitalGlobe, Blackbridge, and Airbus," says Charpentier. "By band combination you can actually extract information and analyze the imagery and use this as an information product rather than just a nice looking map. In the case of DigitalGlobe, you are getting access to the full eight bands of imagery here. So, through the image services, you can actually do the image exploitation and analysis that you would expect to do with those original pixels on your desktop. Here, however, you do not have to worry about hosting it yourself or serving it out; that's already been taken care of by DigitalGlobe, yet you have all of the analytical capabilities at your fingertips."

Some of the imagery is updated very frequently, such as DigitalGlobe's First Look product, which focuses around events or disasters. It can be used for crisis response, planning, and disaster recovery, starting shortly after a disaster.

DigitalGlobe fully expects to enable access to WorldView-3 imagery to ArcGIS 10.3 users in early 2015 and they are especially excited about the 6-inch resolution capability. "We are excited to be entering this new remote-sensing era with Esri, one where the analytics are configured into the web service and where the user is not asked to think about whether a sensor had to be tasked in order to provision the content in the first place," said Pierre Izard, Director, Alliance Sales with DigitalGlobe.

Blackbridge has created color-balanced, virtually cloud-free, cached country-wide mosaics. Currently, they are available for 22 countries and are updated on a regular basis.

▼ **FIGURE 4.** RapidEye mosaic of Turkey, courtesy of BlackBridge.

Airbus Defence and Space (Airbus DS) provides Thematic Imagery, which is a great basemap product. It consists of of 50-centimeter Pleiades data, which the company plans to update annually, as well as 1.5-meter SPOT 6 and SPOT 7 data, and radar imagery products from its TerraSAR-X satellite, which is refreshed every 11 days. Its Site Monitoring service combines imagery from all of these sources, and allows users

to choose their preferred frequency. "If you want a daily revisit over your area, we may not be able to do it every day with TerraSAR-X, but we can do it with our constellation," says Jessi Dick, Cloud Services & Online Partnerships Marketing Manager for GeoIntelligence at Airbus DS.

DIRECTLY TASKING AIRBUS DS SATELLITES

One of the most interesting applications currently on the Marketplace is Airbus DS' Satellite Tasking & Archive app, launched in July at the Esri International User Conference. It allows users to search the company's archive of imagery from its SPOT and Pleiades satellites and, if they don't find exactly what they need, to directly task a satellite to cover their area of interest.

"We've actually wired in, through the Airbus API, the ability to task the satellite live," says Tony Mason, a Senior Consultant with Esri who has been leading the effort to implement content vendors on the Marketplace. "There is no human interaction." Users can then download the imagery through the application. "That application is published and operated by Airbus," Charpentier explains. "Esri is just a facilitator through the connection with the user by exposing the application and by posting the end results of the imagery onto ArcGIS in the user's private account."

"When we say that you are tasking the constellation, you are physically tasking it yourself," says Dick. If users choose to do the instant tasking, they will get an image as soon as the next Airbus DS satellite passes over their area of interest, regardless of cloud cover. "It is something that should be used only in emergency situations, or when you need something on a specific day," says Dick. "For as little as $1620, you can task one of our satellites, and receive newly acquired imagery of your area within hours."

Alternatively, they can choose the 30-day or the 60-day tasking options, in which they will receive the image as soon as a satellite gets one that fits their parameters. The 60-day option is a little cheaper than the 30-day option. "All instant tasking requests have maximum priority and will be shot, no matter what. These requests override anything else that has lower priority." The 30-day tasking has lower priority and the 60-day has the lowest priority. "You will get it within 60 days, but usually much earlier." Whichever options users choose, once they place the order in the application, it is added directly to the satellite's plan, then acquired and delivered automatically, without any further human intervention.

In contrast, another Airbus DS service on the Marketplace, Site Monitoring, is managed by company staff, based on the user's request to monitor particular areas or activities. "We put in the order to the satellite, we decide what makes sense, and send an analysis report to you," says Dick. This service allows users to specify one or more sites that they want to monitor and their monitoring requirements. For example, a user who wanted to monitor the construction of soccer stadiums in preparation for the World Soccer Cup in Brazil would have been able to see the progression in their construction. Airbus DS delivers both the imagery and information on the changes from one image to the next, overlaid on a Webmap. "We deliver it to you in a nice Esri Story Map format, complete with both imagery and analysis," says Dick.

A third Airbus DS service on the Marketplace, called Thematic Imagery service, provides different themes, which it updates on a regular basis. The first one they have launched is airports of Eastern Europe and the Middle East. "As time goes on, they'll add other themes, such as ports and railroads," says Mason.

BLACKBRIDGE PRODUCTS

BlackBridge offers three services based on orthorectified RapidEye imagery: RapidEye Mosaics, Living Image Basemap, and Living Image Multispectral. "RapidEye Mosaics are seamless, cloud-free, static collections of the best available imagery over a country," says Scott Soenen, the company's Chief Technology Officer. "They provide an up-to-date, high-quality image basemap for GIS projects. The Living Image Basemap is a dynamic, natural-colour mosaic of RapidEye imagery over a user's area of interest that is updated quarterly with the best available imagery. The Living Image Multispectral is also a dynamic mosaic, but is available with the full 5-band multispectral data, including the red-edge band. Clients can choose their area of interest and frequency of updates: quarterly, semi-annually, or annually. BlackBridge then selects the best-available imagery from our collection to populate the services."

The Living Image services are only available through the ArcGIS Marketplace. "ArcGIS enables true dynamic delivery of imagery through Web services," Soenen explains, "which means that imagery

▶ **FIGURE 5.** San Francisco Bay mosaic in RGB, courtesy of BlackBridge.

▼ **FIGURE 6.** Florida Keys, RGB image captured March 1, 2014, courtesy of BlackBridge.

is updated and delivered to customers with very little effort required on their part. When customers load the service in ArcGIS, they will always be using the highest quality, most current RapidEye imagery."

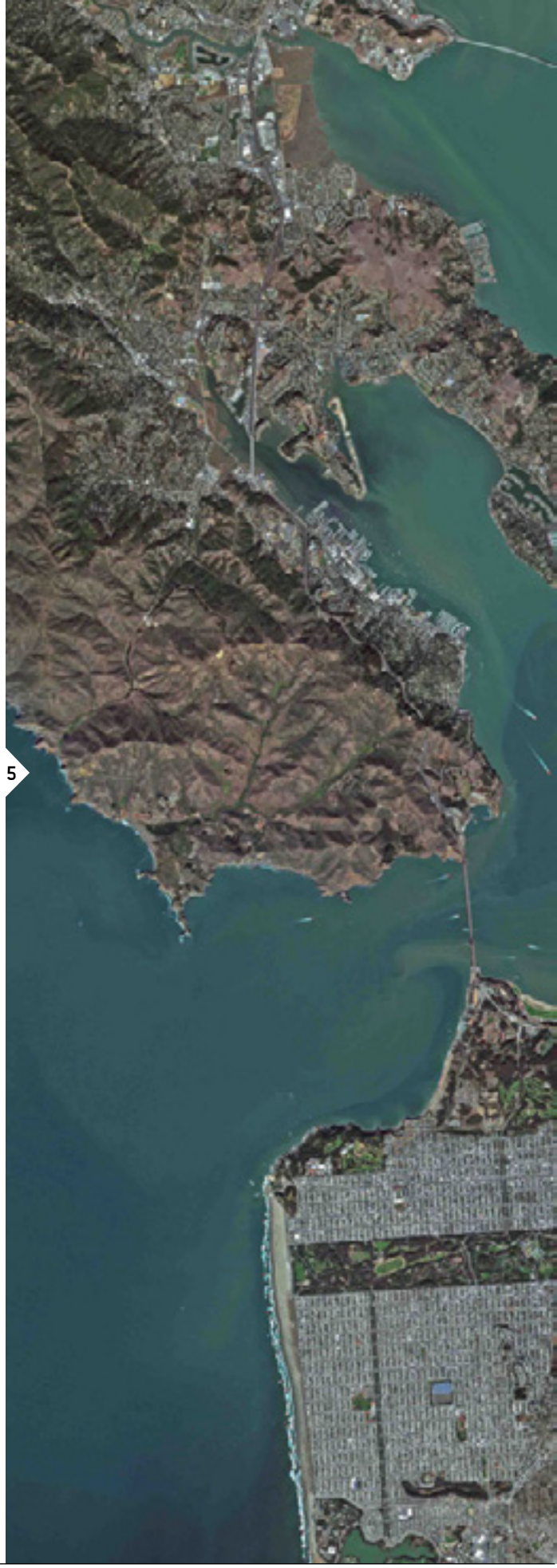
CUSTOMIZED FOR ARCGIS

Some of the providers are customizing their imagery to work best in ArcGIS. For example, Mason points out, DigitalGlobe's multispectral service is a completely customizable service. "We are going to deliver this data at one of the rawest possible levels of imagery, then we are going to work with the customer to customize it. They are not just delivering plain old DigitalGlobe imagery. They are working with the customer to understand what their use case is going to be. So, if I am doing coastal or hydrology analysis, I may need some different algorithms tied to this particular service."

Blackbridge's imagery is orthorectified to a very high positional accuracy standard so that the imagery aligns with the users' data, according to Soenen. "We try to ensure that all imagery is orthorectified with less than 10-meters RMSE (root-mean-square-error) positional error. Recent testing shows that we average 6-meters RMSE."

BUSINESS MODEL

Most of these services are available only through the ArcGIS Marketplace. "This data is like a dial tone into ArcGIS Online," says Mason, "meaning that ArcGIS Online is where our users come in to share and find their data. So, these are exclusive services to ArcGIS Online and the ArcGIS platform." However, the content is not necessarily exclusive to the Marketplace. "We are



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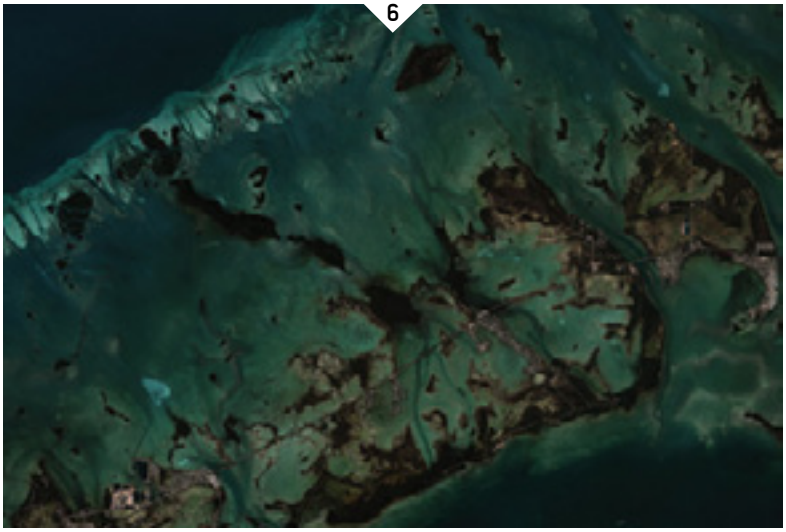

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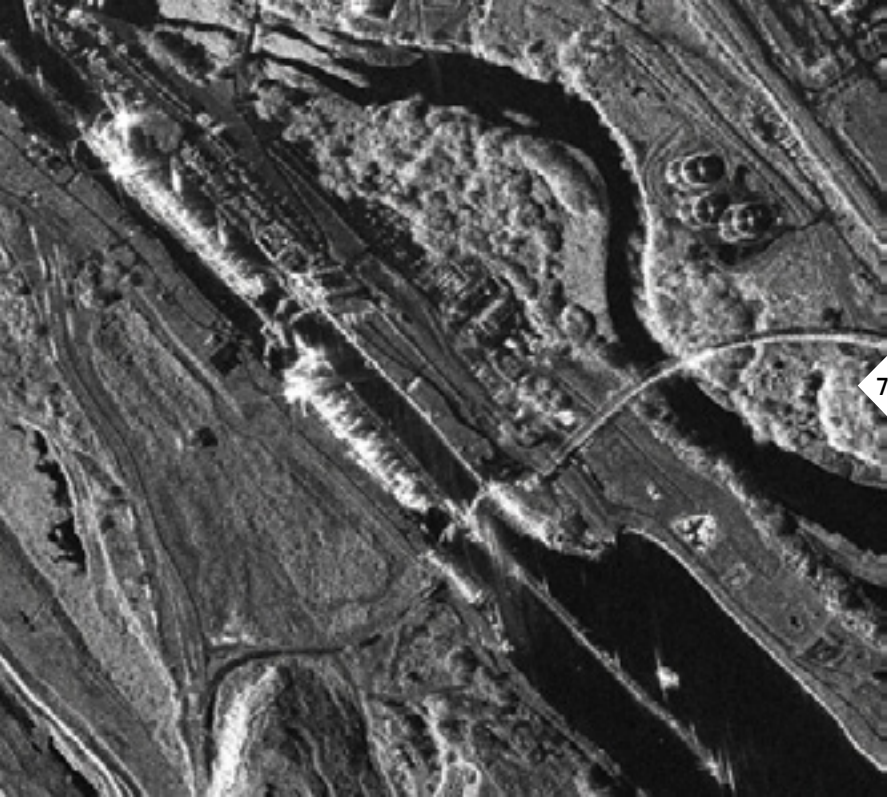
– Jessi Dick of Airbus DS



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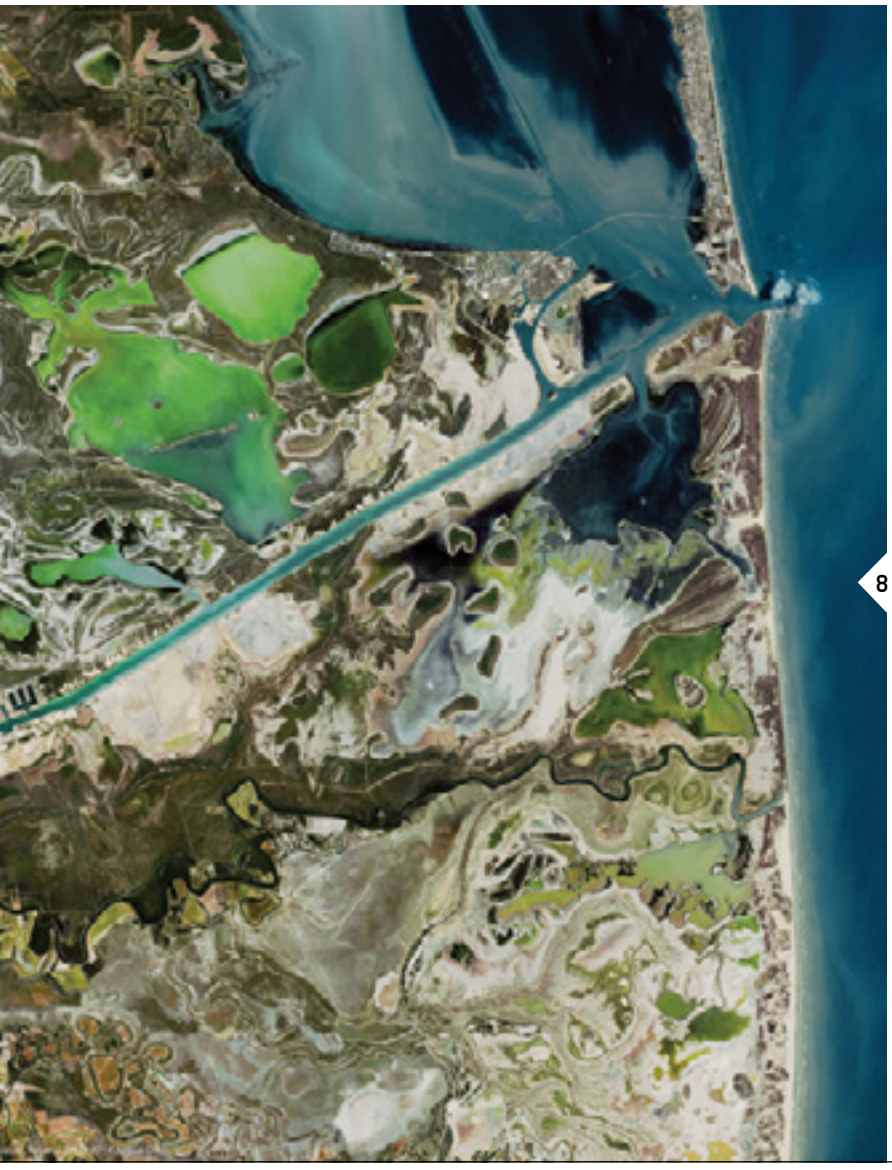

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not prohibiting them from selling their content to other customers in other sales channels or with other delivery methodologies," says Mason. "We are taking a service from them and making it available in ArcGIS Online."

None of the imagery available through the Marketplace is stored on Esri servers. "Unlike traditional imagery delivery mechanisms, where pixels and individual files get moved around, the individual images and files stay with the partner and, instead, they just register a Web service—in this case, an image service—inside of the Marketplace for the customers to access," says Mason. "We are moving away from the model of our users having to buy and store the pixels themselves. Instead, they are renting access to the imagery through the ArcGIS Online platform and the Marketplace."

"For many, many years," says Charpentier, "if you wanted to get access to multispectral imagery, you had to get it physically delivered to you and it was a huge challenge. So, imagery vendors and Esri were getting along very, very well but each of us was delivering our own capacity to the end user and the end users were implementing them on their own systems. This is offering us, mutually, the capacity to offer to end users a much better user experience. Now we are offering users the capacity to get access to the power of multispectral imagery through their standard ArcGIS experience, without having to deal with the logistics of where the imagery is, how to implement it, and how to set it up. That is where it really reinforces Esri and the imagery vendors: they are offering a much better user experience to the end users."

Airbus DS' satellite tasking application automatically charges the users' subscription accounts every time they buy imagery, whether from the archive or from direct tasking of the satellites. Its site monitoring and thematic layers are also subscription services. On the ArcGIS Marketplace, the company provides imagery from all of its sensors, but it does not currently offer any of its 3D products, image processing services, global seeps database, geological studies, or some of market-specific monitoring services. However, some of those may become available later on, according to Dick.

While Airbus DS sells its imagery products to anybody through a variety of channels, its Thematic Imagery layers optimized for ArcGIS and its Satellite Tasking application are available only through the Marketplace. "Site Monitoring is something we also do elsewhere," says Dick, "but it is only through the Marketplace that you get it delivered in a nice, Story Map format that allows you to

quickly go through the reports day by day in one screen."

Airbus DS has also sold to Esri its SPOTMaps 2.5 global mosaic product and some Pleiades imagery over cities across the world, so that Esri could include them in its world imagery basemap, which is available for no extra fee to all ArcGIS Online users.

With its imagery and services on the Marketplace, Airbus DS is not targeting its current users, according to Dick, but potential new ones, "the Esri users to whom we have not previously had access, or who maybe have not used our imagery in a while."

BlackBridge became an Esri business partner three years ago. "Many of our customers view or process RapidEye imagery with ArcGIS, so we were interested in how we could enhance that experience for them by partnering with Esri," says Soenen. "The ArcGIS Marketplace has allowed us to tailor new BlackBridge products specifically for the Esri community and makes it easy for Esri users to discover relevant RapidEye imagery."

"We've had a partnership with Esri for more than 20 years," says Dick. "The advent of their Marketplace gave us an outlet to reach out and help serve their customers better. We and Esri worked very closely together, over several months, to get those done, so we definitely strengthened our partnership and continue to do so."

BlackBridge offers three services based on orthorectified RapidEye imagery: RapidEye Mosaics, Living Image Basemap, and Living Image Multispectral.

Izard notes, "DigitalGlobe and Esri continue to collaborate actively to streamline accessibility of imagery and imagery-derived information for the WebGIS user. Esri's work on the ArcGIS Marketplace but also on imagery processing technologies overall are truly helping the raster and vector cultures converge. This is a significant dynamic for the geospatial industry."

The ArcGIS Marketplace offers clear benefits to Esri's users, who get direct access to a wealth of imagery and imagery services, and to its partners, who get direct access to Esri's huge user base. Additionally, some of the services provided through the Marketplace, such as BlackBridge's extensive archive of multispectral RapidEye imagery over very large areas, would not be sustainable without access to this large market.

◀ **FIGURE 7.** Panama Canal 50-cm image, collected Dec. 12, 2013, from radar satellite TerraSAR-X. Copyright DLR e.V. 2013, Distribution Airbus DS/ Infoterra GmbH.

◀ **FIGURE 8.** SPOT 7 1.5-m pansharpened image of Port Isabel, Texas, taken July 3, 2014, copyright and courtesy of Airbus DS/Spot Image 2014.

UNOOSA's Commitment to Earth Observations

Building Capacity in the Use of Space for Sustainable Development

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Editor's Note:
See related columns, *Secure World Foundation Forum* on page 10, and *On the Edge* on page 36.

Space-based technologies and data are vital to the goal of global sustainable development, a fact that is well-recognized by a myriad of international bodies and through important conferences, none more so than the United Nations Conference on Sustainable Development in 2012. More and more satellites are launched into space almost weekly by a growing number of space-faring nations. These numbers, the result of significant investments and efforts, demonstrate the importance of these technologies for a wide range of societal benefit areas, for both developed and developing countries.

The recent establishment of the Group on Earth Observations (GEO), in 2005, and the rapid growth of its membership and interest from many countries with no space technology capabilities, further supports this evidence. This Group aims to build the Global Earth Observation System of Systems (GEOSS) with the aim to enhance the relevance of Earth observations for global issues.

In spite of the rapid growth in such cooperative efforts, only a small percentage of the 200+ countries in the world have adequate access or capacity to work with space-based technologies and data, due to technological or resource limitations and often a lack of capacity awareness. This has become more evident in recent years, especially when such visionary programmes as Landsat paved the way for a large amount of space-based data to be released into public domain, while many experts around the world lacked awareness and/or ability to access such assets. And unfortunately, this issue still exists.

The United Nations Office for Outer Space Affairs (UNOOSA) aims to support countries in this respect and bring the benefits of space technologies for sustainable development in an equal way to the broadest spectrum of nations. The Office, through its Programme on Space Applications and Platform for Space-based Information for Disaster Management and Emergency Response (UN-SPIDER) assists these countries to build their capacities for accessing and working with satellite-based data and information and in developing indigenous space technologies.

Globally, capacity-building efforts in space technologies are supported by numerous international organizations and United Nations entities, and the variety of actors and offered programmes have increased in conjunction with advances in space-based technologies and the wider availability of space-based data and derived information. Under the United Nations family of organizations, entities provide such support, within their respective mandates, and for their government clients, for humanitarian, food security, crime prevention, disaster management, and environmental monitoring and assessment purposes.

In addition, the commendable efforts by a few visionary private entities in particular in the last ten years have made space-based data accessible to the public through their significant investments into the accessibility of space-based data (satellite imagery) and applications permitting greater familiarity with the availability and benefits of space-based data. One example is Google Inc., which has taken the then little-known specialized software tool Keyhole and transformed it into the universally, and freely available Google Earth application.

If there is a more equal playing field in terms of access to space-derived data, it is thanks to strategic and crucial decisions to make the data public (more in the mid-resolution range such as Landsat or CBERS, but also high-resolution data such as OrbView-3, older SPOT panchromatic imagery or older declassified spy satellite imagery). This led to a growing interest and demand for training on how to work with such data and on how to derive information from it for more informed decision-making and for varied uses. It is in this context that UNOOSA was and is delivering on an important component of its mandate through the various capacity-building activities and efforts, in the framework of the Programmes it implements.

◀ **FIGURE 1.** Huge ash plume caused by an eruption of Puyehue-Cordón Caulle Volcanic Complex in Chile just west of the Argentinian border in June 2011, courtesy of NASA.

▼ **FIGURE 2.** UN-SPIDER Training Advisory Support mission to the Dominican Republic, for an inter-institutional team on geospatial information for disaster-risk management and emergency response, courtesy of UNOOSA.

A LOOK AT THE HISTORY

Through UNOOSA's Programme on Space Applications, established on recommendation of the first United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE), held in 1968, the Office has been active since the 1970's organizing a series of annual training activities and workshops in various countries to promote the use of space technologies for environmental aims, sustainable development and disaster management.

UNISPACEII, in 1982, broadened the mandate of the Programme and paved the way for a number of Regional Centres of excellence to be affiliated to the UN. These Centres have the long-term goal of aiding sustainable development by building indigenous capabilities

▲ **FIGURE 3.** Satellite images of Hurricane Gustav as it approaches the United States in August and September 2008, courtesy of ESA.

▶ **FIGURE 4.** Flooded area in La Plata, Argentina in April 2013, courtesy of NASA.

for research and applications in space technologies for developing countries.

The Centres offer annual courses (similar to degree courses) to select students of developing nations and, together with UNOOSA, financially support their participation, thus enabling widespread participation. Students undertake rigorous theory, research, applications, field exercises and pilot projects under the guidance of university educators and scientists in the core disciplines of remote sensing and geographical information systems, satellite communications, satellite meteorology and global climate, and space and atmospheric sciences for sustainable development. The Centres benefit from education curricula in each of these core disciplines, developed by UNOOSA with the support of prominent educators. The curricula can be found at the website of UNOOSA.

▼ **FIGURE 5.** UN Programme on Space Applications Global Map, courtesy of UNOOSA.

As a result of the recommendations arising from UNISPACEIII in July 1999, the UN General Assembly established the United Nations Platform for Space-based Information for Disaster Management and Emergency Response (UN-SPIDER) programme in 2006 (General Assembly Resolution 61/110, A/RES/61/110). UNOOSA has carried out a number of targeted capacity-building activities in the domain of space technologies for disaster management since 2008. These activities most often take place as a follow-up to thorough UN-SPIDER technical advisory missions carried out in a number of developing countries on invitation by their governments. These activities provide targeted training and support for selected staff from local government, academia and international organizations, to address gaps in the exploitation of space technologies and space-based data for disaster management within a national context.

In conformity with its mandate, UNOOSA has also been a long-time active Associate member of the Committee on Earth Observing Satellites (CEOS), established in September 1984 to coordinate and harmonize Earth observations to make it easier for the user community to access and utilize space-derived data. The Office is involved in the Working Group on Information Systems and Services (WGISS) under CEOS and co-chaired and played an important role in the former Working Group on Education (WGEdu), followed by current participation in the Working Group on Capacity Building and Data Democracy (WGCapD) http://bit.ly/1sUY0EE.

The Office also joined GEO as a Participating Organization and has supported various GEO capacity-building and awareness-raising efforts, as well as the "Data Democracy" and data sharing principles development work. The Office has recently strengthened its relationship with GEOS and intends to work more closely together in the future on issues of mutual interest.

Recently, Office staff have contributed to the development and delivery of a WGCapD e-learning introductory course on Remote Sensing, targeting existing students from various developing countries. Staff also gave presentations and lectures at Summer University for post-graduate students on the benefits of space-based data and technologies for environmental monitoring and assessment at the Central European University in Budapest, Hungary. UNOOSA also supported capacity-building efforts under the Eye on Earth initiative (http://www.eoesummit.org/).

These efforts are essential for UNOOSA to ensure delivery of its mandate. An overview of future workshops and training sessions being planned at this time can be found at the Programme on Space Applications Activities schedule web page (http://unoosa.org/oosa/en/sapidx.html).

DISASTER MANAGEMENT

Climate change has led to more severe weather phenomena and heightened the risk of disasters. As such, disaster management has become a highly-relevant topic, with decision makers constantly seeking ways to mitigate exposure to disasters of communities, to invest more into prevention and early warning, and to reduce economic losses and loss of life in disaster situations.

The establishment of the UN-SPIDER Programme expanded the work of UNOOSA into specific capacity building and training in the use of space technologies for the full disaster management cycle, from early warning to recovery. This includes not only Earth observation data and derived information but also the use of global navigation satellite services and satellite telecommunications. This work is made possible largely thanks to multi-year voluntary contributions made to the Programme by the Governments of Austria, China, and Germany, with further support provided by Croatia, Indonesia, the sixteen institutions and countries hosting UN-SPIDER Regional Support Offices and the individual experts who contributed to the missions.

UN-SPIDER Technical Advisory Missions (TAMs) have visited over 25 countries where the TAM expert teams identified specific needs for training. These recommendations often lead to the organisation of follow-up capacity-building workshops run by the Office in the country in which the TAM took place (most recently in Cameroon, Mozambique, Nepal, Sri Lanka, Sudan and Vietnam).

These workshops typically bring together 40-50 participants from local civil protection and disaster management authorities, relevant national government entities, staff of local academic institutions supporting the government with disaster management and in-country UN staff. Topics are chosen relevant to the needs of the country, to provide practical training on software tools, remote sensing data processing and GIS techniques applicable in disaster situations and rapid assessments, and on the methods to identify and download relevant free satellite data or derived products.

UN-SPIDER efforts in training and capacity-building provide the local population with the skills to access data analysis techniques and sources of space-based data. Participants are made familiar with the process for requesting specialized support from the International Charter, Sentinel-Asia, GIO or other support mechanism activations, and on how to access data and online modelling tools and services. The local experts also build up their global network including through the UN-SPIDER Regional Support Offices.

This capacity-building component will continue of course, but it remains dependent largely on available voluntary contributions to the UN-SPIDER programme (currently very limited compared to many other UN initiatives resourced by voluntary contributions), as a large number of existing TAM recommendations remain unimplemented, while more developing countries request such advisory missions to evaluate their own capabilities and processes.

WHAT'S NEXT: SDG'S

As the 2015 deadline for the Millennium Development Goals approaches, the UN and its Member States are galvanising their efforts for the post-2015 development agenda in a process initiated at the Rio+20 Conference on Sustainable Development. Member States agreed to work on a process that would culminate on a set of Sustainable Development Goals (SDGs).

At this critical time, when the world shapes these Sustainable Development Goals and formulates the global development agenda in the post-2015 context, the momentum from the Rio+20 Conference has lent a heightened awareness of the contribution of space technology for sustainable development. The establishment and strengthening of sustainable and standards-driven spatial data infrastructures merit recognition as an important means of implementation of those development goals and objectives.

UNOOSA has a unique opportunity to mobilize support and commitment at the global level for increasing the role of space-based technology and information as an enabler of the goals and objectives of the post-2015 development agenda. Through its capacity-building activities, UNOOSA can ensure that equality in the fundamental access to space-derived information and its use in supporting decision making at all levels is guaranteed in the work towards global sustainable development. ∧♂

3rd UN World Conference on Disaster Risk Reduction, March 2015

Recognising the relevance of the on-going process devoted to the development of the post 2015 framework for disaster-risk reduction, which will be launched during the upcoming 3rd UN World Conference on Disaster Risk Reduction, to take place in Sendai, Japan, in March 2015; UN-SPIDER/UNOOSA has been active engaging its network of Regional Support Offices and partners including GEO, CEOS, UN agencies, Space agencies, regional organisations as well as ministries and government agencies dedicated to disaster risk reduction to ensure that the new framework for disaster-risk reduction will incorporate explicitly the use of Earth observations and space-based applications and to promote the use of such applications through the conduction of working sessions during this world conference.

Accurate Gr
is Critical for Calibrati

Global Network Now Available

BY PHILIPP HUMMEL, PLS, CFEDS, CP
TECHNICAL DIRECTOR / COMPASSDATA, INC.
CENTENNIAL, CO. / WWW.COMPASSDATAINC.COM

EARTH OBSERVATION SATELLITES ARE TYPICALLY DEFINED BY THE spatial resolution of the imagery they collect. While resolution – the ability to differentiate small features on the ground – is undeniably important, the absolute geometric accuracy of acquired image data is just as critical for the vast majority of mapping applications. Whether high-, medium- or coarse-resolution, every imaging sensor system must undergo extensive calibration after launch and maintain a consistent calibration while operating to achieve the highest possible geometric accuracy. To facilitate this process, CompassData has established a worldwide network of calibration test sites for imaging sensors.

Numerous remote sensing satellites now orbit the Earth capturing a nearly continuous stream of imagery that plays a crucial role in monitoring natural and man-made changes to the planet. Accuracy is paramount in detecting slight alterations to land forms, vegetation and infrastructure. But before these images can be relied upon in vital research,

ound Control
on of Imaging Sensors

◀ **FIGURE 1.**
The aerial and satellite sensor calibration site located at McMahon-Wrinkle Airport, Big Spring, Texas (Google Earth Image)

▶ FIGURE 2.
Collecting a GCP (ground control point) at the aerial and satellite sensor calibration site located at McMahon-Wrinkle Airport, Big Spring, Texas

the sensor systems must be calibrated to ensure that the data they collect is reliable.

Geometric accuracy refers to how closely the horizontal and/or vertical location values of coordinates match the actual coordinates on the ground. The quality for the sensor system in question is then defined as the difference in coordinate values between the model and the real ground points. A minimization of this difference, or error, is desired to produce high-quality imagery and subsequently models.

Many factors influence image accuracy. The developers of imaging sensors and digital cameras put tremendous effort into building equipment with perfection in mind. Still there will always be minute flaws in manufacturing of sensor arrays and infinitesimal imperfections in the opto-electronic components that detract from perfect accuracy in the sensor.

The integration of sensors into satellites or in an aircraft are complex steps of embedding the imaging hardware in an overall system of processors and navigation equipment such as gyros, star trackers, GPS, IMUs and other high-tech modules. Once integrated, the imaging hardware has become part of a sensor system. This integration can induce errors that impact accuracy as well.

After it has been launched or flown, this integrated system requires testing and calibration, which involves calculating the accuracy of acquired imagery and then adjusting the system to compensate for errors.

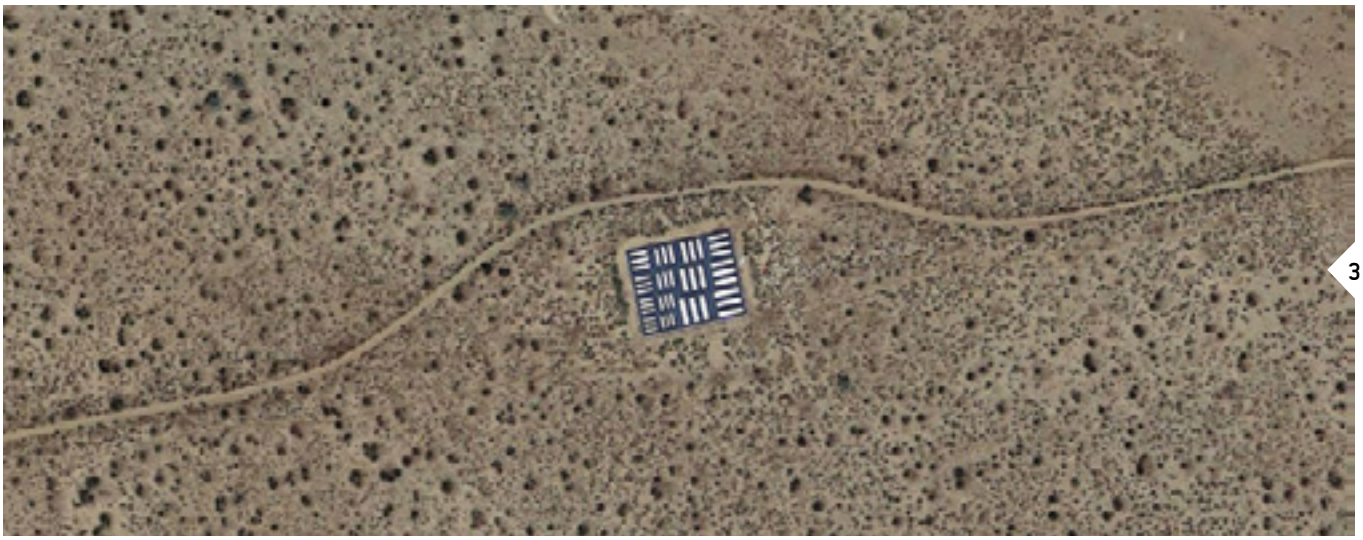
Adjustments to sensor systems can be made either mechanically or numerically. Although some mechanical alterations can be made, most calibration adjustments are made numerically. The unwanted imperfections of sensor systems are therefore controllable and compensated for during processing of the raw image data after acquisition by the sensor system.

GLOBAL NETWORK OF CALIBRATION SITES

With so many new Earth observation satellites being planned and launched, accurate GCPs (Ground Control Points) are much in demand for calibration of imaging sensors. To meet this demand and facilitate the calibration process, CompassData offers clusters of GCPs as calibration sites around the world. Of course, any other combination of GCPs can be used to calibrate a system, but these points are stored in a commercially available, web-accessible archive along with extensive metadata, photos and station diagrams.

The archive currently contains 30,000 points collected in over 79 countries. Although the GCPs are used for a variety of geospatial applications related to satellite and aerial image products, as well as LiDAR and IFSAR surface models, CompassData has worked closely with numerous sensor developers to provide the GCPs needed to calibrate new sensor systems.

While accuracy is always a primary objective in GCP collection, the firm has put significant effort into developing standardized procedures to ensure the points have consistent quality regardless of where they are captured on Earth. For many geospatial applications, including sensor calibration, GCPs in North America must be consistent with those in Asia, Europe and Africa.



▲ FIGURE 3. The aerial sensor calibration site located at Edwards Air Force Base in California (Google Earth Image)

CALIBRATING THE SENSOR

Ground-based GPS surveys and the GCPs they generate play a vital role in the calibration process. Once a system has been launched or deployed for the first time, the initial image data it collects are compared against multiple GCPs to calculate the horizontal and vertical geometric accuracy.

Developed specifically for sensor calibration, the test sites created by CompassData are comprised of multiple archived GCPs surveyed in a small geographic area. Catering to a variety of image scene sizes, the test sites vary in density of points. Padua, Italy, for example, contains 91 GCPs in an area of 100 sq km (10 km by 10 km), while the Helsinki, Finland, site has 22 points in an area of 320 sq km (16 km by 20 km) sq km.

The calibration sites have been rated for satellite, aerial photo/LiDAR or all sensor types. In general, the test sites that are considered appropriate for airborne sensors contain GCPs collected on smaller photo-identifiable features easily visible in very-high-resolution imagery acquired by a low-altitude aircraft. Points in the test sites rated for satellite sensors are typically larger ones that can be identified more easily at the spatial resolutions more common in orbiting platforms. Many GCP sites chosen with black-and-white panchromatic sensors in mind have high visual contrast—a white sidewalk in a grassy field, for instance.

While airborne sensors are often calibrated by flying over a single test site close to a base airport, satellites utilize GCPs from multiple sites worldwide in their calibration processes due to the global nature of their operations, and so that Earth observation satellites can be calibrated based on a variety of atmospheric and terrain conditions around the world.

For these situations, high-quality ground control points collected at more than 500 worldwide airports and thousands of other locations around the globe are included in the CompassData archive for use in processing imagery and re-calibrating the sensors when they are far from the official calibration sites.

ENSURING GCP ACCURACY

It's important to keep in mind that no sensor is perfect, but GCPs on the ground can overcome imperfections and establish a perfectly georeferenced product. Collection of accurate consistent GCPs is as much art as science. GCPs must be acquired by certified surveying experts using professional-grade GPS receivers and adhering to standardized, documented procedures that do not change with the personnel or geographic location involved.

True for any ground control application, GCPs used in sensor calibration must be captured along with metadata information that ensures the right point is found in the imagery—station diagrams or sketches as well as ground photographs showing the exact location of the point. And of course, the accuracy of the control point itself must be included with the data set.

▼ FIGURE 4. CompassData has over 30,000 photo-identifiable ground control points and growing. Each dot is representing a cluster of GCPs covering a major city.

ON THE EDGE

The Year 2015: The Start of a New Decade of Making it Right?

BUILDING A GLOBAL RESILIENT COMMUNITY

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FINALLY, IN AUGUST THIS YEAR IT WAS PUBLISHED: "The Collapse of Western Civilization - A View from the Future".[1] Taking the view of a historian in the Second Peoples Republic of China, who in 2393 looks back and analyzes why 300 years earlier the western culture collapsed, Naomi Oreskes and Erik M. Conway (yes, the same authors who worked together on *Merchants of Doubt*)[2] paint a beautifully scary picture of what might happen in the 21th Century.

The scary part is not so much the story itself, but rather that every detail leading to the total collapse of the North-Atlantic culture and several satellite cultures is scientifically sound and could take place in the way the authors describe it. The scary part is that the collapse is the best-documented disintegration of a civilization; one where all the knowledge was there—but it did not result in decisions that could save the civilization.

Everyone should read the book; it's thin, affordable, scary, fun and essential. It describes a scenario that could turn out to be very similar to what may happen in this century with the most evolved and complex human civilization ever on Earth. But let's hope that things turn out rather differently.

I agree with Arthur Simms that there are a number of reasons to be an apocaloptimist.[3] Anybody who can interpret the data and understand the science doesn't need a NASA-funded study under the lead of Safa Motesharrei[4] to inform us that we are heading for a "perfect storm" with the potential to lead to a civilization collapse. To me, it is very clear that we are heading towards a sustainability and climate apocalypse. But I am optimistic and think we still can turn this around.

There are signs that slowly the evidence for a looming catastrophe is convincing. Reuters just published two parts of a study emphasizing the risk associated with doing nothing,[5] and another study showed that fixing climate change would not add any costs.[6] It seems like we are slowly realizing that being inefficient and wasteful and degrading our life support systems on our home planet may be inhumane and not be very smart.

Yes, there are also some who do not understand the science, and a few who for personal advantages tell lies about the science (as documented in *Merchants of Doubt*). A recent example is the "*Wall Street Journal* Parade of Climate Lies",[7] where non-experts construct sophisticated logical fallacies to please the journal's owner, Rupert Murdoch, a well-known "bully in the schoolyard," who has been prosecuted in other countries for crimes.

The authors of these lies know as little about the complex Earth system processes and the resulting climate as they know about building an airplane. I would never want to fly in a plane built based on their schemes, and I do not want to see humanity's future being built on their unqualified assessment of climate science. They do not deserve our attention.

What deserves and should have our full attention is the fact that the year 2015 might be the turning point. It is a very special year for our global community. Why is this so? Because we humans are rethinking many global goals, objectives and approaches.

We are in the middle of a number of seemingly independent processes that will set the

global framework for the next ten years. There will be key gatherings at the ministerial level that will determine the focus of the international community in several areas, including but not limited to development goals, disaster risk reduction, and Earth observations.

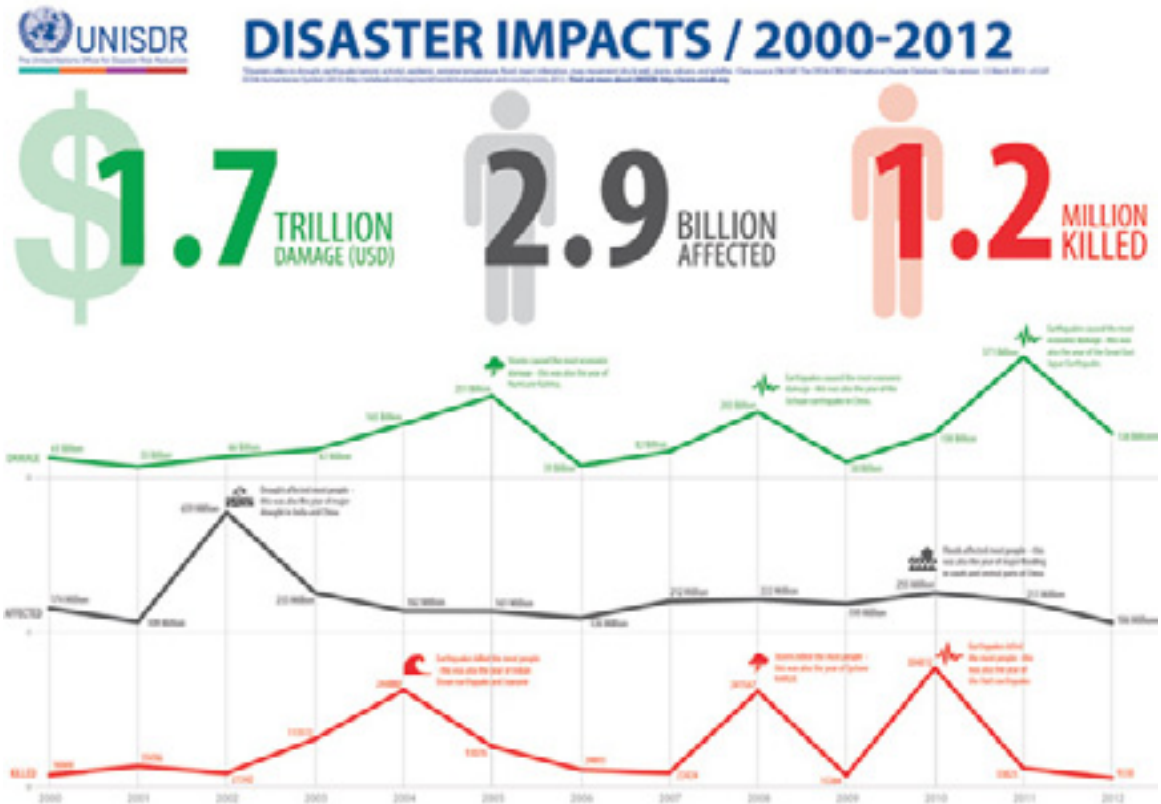
In 2000, the international community agreed on the Millennium Development Goals (MDGs)[8] to be reached by 2015. While we have made progress on some of these MDGs, progress has not been uniform across the planet. Sub-Saharan Africa is an epicenter of the crisis resulting from not reaching the goals. In many areas, climate change and conflicts are threatening the progress made during the last one and a half decades. See ***Figure 1***.

In January 2005, the World Conference for Disaster Reduction agreed on the 10-year Hyogo Framework for Action,[9] which has the goal of substantially reducing disaster losses by 2015 by building the resilience of nations and communities to disasters. Although we have made progress in many regions towards increased resilience and reduced disaster risks, the number of people impacted by hazards keeps increasing. See ***Figure 2***.

1

▲ **FIGURE 1.** Food Security Index. The MDG of reducing hunger has been achieved in part, but in many regions, food security is still low and people often go hungry. See http://food-securityindex.eiu.com

In 2013, 22 million people were uprooted by floods, storms, and earthquakes, and these numbers are rising.[10] Likewise in 2005, ministers of more than 50 countries came together in Brussels to agree on an ambitious 10-year Implementation Plan for the Global Earth Observing System of Systems (GEOSS) and to initiate the Group on Earth Observations (GEO) with the mandate to implement GEOSS by 2015. GEO has made great progress with respect to data sharing, the discovery and accessibility of data, and the availability of new services for end users. But there is still a gigantic gap between the available data and the information and wisdom needed by our



2

◀ **FIGURE 2.** The Hyogo Framework of Action was instrumental in improving resilience and reducing disaster risk. However, increasing exposure of a growing population and a changing hazards spectrum leads to more and more people being impacted by disasters.

leaders to make the right decisions to avoid the apocalypse.

Now, at the brink of 2015, leading thinkers are working on defining the Sustainable Development Goals (SDGs) for the next ten years,[11] and these SDGs are likely to be accepted by the United Nations early in 2015. UNISDR (UN International Strategy for Disaster Risk Reduction) is facilitating the process of developing a post-2015 framework for disaster risk reduction, and this process will culminate at the 3rd United Nations World Conference on Disaster Risk Reduction scheduled to take place in March 2015 in Sendai, Japan.

GEO is in the process of defining the scope for the next ten years, and a ministerial summit later in 2015 will decide on the implementation plan for the 2015-2025 period. This is a unique opportunity to ensure that GEOSS is providing the information required to measure progress towards the SDGs, to inform about the hazards our increasingly exposed population are facing on a changing planet, and to support the development of a more resilient global community.

Yes, I do agree with Safa Motesharrei and colleagues that we are heading for a "perfect storm" and apocalypse and I can imagine our future unfolding like envisioned by Oreskes and Conway. 2015 is the year when we can turn this around. We have the knowledge and the means.

Remember, fixing climate change may not add costs[6] but a global climate crisis would. Instead of reading climate lies in the *Wall Street Journal*, shouldn't we all be excited and yearning for news about the progress we are making? Progress towards defining the SDGs for the next 10 years, building a new resilience framework for action, and developing an implementation plan for a future GEOSS that keeps our decision makers informed about the state of the planet and provides foresight about the future?

I personally believe so much in our ability to make it right that I spend considerable time on organizing workshops[12] to bring together those discussing the SDGs and those working for a new framework for action for resilience and those building the next GEOSS to make sure that GEOSS serves the needs of humanity. Call me an apocaloptemist, if you want. ∧○

Endnotes:

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8 See e.g. http://www.undp.org/content/undp/en/home/mdgoverview.html

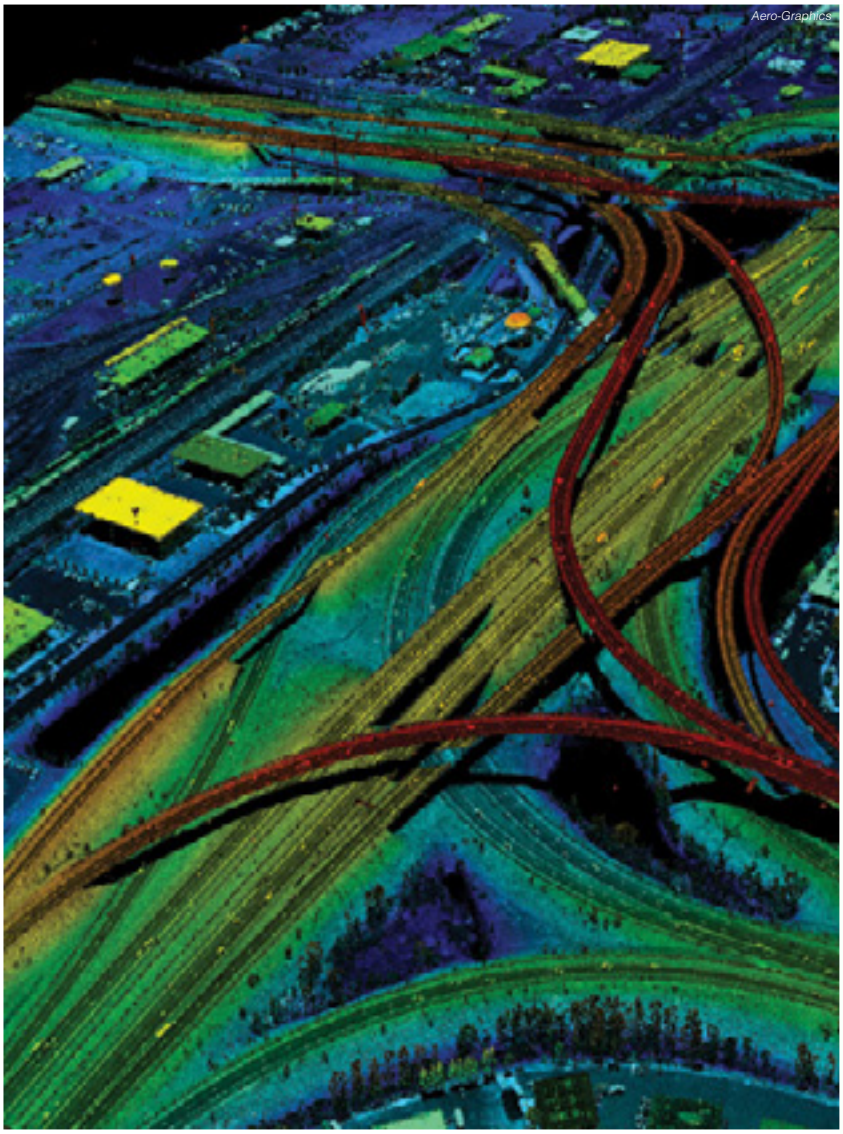
9 See e.g. http://www.unisdr.org/we/coordinate/hfa

10 See http://www.reuters.com/article/2014/09/16/us-foundation-disasters-displaced-idUSKBN-0HB2PG20140916

11 See http://sustainabledevelopment.un.org/index.php?menu=1549

12 See http://www.gstss.org/2015_Norfolk_3rd/ and http://www.gstss.org/2015_Norfolk_4th/

European LiDAR Mapping Forum



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