PATHFINDER

Right Place Right Time

Human geography tells 'when' and 'where' to put boots on the ground

On My Mind:

Driving Innovation

Changing technology and increased access to geospatial information are rapidly transforming our world. New technology offers new possibilities to bring geospatial intelligence online and on-demand. At the same time new data sources like social media and human geography offer broader and deeper analytic insights. As I have said before, NGA will always seek to put GEOINT into the hands of our users by leveraging the advantages that technology and improved tradecraft provide.

The Director of National Intelligence has made effective integration of intelligence his top priority. NGA is a key partner in this community-wide effort. GEOINT's intelligence advantage lies in its visual foundation for all intelligence disciplines, enabling situational awareness and understanding. GEOINT can provide the intelligence advantage for real-world situations. Earlier this year, to drive end-user innovation, we introduced a new construct called the integrated work group (IWG), where developers, analysts, security professionals and others work side by side to address real-world issues. As a result, we now deliver innovative capabilities every 60 days. These capabilities improve efficiency and productivity, and ultimately improve the quality of analysis.

For example, to develop deeper analytic skills, we established the IWG for Iran. The IWG continues development of a new integrated analytic environment that allows analysts to display and analyze disparate geospatial data with other intelligence in a common framework. The environment is available on three network domains to broaden community access. The IWG construct fosters deeper, more collaborative analysis, and results in more consistent and accurate judgments conveyed with a unified voice.

To improve data discovery, accessibility and usability, we established the IWG for Yemen and the Horn of Africa. Human geography is one of the sources informing this effort. The team has made great progress in ensuring data enhancements improve decision making about data collection through the new Geospatial Requirements One-stop Visualization Environment, or GROOVE. Historically, when trying to understand what data exists about a specific area of the world, analysts sorted through databases, printouts and shoe boxes of information. GROOVE puts all of that information online at users' fingertips. This saves time by allowing users to focus on analysis, not data searches.

Lastly, to improve GEOINT access and use in the unclassified environment, we established the IWG for Readiness, Response and Recovery. A number of innovative solutions in this environment have sped access to data, automated data collection and improved analysis. One such solution is the Synthetic Aperture Radar Flood Analysis Tool, which cuts analysis time by 50 percent and reduces the resources needed to analyze critical infrastructure potentially impacted by flooding, such as roads and power stations. The time saved can be used to provide real-time, broader and deeper analysis for response and recovery efforts.

These are just a sample of the innovative solutions NGA is developing and deploying as a result of our IWGs. In this issue, you will read more about the IWGs' progress, and other advancements occurring across NGA and the GEOINT community, and about the emerging use of human geography data. As we move forward, we will continue to aggressively develop and deploy new solutions to put the power of GEOINT into our customers' hands, when and where they need it most.

Letitia A. Long

Letitia A. Long
Director

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On the Cover: The study of human geography allows NGA's geospatial intelligence analysts to provide decision makers with the information necessary to ensure our military is at the right place at the right time to provide assistance to those in need. U.S. Marine Corps Lance Cpl. Tom Morton hands an Afghan child a toy during a security patrol in the Garmsir district of Afghanistan's Helmand province, Feb. 25. Morton is a team lead assigned to Kilo Company, 3rd Battalion, 3rd Marine Regiment. U.S. Marine Corps photo by Cpl. Reece Lodder. NGA photo illustration by Jay Conklin.

Inside back cover: Design by Glenn Holloway. Photo by Tony Boone.

INSCOM Commander Speaks to 'Power of NGA'

By Rosemary Heiss, Office of Corporate Communications

DOD photo

Amy Maj. Gen. Stephen Fogarty is the commander of U.S. Army Intelligence and Security Command, which oversees the Army's use of geospatial and other intelligence disciplines. Before taking the lead at INSCOM, Fogarty also served as the senior intelligence officer for the International Security Assistance Force, Afghanistan, during which time he saw firsthand the value of using GEOINT in influencing international decisions favorable to ISAF forces.

Q. What has been your experience with the National Geospatial-Intelligence Agency?

I can't be more complimentary of the support that NGA has provided both for the two years I spent at CENTCOM (Central Command) and the year and a half I spent at the J2 (joint intelligence office) over in ISAF. When you start to look at challenges that we face, everything starts with a dot on a map. It's the ability to present that in an effective and accurate manner that's critically important. I don't think there was a time that I briefed Gen. [David] Petraeus or Gen. [John R.] Allen that we didn't sit down with a map—start with a description of the environment, what the situation was. It could be a political situation or a tactical situation, but it always started with, 'OK. Where are we talking about, and what are we talking about?' The multiple tools that your analysts use to depict the information really brings it to life. The old adage, 'A picture is worth a thousand words,' is absolutely true. There were multiple situations. It could run from a target that we had captured or killed. It might be an allegation of a civilian casualty incident. It might be something that the Afghans were reporting, and it was our ability to go into the boss and say, 'Look. This is really the ground truth.' And that always had a map or a GEOINT product—an image—to really explain what happened.

Q. Can you give an example of how you used GEOINT?

If you think back to the November border incident (Early reporting said 24 Pakistanis were killed by NATO fire. In the immediate aftermath, Pakistan closed the border to NATO.), the first thing we had to do—the first instinct—was to call the NGA team and say, 'Let's lay out a picture of the area.' And when I say picture I mean it's more than just a photo. It really is the whole product—to show the terrain, to show where the border was, to show where the [Pakistan] (PAK) positions were, to show our guys on the ground and walk step by step through this entire incident. The team was able to do that very, very quickly. What we were able to do was get a universal understanding on the friendly side of what happened, and it was very apparent after that what the facts were and where the friction occurred.

Q. You mentioned that NGA is uniquely capable of providing certain types of support. Why do you think that is?

You have people who are first of all technical experts and state of the art in their capabilities. They are completely networked and take an enterprise approach. They can reach back to the rear for help where needed. They can reach forward to confirm or deny a particular aspect of what we were trying to do. And then we could layer in all the other INTs (intelligence specialties)—I could layer in SIGINT (signals intelligence), I could layer in HUMINT (human intelligence) reporting. That enhanced their production and their products. Every time we [would] bring in a visitor, we'd sit down at the table, and I would walk them through the situation using the very effective tool the NGA analysts had produced to tell the story for the command. So they're technical experts. They are very comfortable using all the disciplines to enhance the products, so very good team players. And the last aspect is absolutely integrated at all levels. They are connected with each other and connected into the customer, so they end up being very flexible and very responsive. That's for me, the power of NGA. The power of the enterprise: the technical expertise, the ability to integrate with the other disciplines to tell a complete story and approach the practice exactly where they're needed. That really gives NGA a very responsive capability.

Q. What do you need from NGA?

What I think we need is to sustain the relationship. My fear is that as overseas contingency operations wind down, we will regress to where we were before and that [despite] all the lessons learned, we'll go back to the way we were doing business. We can't afford to do that. I think that with NGA, by the integration we have in the facility, that won't happen. We're postured well to articulate our requirements to NGA. As long as they continue to be flexible and responsive, we're going to be good to go. What we see is there's this insatiable demand for GEOINT across the enterprise. I think it's staying at the cutting edge, constantly having a chance to wring out within your organization, and we can help you wring those things out and promote that very quickly to the forward edge. We're very confident that we'll be able to sustain that. I tell all the agencies that we've made so much progress over the last 12 years. Some of it has been a result of incredible pressure that has allowed some things to move forward faster than they would. We can't afford to slip back to the way it was before. As long as we remember that we'll be OK.

Q. What's next for GEOINT in the Army?

If you look at Intel 2020 for the Army, one of the pillars is 'Relevant intelligence to the edge.' What we want to do is move to where I can push a final [product] very quickly. If we're building our visualization tools and you guys are there right from the beginning, you [can] understand what the requirements are and you can build to those requirements. We have to work day to day to increase our collection where we have access. When we get access, we have to take advantage of that. Then we've got to really listen to the customer. In some cases, it's the ability to take really dissimilar, disparate types of data and integrate it into a standard product very quickly and be able to push that down in the most efficient manner to the guy out on the edge. There's a mutual benefit to that. In COIN (counterinsurgency) in particular, information has a tendency to be bottom up. If we enable the [soldier] with the latest, most advanced, most sustainable graphic representation that will speed information flowing back up. If we can send a guy out and he's got a pre-loaded set of maps or charts, and all he has to do is put an icon on a spot, send a report and shoot that back up and it automatically populates, number one it will be a lot more accurate. It will be much more timely, and that's what we're striving for.

Q. Is there anything you'd like to add?

My admiration and appreciation for how talented and dedicated the workforce is. I don't know how many times I saw the same guys that had been at previous locations with me. You've got frequent deployers. They bring such incredible expertise. NGA had the right people. They had good technology, but it was the integration of all of that with the commander forward that made that very, very successful. The reality is NGA guys are saving lives. There are men and women who made it home today because of the work that a crew of very talented, very dedicated NGA engineers, scientists and analysts were able to work. I will forever be in your debt for that. You had the whole enterprise leaning into something that you were committed to and making a difference where it was really important. ✺

Sgt. Will Daniels, a forward observer in the Long Knife Brigade's combat observation and lasing team, revamps his plan with the guidance of Romanian Lt. Col. Vasile Vreme, the commander of the 341st Infantry Battalion, during a nighttime observation mission Nov. 4, near Nasiriyah, Iraq. The group consisted of a small team of American forward observers with a large number of Romanian troops working together.

U.S. Army photo by Spc. Creighton Holub

GEOINT IT Changing to Better Support Analysts, Integrated Intelligence

By Rosemary Heiss, Office of Corporate Communications

Army Lt. Gen. Michael T. Flynn, keynote speaker at the NSG Infotech Users Conference in June at the National Geospatial-Intelligence Agency campus in Springfield, Va., speaks during the change of directorship for the Defense Intelligence Agency on Joint Base Anacostia-Bolling in Washington, D.C., July 24. Army Lt. Gen. Ronald L. Burgess Jr. turned over directorship of DIA to Flynn after serving in the position since 2009.

More than 90 percent of the stored data in the world has been created in the past two years, according to a June Financial Times article on big data. About 2.5 exabytes (an exabyte is 1 billion gigabytes) of data are created every day — only .1 exabyte less than all the data created in 1986.

That's a mindboggling increase in the volume of data created, and that volume only reflects one part of the big data challenge that users must solve in order to make high technology work for an industry. Variety and velocity of data are equal parts of the challenge, according to a June Mashable article. Variety refers to the different data and file types, including movies, images, text strings and geo-location data. Velocity refers to the rate of change in the data.

The geospatial intelligence community, long known for its bent toward high tech, has been working to take advantage of this onslaught of data in its effort to serve up visualized intelligence data as the foundation for integrated intelligence. The National Geospatial-Intelligence Agency is in the middle of this drive for transformation.

NGA hosted members of the National System for Geospatial Intelligence at NGA Campus East in Springfield, Va., in June for the NSG Infotech Users Conference, during which speakers provided updates on how the community is adapting information technology to make GEOINT data more relevant to the intelligence community.

During the conference, NGA Director Letitia A. Long provided attendees an overview of NGA's efforts to transform. She talked about the NGA strategy, which outlines two goals — online, on-demand access to GEOINT and broader and deeper analysis — and the seven objectives that will help the agency achieve those goals.

"The changes we're making are crucial," said Long. "We know we have a lot to offer. We have to deliver it in a totally new way in a format that our customers will want."

We are overwhelming analysts with data, said keynote speaker Army Lt. Gen. Michael Flynn, who was assistant director of national intelligence for partner engagement at the time of the speech and is now director of the Defense Intelligence Agency. Analysts have the problem of solving data challenges — including storing, cataloguing, searching and processing it — instead of spending their time solving intelligence problems, Flynn said. The analyst is the customer.

NGA is working to make the volume, velocity and variety of data that is available to the IC easily and quickly accessible to GEOINT analysts, regardless of where the data is stored. NGA's emphasis on better serving its customers is being led by the Online GEOINT Services team.

OGS Director Barry Barlow explained that GEOINT analysts might have to search more than 1,400 content storage sites to find useful data.

OGS is working to change that, he said. His team has been working with customers to understand their GEOINT needs and will use what they have learned as they develop a new online GEOINT content site.

Part of his team has taken a fresh look at NGA's customers to validate legacy understanding of their GEOINT needs and collect information about needs that GEOINT has not filled, said Christine Batchelor, who works for OGS's customer service focus area.

"We know a lot about our customers and how they use our current products, but what we're trying to focus on more is their need for dynamic products or services that today we may or may not provide or that we would be able to provide better in the future," said Batchelor.

"In traditional IT development, the user's definition of a requirement can be different from an engineer's interpretation of the requirement, which is sometimes obvious when looking at the final product," said Mark Riccio, director of OGS application services.

NGA's agile development process is "very interactive," said Riccio. "The developer and customer are in constant coordination to make sure that what is delivered meets the intent of the user."

NGA has already seen this process make GEOINT data more accessible and more useful. Integrated work groups—which contain analysts, source strategists, human resources specialists, research and development scientists and other skilled people working together to solve key intelligence problems—are actively testing the agile development process.

The work groups, which collaborate routinely with NGA mission partners, are identifying requirements, and through the agile development process, NGA is delivering solutions.

The integrated work group responsible for creating new ways to operate in an unclassified environment has already used applications created through this process to benefit some of their partners—first responders.

Information NGA analysts traditionally provided to first responders in hard copy—expensive to print and often out of date before the ink dries—analysts instead placed into a mobile application that first responders could dynamically update and share in the field.

"When first responders call, we are providing unclassified, near real-time, mobile GEOINT—not in hours, but in minutes," said Long. "We are giving first responders the decision advantage and equipping them to save lives."

Knowing When We've Got it Right

NGA will use business analytics to learn what GEOINT applications are used most frequently and, conversely, what apps are not used, said Barlow. Business analytics will provide the metrics that guide further GEOINT creation.

Barlow described how incorporating analytics will allow NGA to change its acquisition of GEOINT IT support. Instead of buying application developers' time, the agency is going to metered service, paying for applications based on how much customers use them and how valuable they are to the user, quantitative and qualitative metrics the online GEOINT site will provide.

NGA is working to provide a customer-focused environment that gives GEOINT analysts tools that harness the volume, velocity and variety of data to solve intelligence problems. ✴

"In traditional IT development, the user's definition of a requirement can be different from an engineer's interpretation of the requirement."

— Mark Riccio, director of OGS application services

U.S. soldiers with Bravo Troop, 1st Squadron, 113th Cavalry Regiment, Task Force Red Horse, 2nd Brigade Combat Team, 34th Infantry Division, Task Force Red Bulls, conduct a dismounted patrol along the mountainside approaching the village of Pacha Khak in Parwan province, Afghanistan, April 7, 2011. Bravo Troop's main objectives were to clear the village of weapon caches and to conduct a key leader engagement with the village malik.

U.S. Army photo by Spc. Kristina Gupton

NSG Expeditionary Architecture: Harnessing Big Data

By Keith L. Barber,
Director, National System for Geospatial Intelligence
Expeditionary Architecture Integrated Program Office

How does the National Geospatial-Intelligence Agency harness the power of "big data," data so complex and voluminous that users cannot easily store, transmit or retrieve it?

NGA faces three fundamental challenges with big data:

- managing the enormous volume of the data
- planning for its seemingly unquantifiable and exponential growth
- synthesizing the disparate varieties of the data into useful knowledge, i.e., understanding

The National System for Geospatial Intelligence (NSG) Expeditionary Architecture (NEA) Integrated Program Office is pursuing advances in high-performance computing (HPC) and virtual cloud structure to overcome these challenges and enable big data storage, retrieval and transmission (see related July/August Pathfinder article, "NEA Provides Virtual Capabilities"). When coupled with the emerging intelligence discipline of activity-based intelligence (ABI), big data can be effectively harnessed, exploited and analyzed, permitting analysts to provide answers to warfighters and strategic decision makers.

Activity-Based Intelligence

Activity-based Intelligence is defined as a discipline of intelligence where the analysis and subsequent collection are focused on the activity and transactions associated with an entity, a population or an area of interest. These activities and transactions are not solely tied to geospatial actions, but also apply across the cyber, social, financial and commercial domains.

Big data, across all domains, provides the substance for ABI analysis.

ABI enables focused intelligence analysis, within critical timelines, on hard problems such as irregular warfare, counterterrorism, counterinsurgency and counter-weapons of mass destruction. ABI is valuable in understanding the environment, even if there are no direct hostile actions or actors. Preparation of the environment, support to stability operations, nation

Keith Barber, Director, National System for Geospatial Intelligence Expeditionary Architecture, briefed at the NSG Info Tech Users Conference 2012. Barber provided attendees an overview of how NEA is evolving its architecture to include cloud architecture and the use of activity-based intelligence.

NGA photo by Tony Boone

building and civil affairs operations all benefit from characterizing and understanding the patterns of life in an area of interest and exploiting that knowledge.

"We are being called upon to think differently, work differently and collaborate differently … We are being challenged to think in terms of activity-based GEOINT rather than target-based GEOINT and to explain not only where something is happening, but also why," said NGA Director Letitia A. Long in her April 2011 Pathfinder column on leveraging technology.

To meet this challenge, NGA must embrace and deal with big data effectively. The efforts of the NEA, which has been working on ABI enablers for the past several years, have been instrumental in managing big data and maximizing its potential.

Data and Knowledge Management for ABI

ABI encompasses multiple phenomenologies, locations, timelines and confidence levels, as well as big data. Information about activities, transactions and entities adds another complexity; the analyst may describe any and all of these data points differently, even though they may in fact represent the same entity. The analyst must resolve entities — that is, understand the details of the entities — and can only do so when ABI processes supported by HPC render the big data information unambiguous.

Further complicating the issue, ABI data sources can be conventionally structured (such as traditional GEOINT) or completely unstructured (such as free-form text). Being able to use this data is the basis of the NEA ABI quick-reaction capability, a Web-based service to support U.S. military operations in in theater.

The underlying premise of ABI is that analysts can use activity data (and its related metadata) to identify associations within the data and thereby relate entities of interest. More data is better for the ABI analyst, and big data represents limitless possibilities for ABI. ABI analysts are investigating relationships which may have little to no signature, yet when taken in aggregate with all other related data, may provide a signature.

Associating data is vital to ABI analytics, thereby making it crucial to use all of the metadata that is available. The true promise of associations is only possible in the metadata. For example, two entities may be related in space and time per their positional metadata; or related across cyber space per their computer metadata; or relationally, per the metadata associated with, for example, a census. Today, metadata is almost an afterthought; very soon it will be the linchpin to the associations that make big data so valuable for ABI.

NEA recognizes that high data volumes are both a blessing and a challenge; with large data volumes the analyst is more likely to discover data that could be related. Yet understanding what data was captured and how analysts can link it is a much harder issue. ABI also poses the challenge of how to represent the significant information contained within large data sets.

NEA's response is to work with industry and federally funded research and development centers to explore representations of association data hidden within large data sets. Commonly called graph analysis, this new approach to data representation based on metadata provides the analyst unprecedented insight into data contained across phenomenologies and across the enterprise. It provides a way to view, filter and manipulate the data in more powerful ways than in traditional relational databases. Graph analysis dynamically changes as analysts find new associations in the big data, making new connections, weakening existing connections or showing a completely new pattern or association.

NGA is working to ensure that data collectors and suppliers keep and provide all available metadata. NGA's InnoVision Directorate, which concentrates on research and development, is working with providers to establish standards for data and metadata. Industry is also working to develop highly flexible and evolving metadata that will enable search and retrieval beyond simply spatial and temporal correlations. NGA's challenge is to balance standardization of data and queries with flexibility for data discovery and association. Exposing and refining the metadata associated with big data strengthens ABI analytics.

NSG partners discussed improved access to GEOINT data through the use of next generation collaboration capabilities at the NSG Info Tech Users Conference 2012. Panel members left to right are Keith Barber, NGA; Chuck Gassert, Space and Naval War Systems Command; Dan Synder, Air Force Special Operations Command; Chris Philips, Air Force GEOINT Office; and John Snevely, Undersecretary of Defense for Intelligence.

NGA photo by Tony Boone

The Cloud Provides the Solution Space

Bringing big data together (either physically or virtually) in a cloud environment is essential to realizing the potential of ABI. Much like ABI, NEA's cloud architecture is based on principles of access, sharing and collaboration; NEA's cloud will provide on-demand access to all available data, both exploited and unexploited. The reliance of ABI on raw multi-intelligence data, which an analyst has not yet formed into a finished intelligence product, demands the existence of a data cloud. The cloud is the ideal construct to contain raw data, as well as analyzed data, finished intelligence products, analyst reporting and association data/metadata.

The most difficult challenge in ABI is organizing association data (which forms the basis of the ABI analysis and reporting), archiving it and providing for its intelligent retrieval and display. The cloud presents the ideal solution space where association engines can cull through the metadata and make the required associations. Having data reside in a common cloud environment allows the power of concepts such as complex event processing to begin the association processes. By compiling activity-based association data with its metadata over time, and adding analysis and reporting from many analysts, a rich archive will be formed to harvest patterns of life, networks and abnormalities which may have been overlooked otherwise.

Ultimate End State for ABI Knowledge Management

One of the goals for enabling ABI to the maximum extent possible is to design an architecture which will take advantage of the inherently multi-INT nature of ABI and provide a unifying vision for how data can be exploited in "activity space." By focusing on activity, performing integration in the activity layer, and using rich metadata for associations and relationships, disparate big data sets can be greatly reduced and exploited. Analysts can then more easily obtain the significant data for subsequent analysis. By establishing a cloud architecture to encompass the data and processes associated with ABI analytics, and providing an advanced high-performance computing environment, NEA is enabling the NSG to harness the full benefits of both big data and ABI.

The Path Ahead for NEA, ABI and Big Data

The vision for NEA is to deploy and sustain a full-spectrum ABI architecture both forward and at home, leveraging past and current investments in communications, cloud infrastructure, high-performance computing and virtualized applications across the enterprise. The ABI applications will be integrated within the forward infrastructure placed in theater by NEA and will support reach-back operations, riding on the backbone of the communications architecture the NEA has established.

ABI applications and tradecraft will evolve as warfare and technology evolve and must support operations anywhere in the world. ABI analysis, relying on the cloud and high-performance computing, will reduce data discovery timelines, improve the ways analysts display data and spawn new analytical products which will take less bandwidth while conveying more actionable information. NEA is positioned to lead the way as the deployable foundation for NGA's instantiation of the emerging discipline of ABI. ✷

NGAA Extends Outreach Efforts

The National Geospatial-Intelligence Alumni Association, formed to bring together former and current members of NGA and its predecessor organizations for continuing social, professional and NGA support functions, is only about 18 months old and already working to extend its outreach.

The association is seeking more interaction with other intelligence community-related organizations.

One example is NGAA's participation with the Intelligence Community Associations Network. ICAN is not an organization, but rather a venue that brings together about 40 representatives of associations, societies, centers, foundations, conferences, institutes, museums, alliances and educational groups. The network meets periodically to share developments in their respective areas and highlight upcoming conferences.

NGAA contributes a geospatial intelligence perspective to the meetings and takes away a broader knowledge of intelligence community-related activities.

NGAA is also working with the U.S. Geospatial Intelligence Foundation to forge a closer relationship that will benefit both organizations and offer increased opportunities to contribute to the GEOINT tradecraft. Both groups plan to seek additional areas of mutual interest and int action.

"USGIF is making significant contributions to raise awareness of GEOINT and foster its introduction into college curricula, making it an excellent partner organization for NGAA," said Allen Anderson, chairman of the NGAA Board of Directors.

Said USGIF President Keith Masback, "USGIF is committed to partnerships of all kinds, and we are excited by the tremendous potential synergy offered by close collaboration with NGAA."

More information about NGAA is available at www.ngaalumni.org. Information about USGIF is available at www.usgif.org. ✷
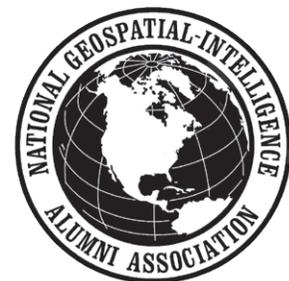
Modeling the Future of GEOINT

By Laura Lundin, NGA Office of Geospatial Intelligence Management

For many organizations, shrinking budgets and constrained resources mean slashing existing programs and limiting future investments. But how do decision makers determine where to cut and where to invest while limiting risks often associated with new technologies and aging legacy systems?

For the geospatial intelligence community, the answer lies in computer models, data sets, visualization tools, system configurations and an increased awareness of system capabilities.

Exploring the GEOINT Frontier

Two current efforts — under way in the National Geospatial-Intelligence Agency's Office of Geospatial Intelligence Management (OGM) Frontiers Division — apply these tools and techniques to help the GEOINT community look to the future while defining, studying and analyzing current capabilities and technology applications.

The division's modeling and simulation efforts and the Community Information Needs Forecast (CINF) database work hand in hand to ensure intelligence community and Defense Department leaders and National System for Geospatial Intelligence (NSG) partners have up-to-date, data-driven information at their disposal to objectively inform their decision making.

The Frontiers Division builds upon today's GEOINT capabilities by identifying potential "system-after-next" systems, which can take years to design, build and deploy.

Given these lengthy development cycles, the CINF database is crucial to understanding current system capabilities and building fact-based, objective recommendations for future ones, often in response to queries from the GEOINT functional manager (NGA Director Letitia A. Long), Congress, Office of the Director of National Intelligence and the Undersecretary of Defense for Intelligence.

The Community Information Needs Forecast

Primarily supporting the NSG modeling and simulation community, the CINF outlines a target set populated with information on the community's GEOINT requirements and systems' performance measures from partners around the world.

Starting as a simple dBase II file in 1990, the CINF is now a large, complex, relational database that contains projected future imagery and geospatial information needs for the NSG and documents the community's end-to-end intelligence foundation, peacetime and crisis requirements.

Built to represent the needs of the NSG user, the Frontiers Division, Future Needs Branch, maintains the CINF and engages with NSG and Allied System for Geospatial Intelligence members to identify intelligence priority areas and projected requirements.

"The CINF provides a holistic snapshot of projected GEOINT needs — 10 to 15 years in the future," said Robert Spans, chief of OGM's Current and Future Needs Branch. "We reach out routinely to the subject matter experts and ask them to think hard about the types of information they will need to answer their GEOINT problems."

The CINF impacts future GEOINT operations by validating GEOINT user needs coupled with an evaluation of possible gaps in capabilities across the NSG, said Spans.

This ensures the CINF represents community needs for GEOINT capabilities that are robust, flexible, integrated and readily available — providing a critical baseline on which to advance GEOINT.

Modeling the Future of GEOINT

Building on the CINF's tools and information, OGM's modeling and simulation program generates "computer models that simulate the performance of GEOINT systems in an effort to analyze their performance and explore alternatives," said Riley Jay, chief of OGM's Modeling and Simulation branch.

Initially, the CINF team produces a subset of the CINF database, tailored to the anticipated global and regional needs appropriate to the questions at hand and supportive of multiple scenarios.

The modeling team then defines the sensor, intelligence cycle requirements and operations concept for the architecture being modeled. These elements are combined with the tailored CINF needs information and input into OGM modeling tools, which provide quantity and quality collection statistics over a specific time period for the system being modeled. The CINF's visualization tools provide breakouts of day by day and cumulative collection results — which can be broken down by things such as architecture, sensor type and target type.

These performance results may also be incorporated into a value model that combines multiple metrics into a single utility value, which can then be plotted to show systems performance versus cost of investment.

"Having an unbiased, hard numbers analysis of performance and of alternatives for the overall GEOINT architecture helps decision makers determine where investments are needed while, at the same time, providing our GEOINT stakeholders a better understanding of how their requirements are going to be satisfied," Jay said.

Historically, these efforts studied capabilities in a larger, general context, but some recent studies have focused on specific

questions or systems from GEOINT partners concerned with systems' performance while facing looming budget cuts.

"In some cases, the studies allowed us to show our partners what the realistic possibilities were and give them an opportunity to refine their original requirements to help ensure cost savings without negative impact to the mission," Jay said.

One such partner at the Defense Intelligence Agency is U.S. Strategic Command's Joint Functional Component Command for Intelligence, Surveillance and Reconnaissance (JFCC-ISR).

"OGM has been a vital partner in supporting efforts to improve national and tactical modeling and simulation products and service available to the combatant commands and defense leadership," said Bob Metcalf, chief, JFCC-ISR Modeling and Analysis Support Branch.

According to Metcalf, OGM's models and studies have helped DOD and IC senior leadership make timely, well-informed decisions by distilling complex geospatial intelligence questions down to necessary details in a concise, accurate and repeatable fashion.

This is evident in the 18-month, community-wide 2010–2011 Integrated Radar Way Ahead Study, which aimed to inform IC and DOD senior decision makers on the NSG future radar architecture.

Within IRWA, NGA's modelers led the Modeling and Simulation Working Group, which included six teams from the NSG-ASG community running models and integrating results into the final assessment.

"Where previous community studies would have multiple teams working independently, the Radar Way Ahead study was very much an integrated effort, with everyone working together," Jay said.

This integrated approach has distinct advantages over past efforts, including an increase in decision makers' confidence in the results. "Having the various models packaged together showed decision makers not only a range of possibilities but the similarities provided by multiple models," Jay said.

The team's understanding of how diverse operational procedures could influence system performance encouraged them to look at the scenarios differently, leading to a more critical, well-rounded assessment.

"Ultimately, we are really about informing our decision makers so they can shape our future architecture," Jay said.

Defining Future Efforts

Both the CINF and OGM's modeling and simulation efforts are vital to ensuring the community's success. By developing robust system data sets and operating advanced models and quantitative tools with analytic flexibility, OGM can address a range of scenarios, deliver results quickly and enable independent verification and validation of analyses.

Given today's austere budget conditions and evolving analytic environment, these objective evaluations grow in importance.

The criticality of meeting NSG users' mission needs, while being good stewards of public investment, necessitates a rigorous examination of each GEOINT capability. As national security priorities evolve, NSG commitments to global and defense operations will continue to demand timely and accurate GEOINT support to U.S. and allied missions around the world.

Additionally, the Frontiers Division is expanding modeling efforts and data sets, providing new capabilities to better inform NSG leadership. The group is working to include phenomenologies like Overhead Persistent Infrared and Light Detection and Ranging, both of which have seen increased usage in GEOINT operations, such as during the 2010 Haiti earthquake humanitarian and recovery efforts.

"OGM is leading the way in developing modeling and simulation techniques for accurately representing contributions of emerging capabilities, like OPIR, to the warfighter," Metcalf said. "They have excelled at making sure GEOINT capabilities are well-understood and accounted for, guaranteeing the best level of support is provided to its mission partners and customers." ✴
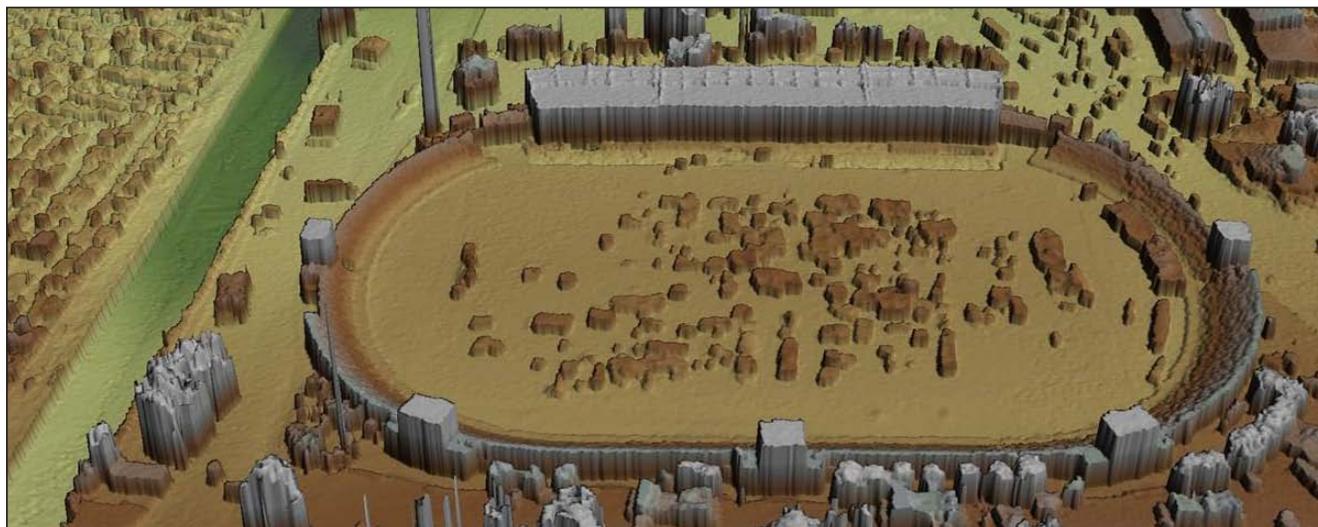
The Office of Geospatial Intelligence Management is expanding modeling efforts and datasets on new capabilities and phenomenologies like Light Detection and Ranging, as this image of a soccer field in Haiti represents.

NGA ALIRT image

Human Geography Provides Context to GEOINT

By Kathi Ghannam, Office of Corporate Communications

What is human geography?

Human geography is a century-old social science discipline that looks for interconnections between people and places, including how people use the physical landscape and how, based on a number of factors, that use evolves over time.

Using this discipline, the National Geospatial-Intelligence Agency and others in the intelligence community analyze ethnicity, language, religion, demographics, economics, education, water and land use, transportation and natural resources.

"There are two branches in the study of geography: physical and human," said NGA's Human Geography lead Bruce Heinlein. "As physical geography is a foundation of GEOINT, so too must human geography be. Human geography must be equally woven into the fabric of our knowledge, understanding, tradecraft and services."

NGA applies human geography to GEOINT by:

- Examining a broad range of geospatial information, including terrain, elevation and features like roads, buildings, hilltops and rivers to determine how people move from one place to the next, and how that movement manifests spatially and over time.

- Analyzing populations: language, ethnicity, education, demographics. Do certain populations commonly or readily form alliances?

- Looking at history: Is there a history of religious conflict in a region?

- Looking at the economy, access to technology and climate

Letitia A. Long, Director, NGA
Geospatial Intelligence Forum Magazine, July 2012

DOD photo by Petty Officer 1st Class Kirk Worley

A man carries a bag of sugar from a truck filled with humanitarian-assistance goods, delivered by Iraqi soldiers from the 4th Battalion, 18th Brigade, to the people of the village of Gambar, Iraq, Aug. 14.

While the major focus of human geography is not the Earth's physical terrain, it is hardly possible to discuss human geography without discussing the physical space on which human activities happen, said Heinlein.

"Human geography adds context," said Heinlein. "You may not be able to see in imagery what water shortages are doing to the cultural aspects (of life) but with that info you could understand why groups are in conflict."

NGA's vision is to create new value for its customers by broadening and deepening its analytic expertise by providing contextual analysis informed not only by the Earth's physical features and imagery intelligence but also by human geography.

"NGA needs to build on what we do well, describing where, when and how many, but we need to be able to anticipate where, what and why," said NGA Director Letitia A. Long. "This is another step as we continue to evolve GEOINT for the next generation, for the next fight."

The integration and analysis of HG data that we can obtain about a place can yield new insight into age-old questions, like:

- Where will the next pandemic outbreak occur?
- Where will transnational criminal activity spread?
- Where will the next mass migration event occur?

The path forward for HG integration

The Director of National Intelligence asked NGA to provide guidance and standards to intelligence community efforts to leverage the power of the human geography discipline late last year, and to lead the IC's efforts to survey all of the community's efforts within that realm, said Heinlein.

As a result, NGA and its community partners are exploring possible solutions for discovering and serving up that much-needed analysis, to include building mobile applications, cataloging existing content and leveraging cloud storage capabilities that will decrease physical database storage requirements.

So what are the specific tasks that NGA will engage in to shore up the community's access to HG?

"First and foremost, our efforts are joint and highly collaborative on all levels, from technology to people and processes," said Heinlein. "We are documenting requirements in the HG landscape and identifying ways that we might be able to satisfy them."

To that end, an IC-wide HG Senior Steering Group was established, which is composed of 22 Department of Defense and intelligence community agencies with HG equities.

Additionally, the agency, along with the Department of State, has established a Worldwide HG Data Working Group to build voluntary partnerships around human geography data and mapping focused on making information available to promote human security.

That working group will develop outreach programs, interface with the community, identify HG subject matter experts in classified and unclassified environments, document best practices and methodologies, develop data standards and seek training and academic opportunities.
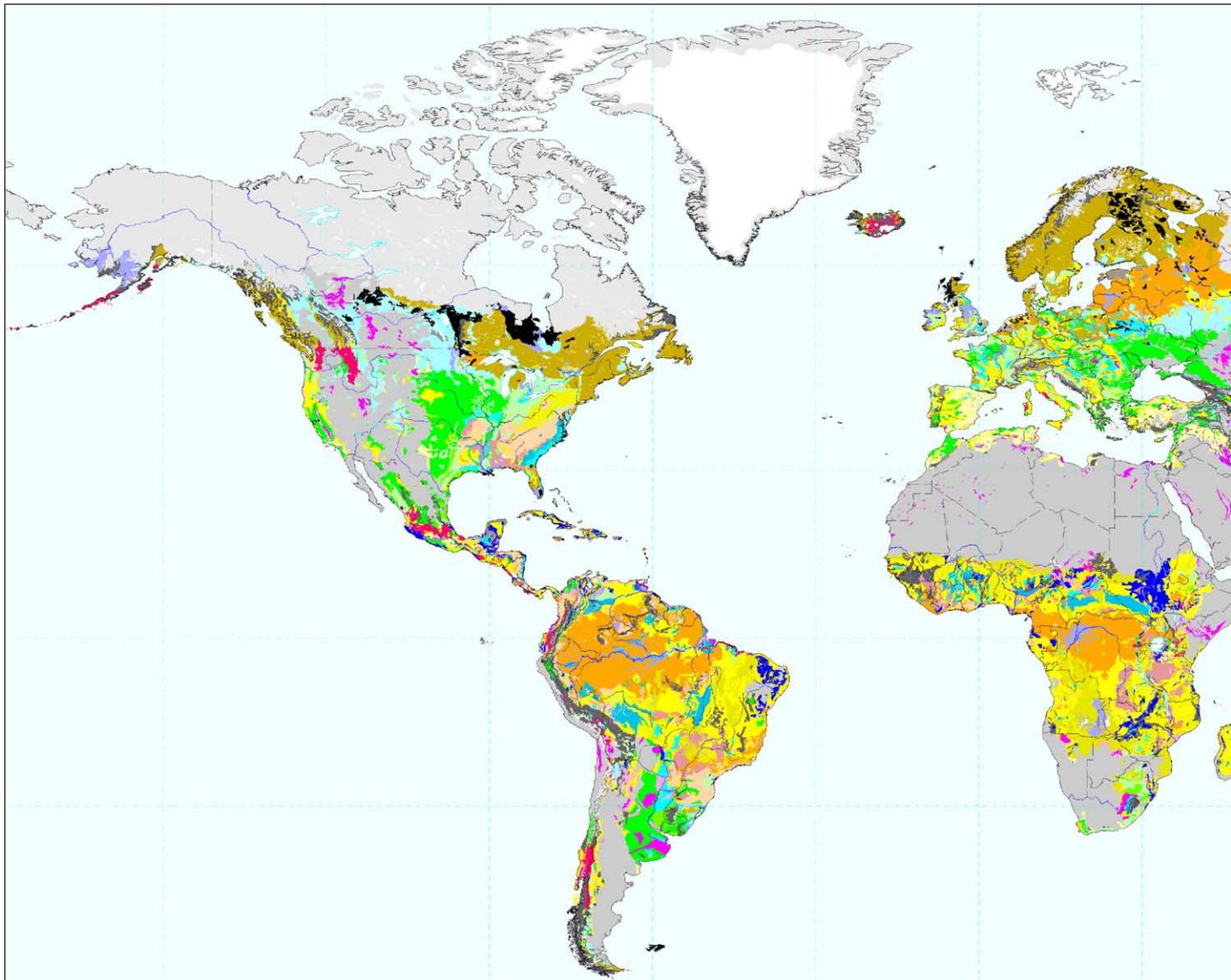
National Geospatial-Intelligence Agency analysts reconcile U.S. Geological Survey data, which reflects a combination of NASA Moderate Resolution Imaging Spectrometer data with field and rem environmental dynamics affecting soils formation and land use.

To determine how to best use HG in NGA's analysis, Long created a Joint Program Office comprised of analysts from both NGA's Analysis and Production and Source Operations and Management Directorates. This office is taking the lead in shaping NGA's HG community of practice, which originated a year ago and recently expanded to include analysts from the entire IC.

"There are pockets of HG excellence within the agency and government-wide," said Heinlein. "A number of the tools that were highlighted during the DNI study are being examined for their applicability and utility."
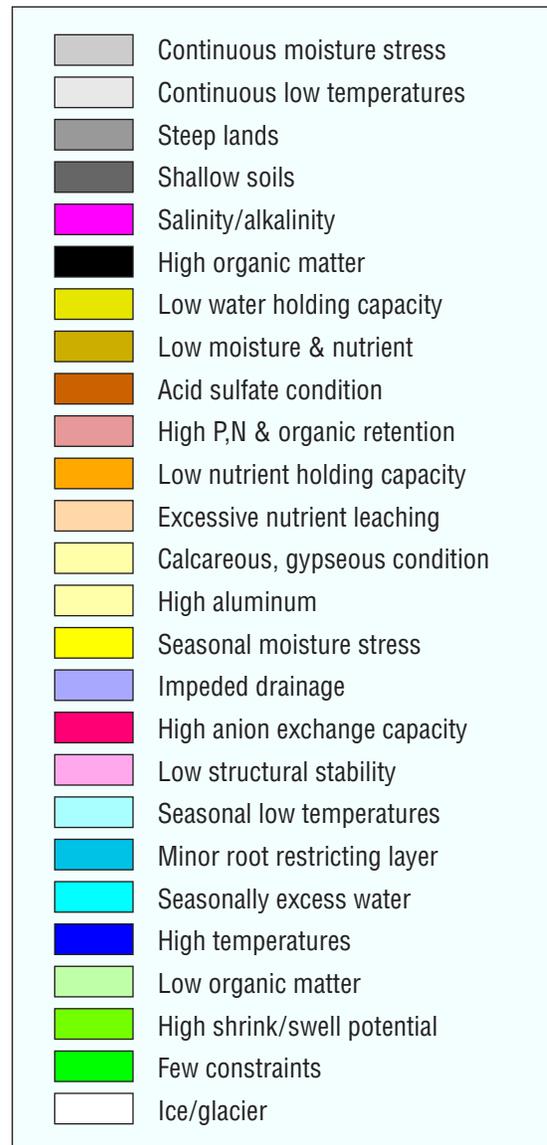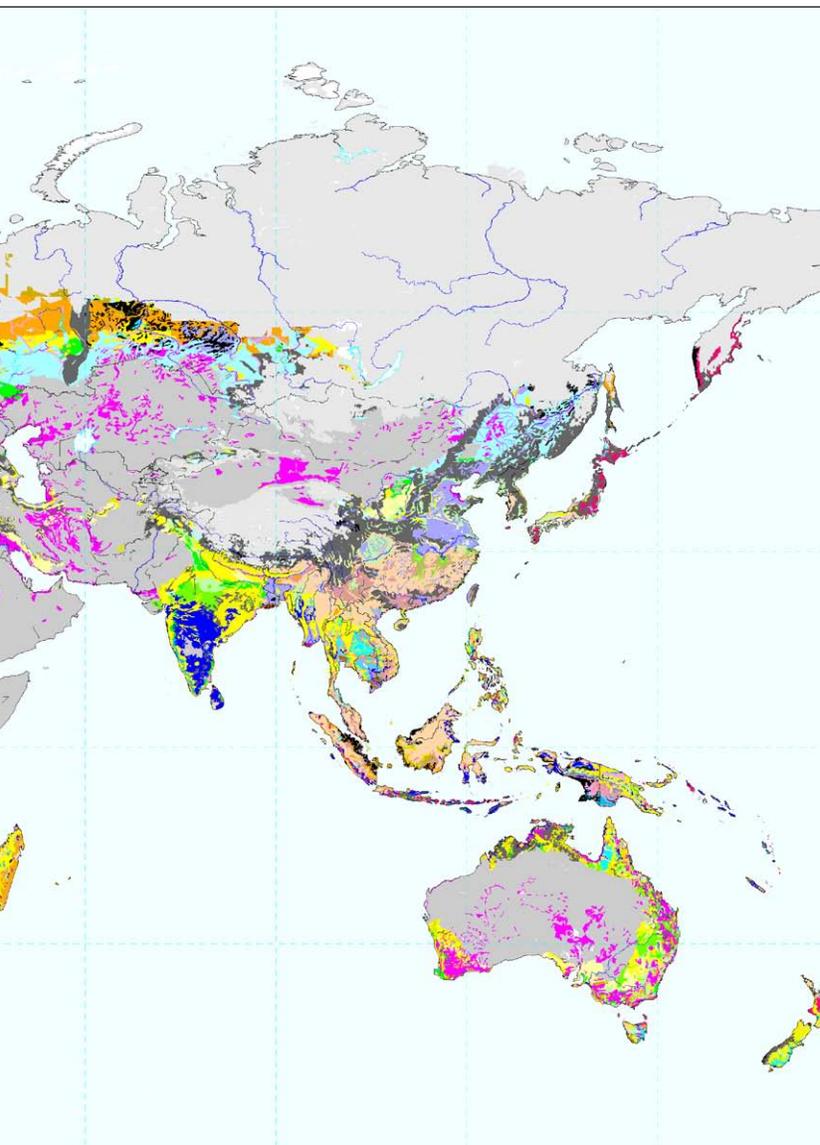
NGA has forged a number of industry and academic partnerships to help develop those tools and technologies needed to collect, analyze and disseminate HG, and equip people with the skills to integrate HG into all aspects of their mission.

An example of the international community's successful integration of HG into analysis comes from the Kosovo war in 1999. Visualization technologies and techniques enabled military decision makers to create spatial and temporal

databases to better understand the various segments of that society, according to a March 2011 article by Karen Kroll in Geospatial Intelligence Forum magazine. By understanding and using HG, planners were able to determine the best locations to pre-position humanitarian aid and medical support prior to the Serbian ethnic cleansing operation.

"Recognizing that the Serbs were burning select homes, and possessing knowledge of the migration routes refugees would use to find safe passage, food and water were staged before the onset of the crisis," wrote Kroll. "In this case, it was a preventative stabilization operation to reduce starvation, infant mortality, water shortages and infectious disease outbreaks."

By refining those pioneering tactics and technologies, Heinlein's team looks to build on early successes to mitigate future conflicts. ✳

	Continuous moisture stress
	Continuous low temperatures
	Steep lands
	Shallow soils
	Salinity/alkalinity
	High organic matter
	Low water holding capacity
	Low moisture & nutrient
	Acid sulfate condition
	High P,N & organic retention
	Low nutrient holding capacity
	Excessive nutrient leaching
	Calcareous, gypseous condition
	High aluminum
	Seasonal moisture stress
	Impeded drainage
	High anion exchange capacity
	Low structural stability
	Seasonal low temperatures
	Minor root restricting layer
	Seasonally excess water
	High temperatures
	Low organic matter
	High shrink/swell potential
	Few constraints
	Ice/glacier

...note sensing interpretations, with NGA terrain, elevation and hydrology data to provide insight into

Forum: Water a National Security Issue

By Kathi Ghannam, Office of Corporate Communications

NGA hosted an educational forum entitled International Waters: Conflict, Cooperation and Climate Change June 26 to explore the relationships between water disputes, international relations and intelligence analysis, including indications of conflict.

"Water has historically been a vital part of human interaction, stress and even conflict," said Bruce Heinlein, NGA, director, Human Geography Joint Program Office, Analysis and Production Directorate. "Within the study of human geography within the IC [intelligence community], water is one of the 13 key themes we are focused on."

Almost 50 percent of the world's population lives in a water basin that crosses the political boundaries of two or more countries, said guest speaker Aaron Wolf, professor of Geography at Oregon State University, who has advised the World Bank, U.S. Agency for International Development, UNESCO, Environmental Protection Agency and the State Department, including their Foreign Service Institute. In addition to the water needed to sustain human life, transportation, hydropower and two-thirds of the world's agriculture production also rely on water.

Nearly 2.5 billion people worldwide lack access to adequate sanitation, causing 250 million illnesses a year, resulting in between 2.2 and 5 million deaths, at a cost of more than $125 billion annually to the world's economy, said Wolf.

Haji Khan Agha, director of the Helmand Arghandab Valley Authority, questions a presenter during a summit that brought leadership from Nimroz and Helmand provinces together with members of the U.S. Agency for International Development and the International Security Assistance Force, March 1, to discuss water management at the Afghan Cultural Center, Camp Leatherneck.

DOD photo by Chief Petty Officer L.A. Shively

"As a result, the potential for paralyzing disputes is especially high," said Wolf.

"Conflicts over water often arise not over natural supplies so much as the human interventions, the water infrastructure intended to manage them," said co-presenter Matt Zentner, Defense Intelligence Agency. "Dams, irrigation, diversion and other infrastructure alter hydrological relations, affecting the quantity, quality and timing of downriver flows, but also power relations between upstream and downstream riparians."

When it comes to water disputes, perceptions can be just as dangerous as realities, said Zentner. If Pakistan believes that India can shut off its water supply, it may act on that perception regardless of its validity.

Zentner and Wolf agree that there are a number of indicators for water conflicts that analysts should monitor closely, to include migration, construction, rioting and the passage of new water usage laws, said Zentner.

There are several IC-wide water initiatives, to include the Water Infrastructure Working Group, focused on analyzing water's impact on the full spectrum of military operations as well as its role in instability, conflict and shaping regional security dynamics.

The Water Resources Working Group provides a forum for discussing how remotely sensed images and geographical information system analysis and modeling can provide environmental intelligence for military decision makers and government policymakers working with security, stabilization, transition and reconstruction operations and water security issues.

Water also underpins a number of collaborative community efforts ranging from the climate change community of analysis to the environmental geography sub-group within Heinlein's office.

Water security informs GEOINT analysis across all of NGA's mission sets. NGA's analysis of food and fuel security, and the impacts of climate change to national security, depend on understanding global water security, as does GEOINT analysis of

ThinkStock photo
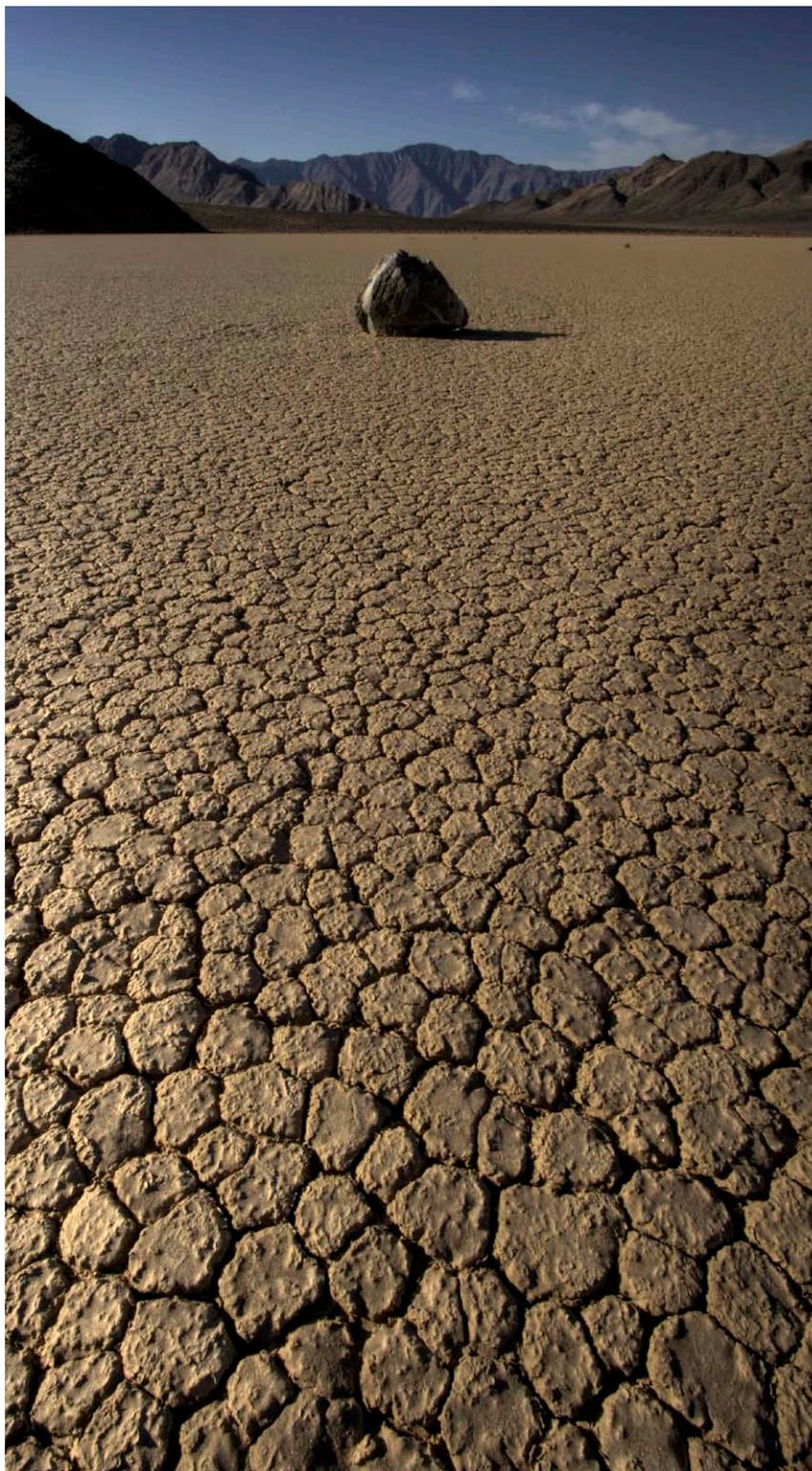
Death Valley, Calif., is the hottest, driest place in North America, according to the National Park Service. Temperatures can exceed 115 degrees. In 1929, the area recorded no rainfall. Cracked mud at the valley's Racetrack area illustrates its inhospitality to man.

transportation-related issues ranging from smuggling to the opening of the Arctic. Since water security affects deployed U.S. troops, NGA provides GEOINT support on issues ranging from supply lines to mobility.

Additionally, NGA conducts GEOINT analysis of water-related hazards worldwide, including support to disaster response and humanitarian operations. ☀

Integrated Work Groups Drive Improvements to Analytic Process

By Sara Fiske, Contractor, Office of Corporate Communications

When National Geospatial-Intelligence Agency Director Letitia A. Long unveiled NGA's vision to "Put the Power of GEOINT in Your Hands" at the 2010 Geospatial Intelligence Symposium in New Orleans, she set in motion a major transformation of the agency.

After conducting an online services contest and pulling together a vision implementation team, the agency established incubators and test beds and developed a set of strategic initiatives. Major organizational changes and re-alignments followed, all to better enable the agency to change the way it does business. In May, the NGA published its new strategy—the roadmap for how NGA is moving to achieve the vision.

One of the many developments was the establishment of three integrated work groups (IWGs) to integrate people and skills from across the agency to focus on specific analytic issues. Each group represents a cross section of NGA and includes everyone from analysts, to information technology specialists to research professionals, among others.

NGA has tended to do its analytic work based on its organizational structure, rather than by issue, said the deputy division chief for the IWG-Iran. Long designed the IWGs to change that paradigm, fostering an integrated approach to GEOINT and moving the agency closer to achieving its vision.

Each IWG has its own unique focus. The IWG-Iran works to improve the agency's analytic expertise and tradecraft on Iran, developing capabilities and solutions applicable across the enterprise for all other GEOINT analysts. This effort addresses primarily the second vision goal to "broaden and deepen our analytic expertise to produce new value."

The IWG-Readiness, Response and Recovery (IWG-R3) focuses on domestic and international disasters, special security events (such as the Super Bowl) and application development. It provides support to NGA's emergency preparedness, response and recovery mission partners, such as the Federal Emergency Management Agency, Coast Guard and FBI.

National Geospatial-Intelligence Agency analysts work in the Mobile Integrated Geospatial Intelligence System, or MIGS, during an Integrated Work Group for Readiness, Response and Recovery hurricane response exercise at Arnold, Mo., in May. The MIGS provides transportation, communication and workstation access for analysts in the field.

These mission partners work primarily in unclassified operating environments, so the IWG-R3 is developing solutions that enable the agency to respond quickly with a more robust analytical presence in unclassified domains, including the Internet. That effort includes strengthening GEOINT self-service capabilities, often in the form of new mobile device applications, some of which Long demonstrated during her 2011 GEOINT Symposium presentation in San Antonio. Providing more self-service capability is a key piece of the first vision goal to "provide online, on-demand access to our GEOINT knowledge."

NGA established the Yemen/Horn of Africa IWG (IWG-Y/HOA) to focus on efforts to enrich the geospatial data offerings for this region, using a variety of traditional and non-traditional sources, including human geography.

Human geography studies patterns and processes that shape human interaction with the environment. It includes human, political, cultural, social and economic aspects of the social sciences. It's part of a broader category of foundational GEOINT data that the IWG-Y/HOA is trying to better collect and leverage to help solve complex intelligence issues.

"If the human geography data is readily available, it'll push me, as an analyst, to examine other aspects of the intelligence problem," said the lead analyst for the Yemen branch of the IWG-Y/HOA.

Motivating analysts to examine different aspects of intelligence problems is a goal of all three work groups. New technology is the enabler.

The IWG-I is working to bring data from a variety of sources directly onto the analyst's desktop. Previously, analysts would log onto a system in one physical location, but then move to another system to incorporate the data into their analysis.

To address this issue, the IWG-I is developing the Integrated Analytic Environment (IAE) to bring all sources of data together on the same desktop, allowing analysts to discover, visualize and analyze all the available information at the same time, from the same place. Currently in the beta test stage of development, the goal is to make the IAE available across all intelligence community domains.

"All the technical solutions exist," said the national GEOINT officer for Iran. "Changing the NGA culture is the biggest challenge."

The chief of data services for the IWG-Y/HOA echoed that sentiment. "We do a good job of collecting data, but we don't make it easy to find and access," he said. "Analysts spend more time searching for data, rather than analyzing it—it needs to be the other way around."

The IWG-Y/HOA is working to make NGA foundational data holdings more discoverable and easier to use. One tool they are developing is a Web-based geospatial requirements management tool called "GROOVE"—the Geospatial Requirements One-stop Visualization Environment. Built on open standards, combatant command testers have given it rave reviews.

Another software tool the IWG-Y/HOA is pioneering is the "Geospatial Observable Web Kit (GOWK)," which requires a specific and disciplined data entry process, but features a user-friendly Web interface that helps analysts capture their imagery observations. With a simple keyword search, users
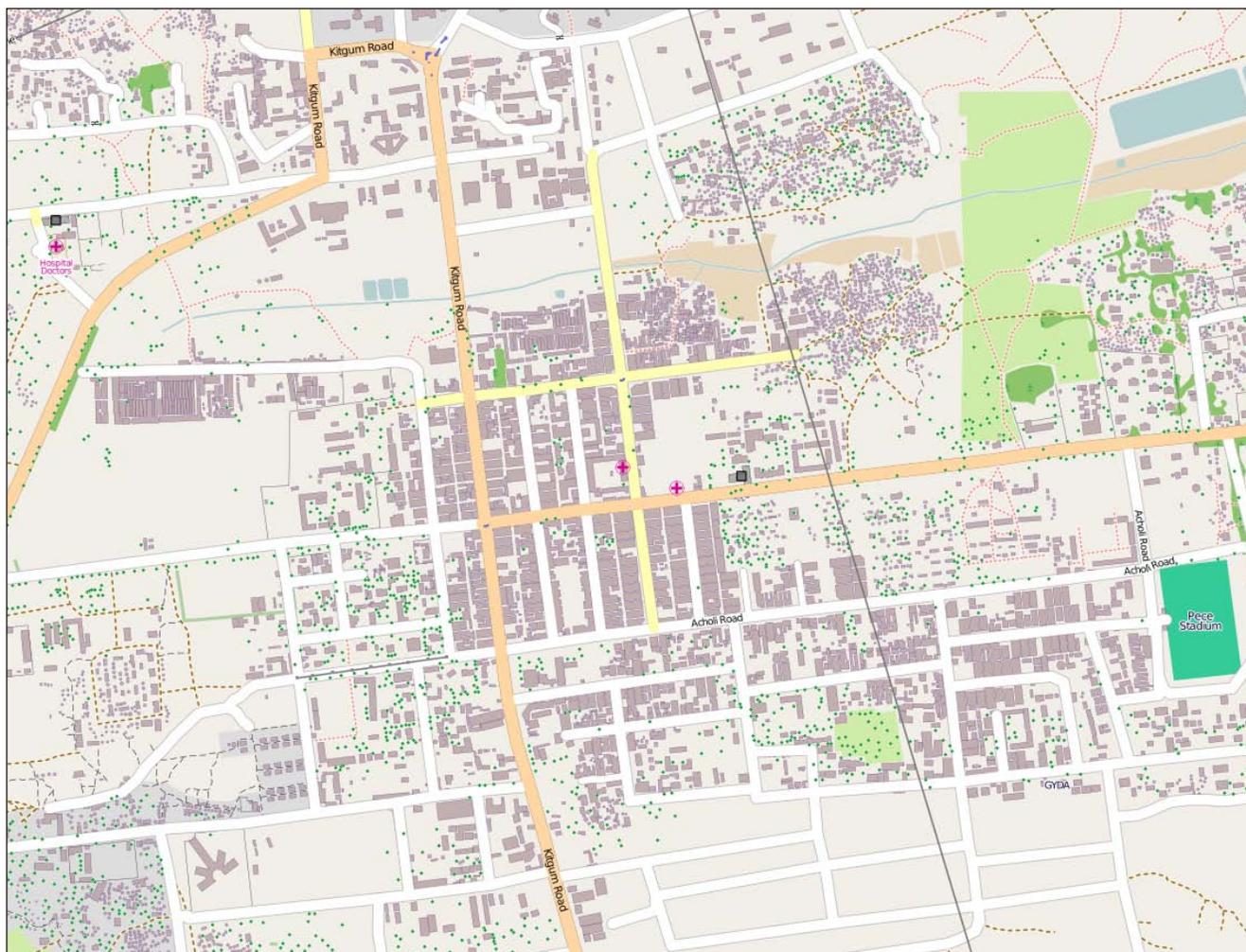
Through a joint project involving NGA's Integrated Work Group for Readiness, Response and Recovery, the Department of State's Humanitarian Information Unit and the American Red Cross, volunteers were able to trace features on commercial imagery over Gulu, Uganda, to create vector data in OpenStreetMap, an online, volunteer community effort that provides first responders and others worldwide foundation data they can use for future disaster risk reduction projects. The American Red Cross is partnering with the Ugandan Red Cross, having locals add attribution such as roads and building names to the data. The final result is an open and sharable resource for human geography data.

> *Pulling people together from around the agency to work on a single intelligence issue was a dramatic move, "but the agency had to do something dramatic to make the kind of change the vision requires," said the National GEOINT Officer for Iran. "The culture required positive disruption."*

can access a dynamic geospatial product, move around the globe, display the data in different ways and interact with its attributes, rather than simply look at a static report. A specific assessment can stand alone or become part of a more integrated analytic product. For example, a user may ask to see all the military equipment located in a certain region at a specific time, or he may ask to see all the equipment movements in the same region over the last six months. GOWK can address both questions.

Common data standards are one key to creating these service-enabled technology tools; changing the slow, bureaucratic way the government has traditionally acquired new technology is another. The IWGs are experimenting with user stories to define needs, and have users and developers working side by side in an iterative development process.

The agency is also looking to the commercial world to help fill the technology gap. "The commercial aspect of our industry is very high tech and very dynamic," said the chief of data services. "We need to work within that environment, using commercial technology where we can and incorporating their way of thinking about development into our processes."

Ultimately, the goal for all the IWGs is to find the best tools, integrate them where possible and roll them out to the rest of the agency. The IWGs are also developing new GEOINT products that are helping drive improvements in the analytic process itself.

The IWG-I has developed a new interactive version of the traditional NGA intelligence brief, or NIB. Unlike the standard NIB — a written report with static graphics — the iNIB is an interactive product that allows users to tailor their viewing preferences, offering them the option of printing a one-page PDF summary, downloading an un-annotated version of a graphic, accessing links to related reporting on Google Earth, and sharing the information via intelligence community social media applications.

The iNIB, the IWG-I associated production process and overarching mission strategy are forcing analysts "to think more

upfront about what they're writing about and how they're writing it," said the national GEOINT officer for Iran. So far, customer feedback about the iNIB has been good.

But the work of the IWGs has its challenges. For example, the IWG-R3's mobile apps and widgets have been met with great enthusiasm by users, but initiatives to enhance mobile apps also extend into what GEOINT Mission Manager for this IWG, Dennis Bowerman, calls "identity management."

The importance of "verifying that it's actually first responders going into our systems to get the data" is paramount in addressing user authenticity, said Bowerman. The group is also addressing legal and policy issues relating to homeland security data and Executive Order 12333, which outlines the rules for how the intelligence community operates within the United States.

But the work of the IWGs is starting to make a real difference for the agency as well as the entire GEOINT community. Part of the IWG-R3's mission is to teach customers how to use all the apps and widgets they've been developing. This will allow NGA to deploy fewer personnel to support natural disasters and special security events in the future, saving both time and money, an important consideration in an era of shrinking budgets.

But sometimes the most significant changes are invisible to the customer. Working closely with colleagues from different parts of the agency, IWG members have the opportunity to learn more about each other's tradecrafts and how to leverage the different expertise available to them.

"Every day, I'm learning about a new [geospatial] dataset that I can use in my work," said the lead analyst for the Yemen branch of the IWG-Y/HOA.

Pulling people together from around the agency to work on a single intelligence issue was a dramatic move, "but the agency had to do something dramatic to make the kind of change the vision requires," said the National GEOINT Officer for Iran. "The culture required positive disruption." ✹

Cartographer Reveals Hidden 70 Percent of Earth's Surface

By Dr. Gary E. Weir, NGA Historian

"I had a blank canvas to fill with extraordinary possibilities, a fascinating jigsaw puzzle to piece together," said oceanographic cartographer Marie Tharp in an oral history interview conducted for the 50th anniversary of the Lamont-Doherty Earth Observatory in 1999 and as reported in their 2006 news release announcing her death.

"It was a once-in-a-lifetime — a once-in-the-history-of-the-world — opportunity for anyone, but especially for a woman in the 1940s," said Tharp of her oceanographic work.

In 2011 the National Geospatial-Intelligence Agency named a conference room at its new campus in Springfield, Va., for Tharp. The designation celebrates her knowledge of the Earth and her skill as a cartographer; few others knew as well as she did that part of the Earth the ocean hid.

I had the good fortune to know Marie. In her South Nyack, N.Y., home we talked for the best part of two days. She unrolled for me across two banquet tables, situated end-to-end, the brown-paper drafts of the comprehensive map of the ocean floor she composed with her partner, geophysicist Bruce Heezen.

The Office of Naval Research sponsored their work and then published the result in 1977, well before the digital revolution took over the process of making maps. I could see the data points they carefully placed on the paper over many months. She and Heezen also produced groundbreaking maps of the North Atlantic, South Atlantic and Indian Oceans.

Marine scientists and oceanographers who professionally came of age in the 1960s and 1970s universally experienced a revelation upon seeing the Tharp map of the world ocean. Allyn Vine of the Woods Hole Oceanographic Institution, father of the Alvin submersible (a deep-ocean research vehicle), noted that since the formation of the Earth no scientist could possibly form a near true mental image of the ocean floor.

Vine related to me that the Tharp-Heezen map stunned every scientist who viewed it. They could suddenly see the object of their lifelong curiosity in a way previously impossible. Apparently it felt somewhat akin to the experience my generation felt when Life Magazine published the first pictures of the Earth

Cartographer Marie Tharp appears here as she did when she collaborated with Dr. Bruce Heezen on the first comprehensive map of the world ocean floor.

taken from the Moon. There we were, and it was real! Marie Tharp made the ocean bottom truly real for geologists and physicists.

Born in Ypsilanti, Mich., in 1920, Tharp departed early from the study of English and music that occupied her undergraduate years. World War II took most of the male students off to war and opened graduate programs in the sciences to women as alternative students. Tharp took full advantage of the opportunity. She completed a master's degree in geology at the University of Michigan and another in mathematics at the University of Tulsa.

In 1948, looking for a true challenge, Tharp moved to New York City and found employment at the geology department of Columbia University. She worked initially as a secretary and then began plotting ocean depth soundings as an assistant to the department chairman, Professor William Maurice "Doc" Ewing, one of the founders of the discipline of geophysics in the United States. She followed Ewing to New York's Palisades' area when he established the Lamont Geological Observatory for Columbia University in 1949.

This is the World Ocean Floor Panorama, the first complete map of the world ocean bottom, created by Marie Tharp and Dr. Bruce Heezen at Lamont-Doherty Geological Observatory under U.S. Navy sponsorship in 1977.

In the process of plotting ocean depth soundings which revealed the bottom by echo return, she slowly traced and exposed the existence of a 40,000-mile long geological ridge, running in a curved circuit around the globe. That discovery formed the basis for her more comprehensive work both in the individual oceans and then in the larger 1977 map.

The intensity and regularity of Ewing's program of collecting terrestrial and oceanographic soundings and other data permitted Tharp to take an additional step, making a remarkable and groundbreaking discovery. She revealed the existence of a valley at the pinnacle and along the length of the mid-Atlantic segment of the ridge that she felt looked very much like a rift valley in east Africa. While the suggestion at the time struck many geologists as absurd, others who favored the new hypothesis of seafloor spreading felt it had promise. Time would reveal that Tharp had contributed a significant element to the emerging paradigm of plate tectonics. The seafloor did indeed move to the east and west from the rift valley along the mid-Atlantic ridge, opening up space for the interior of the Earth to extrude new crustal material to fill in the opening gap.

Like so many modern cartographers, Tharp received credit for her work beyond her immediate peers only late in life. The Library of Congress honored her and three other cartographers in 1997 for their contributions to the field during the centennial of their map and geography division. In 2000 the Office of Naval Research included her as one of the seminal personalities in a celebration of the birth of oceanography as a multidisciplinary science in the United States. I had the opportunity to do an oral history with her at that time, as well as another in conjunction with my own work on the history of oceanography for the U.S. Navy.

A giant in her field, Tharp helped anyone who wished to know the Earth. She set a high standard for her fellows in a venerable, practical scientific endeavor that still serves today as one of the pillars of geospatial intelligence. ✸
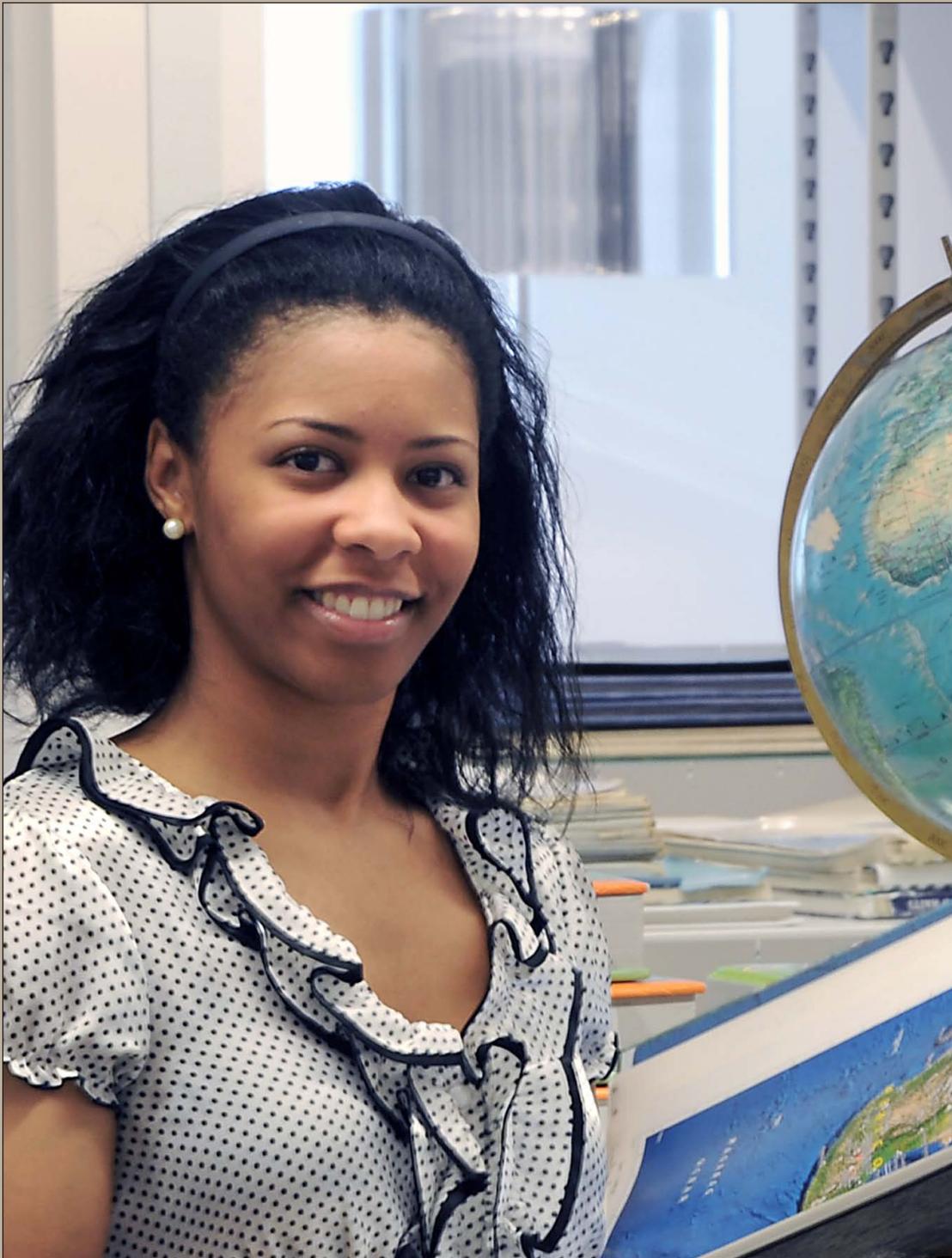
Tierra Tucker is an open-source reseacher at the National Geospatial-Intelligence Agency. She joined the team as an intern while in college and is now a full-time employee who adds her skills and expertise to a diverse NGA workforce. "I love working for a great agency where I know **I make a difference."**

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