Esri News

for Map, Chart & Data Production Summer 2014

Transforming National Map Production

National mapping organizations (NMOs) are in charge of creating authoritative products and services that help people understand where things are and what is happening there. This information helps people in government, business, and everyday life solve problems.

Two NMOs in particular, the Swiss Federal Office of Topography (swisstopo) and Dutch Kadaster have the strategic goal to use common databases and production environments for all their maps enabled by the ArcGIS platform.

Both organizations chose ArcGIS after using other solutions. They found that the ArcGIS platform can transform map production with geoprocessing, including generalization, automated text placement, symbol-level drawing, and printing and overprinting, to radically cut the time required to produce maps. The ability to apply technology in such an efficient manner and produce great cartographic results is one of the many design goals for the ArcGIS platform.

These two mapping organizations exemplify the "capture once, use many times" way of thinking. There are many ways to implement cartographic workflows, but there are several common themes these organizations have discovered using the ArcGIS platform.

Keeping Up with a Changing World

Swisstopo has a unique, highly regarded style of cartography. The production process integrates photogrammetry with geoprocessing production workflows. Swisstopo staff publish topographic map series in scales from 1:25,000 up to 1:1,000,000 using a topographic landscape model (TLM) as the repository for comprehensive, accurate vector data.

Before adopting ArcGIS into the production workflow, it took swisstopo staff considerable effort to keep all the maps up-to-date.

Today, to simplify the work of the cartographers, the links between the vector data captured photogrammetrically and the cartographic products are maintained. The swisstopo central production environment is called TOPGIS, and it is the foundation that integrates photogrammetry and 3D GIS to produce many products from one database. Each map product's production process has a unique digital cartographic model (DCM) that uses data from the TLM that has been transformed to become the product-specific symbolized data. This is important when changes in the real world happen, because it increases the efficiency of necessary updates.

A whole suite of DCMs are used to create different map products. Each DCM corresponds to one of the many map scales required. The office creates many printed products, like the Swiss national map series, which—among other things—is an excellent resource for hiking in the Alps, as well as digital products like SwissMap Online. Today, using ArcGIS, swisstopo has improved its map currency and the world-renowned quality of its cartographic products.

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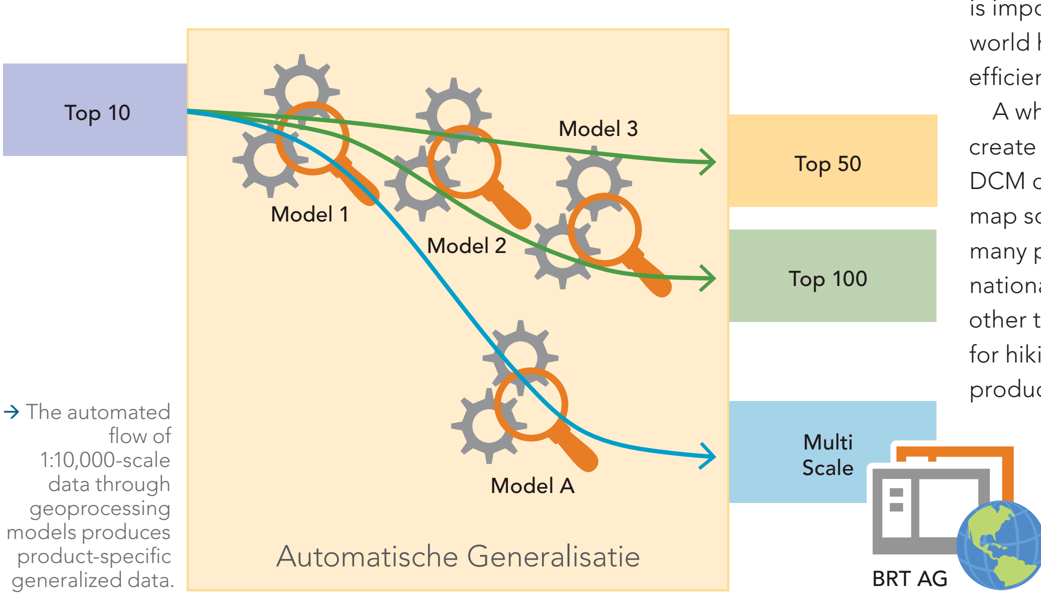

→ The automated flow of 1:10,000-scale data through geoprocessing models produces product-specific generalized data.

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The Netherlands' *North Sea Atlas* Evolves in a World of Devices

Offshore platforms, fish, cables, pipes, and wrecks. It all lies on the bottom or lives in the North Sea. Rijkswaterstaat (the ministry of highway infrastructure and waterways in the Netherlands) has an enormous amount of information about the North Sea, which has been available in its *North Sea Atlas* to anyone who needs it. Available for years as a traditional book atlas, since 2007 it has also been available in a digital version.

The digital *North Sea Atlas* was initiated by the Interdepartmentaal Directeurenoverleg Noord-zee (Interdepartmental Board Meeting North Sea), an affiliation of the ministries involved in the North Sea projects, and now an updated atlas has been implemented to take advantage of new technology and growing user needs. Rijkswaterstaat's first objective for the updated atlas was to be certain that the North Sea information would continue to be available to everyone, the public and professionals alike. It was with that goal in mind that the ministry selected ArcGIS Online after examining the alternatives.

"The new atlas is dynamic," says Kirsten Culp, project manager at Grontmij GIS & ICT, an Esri Gold Tier partner based in de Bilt, the Netherlands, and an adviser in many Rijkswaterstaat projects. "There must be room for growth and the possibility to add new maps. Rijkswaterstaat wanted to keep the old atlas but in a more modern version, and, of course, it had to be accessible to a broad public through PCs, smartphones, and tablets. That's why we had to migrate."

Gerard Poot, contractor at Rijkswaterstaat, says, "You notice the new appearance and texture straight away, because the maps are supplemented by explanatory remarks, photographs, and other illustrations."

During this project, Grontmij was assisted by Esri Nederland B.V., Esri's official distributor in the Netherlands.

For more information, visit www.noordzeeatlas.nl.

↓ ArcGIS Online is the portal for obtaining the North Sea maps.

↑ **Above and right:** The digital *North Sea Atlas* makes an enormous amount of North Sea information, including photographs, available to anyone. (Photo courtesy of Joop van Houdt.)

Earth Observation Platform Benefits Planet

Sensors, satellites, radar, and other earth observation technologies are used to monitor typhoons, oil spills, deforestation, and more. This data makes it possible to track, learn, and take action when events threaten the environment and human safety.

Recognizing a growing and critical need for improved, near-simultaneous observation of the planet, many governments and organizations are collaborating to coordinate their earth observation systems. A voluntary partnership called the Group on Earth Observations (GEO) works to share earth observation data and science. It includes 90 countries; the European Commission; and 77 intergovernmental, international, and regional organizations.

GEO initiated one of the most comprehensive efforts to monitor the entire face of the earth by building the Global Earth Observation System of Systems (GEOSS). The GEOSS program brokers various forms of earth observation data and information via its online platform and a discovery and access broker (DAB). The platform interconnects relevant information systems and infrastructures throughout the world.

Esri has long contributed to GEOSS, primarily as a member of Open Geospatial Consortium, Inc. (OGC). The company is now collaborating with GEOSS Earth to make observation data and services available to the ArcGIS Online community.

Many GEOSS contributors are already using Esri technology in their services, such as the European Environment Agency, the United Nations Environment Programme, and the Food and Agriculture Organization of the United Nations. This makes their systems and data inherently interoperable.

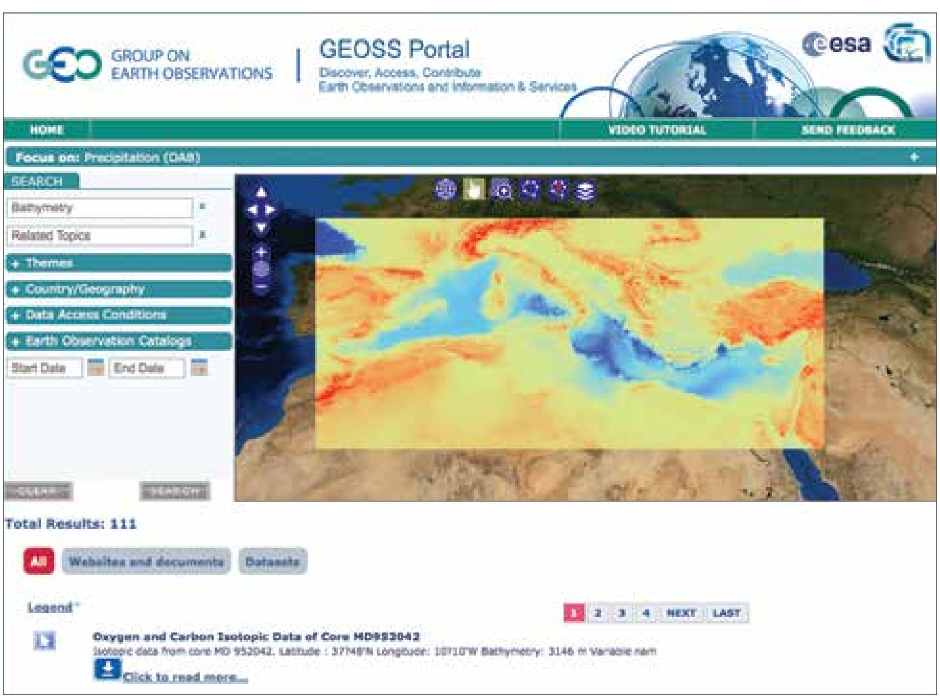
Esri recently entered into a partnership with GEOSS by way of a memorandum of understanding (MOU) between Esri and the Earth and Space Science Informatics laboratory of professor Stefano Nativi at the National Research Council of Italy Institute of Atmospheric Pollution Research (CNR-IIA). CNR-IIA and Esri are designing brokering arrangements and direct dataset access technologies, as well as open standards for data interoperability and cataloging. Through this collaboration, ArcGIS Online will become one of the significant infrastructures brokered by the DAB. ArcGIS Online subscribers can discover and access the resources published by GEOSS, use GEOSS data services, and build applications.

GEOSS categorizes earth observation data into nine societal areas: sustainable agriculture, biodiversity conservation, climate change and its impacts, natural and human-induced disasters, ecosystem management, energy management, environmental sources of health hazards, water resources, and weather forecasting. Millions of Esri's GIS customers whose work intersects these societal areas will find GEOSS data directly applicable to their projects. They can use it to establish baselines, monitor change, analyze problems, and design solutions.

"GIS becomes a platform for understanding when people use it to build on top of existing knowledge and measurements and share new ideas," Esri president Jack Dangermond says. "We are trying to create understanding out of measurement, knowledge, and science so that people can act. These measurements provide the basis for interpreting science for design work such as land-use planning."

CNR-IIA and Esri are building a two-way interoperability technology between the GEOSS DAB framework and ArcGIS Online by way of the ArcGIS Online DAB APIs. Developers will engineer Esri and DAB interfaces and build interoperable web services that interconnect the two systems via several paths.

One path starts from an Esri portal and leads the user to discover the main systems of services provided by GEOSS. ArcGIS Online users will access networks brokered by GEOSS DAB, such as the Committee on Earth Observation



↑ The GEOSS Portal: Here an analyst has overlaid GEOSS oxygen, carbon, and climate sensor data on Esri's Mediterranean bathymetry to study precipitation.

Satellites (CEOS), the International Council for Science (ICSU) World Data Center PANGAEA, the National Aeronautics and Space Administration (NASA) Global Change Master Directory (GCMD), and the World Meteorological Organization's Information System (WIS).

Another path starts from the GEOSS portal, leading the user to discover Esri services. All public content from ArcGIS Online, such as Esri basemaps and imagery, freely contributed datasets and maps, and tools, will be discoverable through the GEOSS DAB. ArcGIS Online is a resource for authoritative basemaps for the world, as well as topographic and hydrographic imagery. Users can overlay operational data from GEOSS on these basemaps, along with other ArcGIS Online datasets. This allows specialized communities to fuse knowledge atop common geography.

"I have often called GIS a platform for understanding," Dangermond says. "People use geographic measurements to create knowledge and take action. GEOSS serves as an earth measurement platform for monitoring change on the planet. Making GEOSS content available in ArcGIS Online increases opportunities for scientists and other communities to visualize information in greater context. Moreover, because the platform supports authoritative and crowdsourcing information, GEOSS members can build networks into other disciplines."

Because earth systems are interconnected, they challenge scientists to reach beyond their specialized domains. Designing technology that bridges scientific disciplines is complicated. Sensor data and sensor measurement systems are highly variable. Data capture, measurement, and quality differ. For instance, sensors and methods used to measure weather are quite different from those used to measure stream flow. Furthermore, scientists manage data differently. Some use manual approaches, and others patch together pieces of software to combine different datasets from different sources. Scientists should not have to spend time learning and modifying technology.

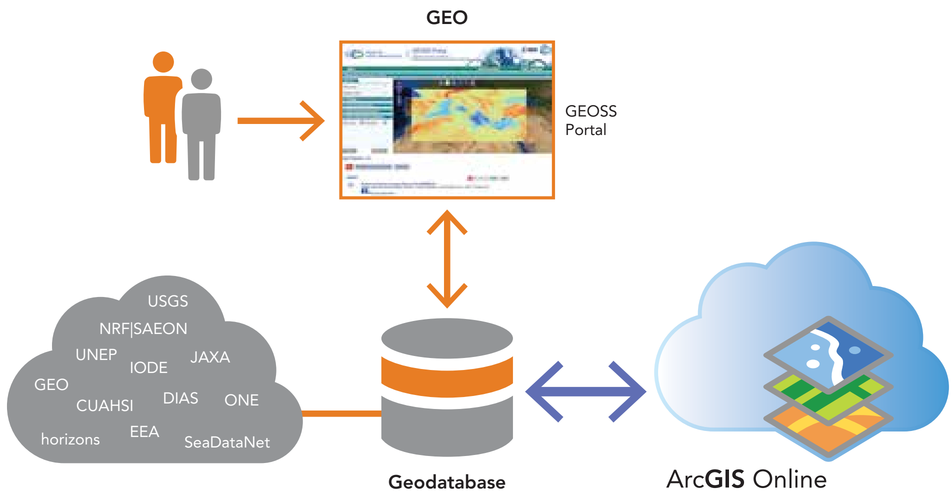
These concerns served to formulate Esri and CNR-IIA objectives for platform design. First, develop a specialized search engine for discovering datasets that allow users to obtain raw data for scientific or other work in a remote workstation or server environment. Second, design a flexible architecture that supports continual inclusion of interoperability with the DAB. Third, devise tools to transform data services that can be harmonized, making it possible to integrate sets of measurements.

"Basically, GIS takes different layers of information or scientific measurements and integrates them analytically, visually, and/or dynamically into various forms," Dangermond explains. "Fusing the platforms sets up a work environment to access data and information sets, see them in context with GIS, and use them for modeling or in various applications."

The GEOSS and ArcGIS Online service is unique. One reason is because GEOSS and Esri's relationship diverges from the traditional scientific relationships between government and public agencies. Since ArcGIS Online is operated by Esri, a private company, it has more flexibility than platforms offered by government-driven or single government initiative programs. Furthermore, ArcGIS Online holds shared geospatial and imagery data of the entire planet rather than for a specific region or area of interest. Data available in ArcGIS Online does not belong to Esri. Rather, the data belongs to hundreds of thousands of organizations that choose to share their basemaps and other kinds of information via the platform.

Esri customers make up but one of the communities that GEOSS brings together. It connects atmospheric, biodiversity, and many other sciences. Bringing GEOSS data into ArcGIS Online will help these communities extend their scope and work together to meet some of earth's critical challenges.

Group on Earth Observations



↑ Organizations can broker their earth observations through the GEOSS Portal, and users can combine data with Esri ArcGIS Online services.

Learn more about GEO and GEOSS at www.earthobservations.org.

Landsat 8 Imagery Available for Online Users

The Landsat program is a series of earth-observing satellite missions jointly managed by the National Aeronautics and Space Administration (NASA) and the United States Geological Survey (USGS). The first Landsat satellite was launched in 1972, and the latest satellite was in the series, Landsat 8, provides continuity, as well as improvements, on important global monitoring of our earth.

Landsat 8 was launched February 11, 2013, and contains two sensors. One collects 8-band multispectral imagery at 30-meter resolution as well as panchromatic imagery at 15 meters. The other collects thermal imagery at 100-meter resolution. The orbit of the satellite results in its capturing 170-by-185-kilometer-sized scenes along a predefined path that returns to the same location every 16 days.

Landsat imagery has significant value in environmental and natural resource studies and research, such as agriculture and forestry. Both governmental and non-governmental organizations interested in monitoring urbanization or analyzing concepts such as carbon sequestration will also find the continual monitoring of the earth at medium resolution to provide a wealth of information. The education aspects of the services are also boundless.

As with the other satellites, USGS manages the collection of imagery from Landsat 8. Every day, staff receive and process approximately 450 new Landsat 8 scenes. These scenes are available for download at no cost within 24 hours of acquisition. The current archive of Landsat scenes now contains more than 4 million scenes. Full-resolution, natural-color renderings of these are quickly accessible using LandsatLook, which is powered by ArcGIS for Server.

Landsat 8 Now Available for ArcGIS Online Users

A new set of Landsat 8 services released by Esri provides access to the latest and best Landsat 8 scenes. These services make the valuable Landsat scenes from USGS quickly accessible as multispectral, multitemporal image services that can be used in a wide range of web and desktop applications.

Esri first released Landsat imagery services—more than eight terabytes—to ArcGIS Online users in 2012. These image services made the collection of Landsat Global Land Survey (GLS) scenes spanning the years of 1980, 1990, 2000, 2005, and 2010 accessible as more than 20 dynamic, multispectral, and multitemporal image services. These dynamic services enable a wide range of client applications, such as temporal access to any of the band combinations, as well as products such as Normalized Difference Vegetation Index (NDVI) without the need to download or locally process any data.

For the Landsat 8 services, Esri daily downloads the latest, approximately 300 Landsat 8 scenes and adds them to a set of image services that contain the best and most recent 50,000 Landsat 8 scenes, which require about 60 terabytes for storage. These scenes are hosted on Esri's cloud infrastructure and available for access in different modes.

By default, the user views the best scenes. The best scene is determined using a weighting of cloud coverage and age of the scenes. Users can reorder the scenes based on metadata attributes, lock onto a specific scene, or use a time slider to see how an area changes with time.

Not all scenes are kept; otherwise, the data volumes for storage would continually increase. Instead, older scenes are removed. Typically, the latest four scenes with less than 50 percent cloud coverage are kept, as well as the scene that is nearly cloud free and closest in date to the GLS 2000 scene, so as to aid in longer-term change analysis.

Services can be accessed in web maps but can also be used in a range of applications and ArcGIS for Desktop. A

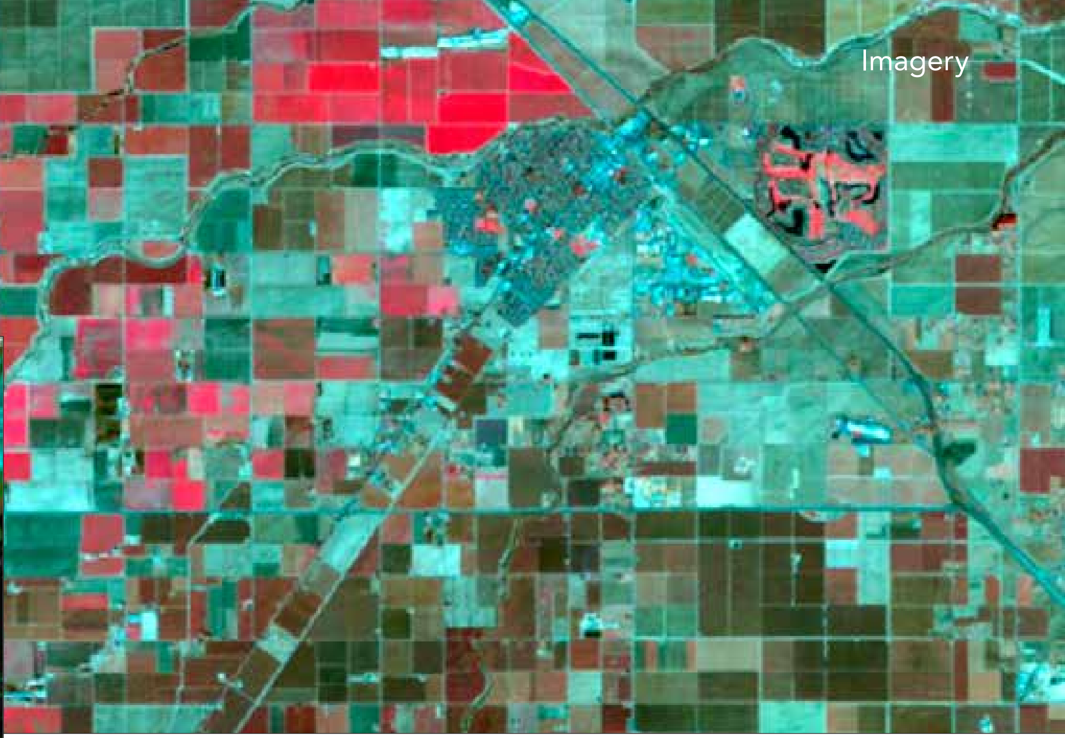
↓ Mosaic of the latest, most cloud-free (but not snow-free) Landsat 8 imagery covering the globe, rendered using three different infrared bands (7,6,5).

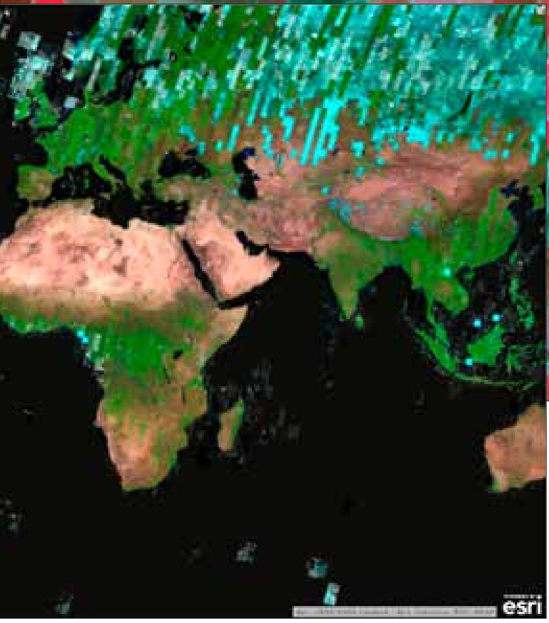
subscription to ArcGIS Online is required to access the services, but there is no charge for usage.

Many Services Available in the Cloud

A number of different image services are served from the same source. The most used is the Landsat 8 Views service. This allows users to view a range of different band combinations including natural color (bands 4,3,2) and color infrared (bands 5,4,3), which highlight photosynthesis in plants. The agriculture band combination (bands 6,5,2) highlights differences in various crop types. The SWIR band combination (bands 7,6,5) provides better penetration for clouds. The bathymetric option (bands 4,2,1) provides better water penetration and is especially useful for coastal applications.

Users can also select any user-defined band combination. The functions can be applied with fixed enhancements or with the Dynamic Range Adjustment Stretch, which requests the server to maximize the contrast so as to get the most out





↑ Landsat 8 color infrared (bands 5,4,3) of Chowchilla, California, highlighting vegetation in red.

of the extended dynamic range of the sensors.

The Landsat 8 Views service also provides two indexes. The Colorized NDVI provides information on the health of vegetation, while the Colorized Normalized Difference Water Index highlights areas that have high moisture content.

The Pan-sharpened service provides enhanced natural-color imagery by sharpening the natural-color bands (4,3,2) with the 15-meter panchromatic imagery. The Panchromatic service provides access directly to the panchromatic imagery. Again, the dynamic range adjustment capability ensures that maximum information content is available even when used in web applications.

While all these services return 8-bit rendered versions of different products, the Analytic service enables applications to access the full range of data values that might be required for some analysis applications.

Powered by ArcGIS for Server

All these services are powered by ArcGIS for Server and the Image extension. Processing and dynamic mosaicking are performed on the fly, directly on the source data. All the processing is applied on the source imagery as it is accessed by the server, enabling the creation of multiple products, as well as enabling the full dynamic range of the imagery to be accessed even when using browsers that are limited to only 8 bit.

The server also applies user-controllable compression. This ensures that the data is transmitted back to the client application quickly, even over low-bandwidth networks. It is important to note that no lossy compression is applied on the stored images. This ensures that there is no data loss or compression artifacts in the processing.

Moving Processing from the Desktop to the Data

These services extenuate the cloud concept of moving the processing to the data, not the data to the processing. Users can define the processing to be applied on the Esri-hosted servers and receive only the results they want. There is no need to download the complete set of data used to get the results.

Since these servers are using the latest Esri technology, ArcGIS 10.2.1 for Server, developers can also define their own functions to be applied on the servers. This opens up the ability for remote-sensing experts to quickly test and apply a wide range of indexes and functions to the data. Results can be returned for any location on earth over multiple time instances.

The on-the-fly processing also includes supervised classification. This enables users to define training areas, with the server computing the signatures and then applying the appropriate supervised classification to return classified imagery. This can be used to quickly perform classification and create web maps or statistics on the result. For example, if the area of a burn scar or flooding needed to be approximated, Landsat 8 imagery can quickly provide answers.

Esri will continue to expand the services provided, including development of different applications and more advanced geoprocessing of the scenes. More capabilities and functionality will continue to enhance this great resource.

To access the services, search for Landsat 8 in ArcGIS Online or visit esri .com/landsat-imagery.

The Relevance of Cartography

By Dr. Georg Gartner, University Professor and President of International Cartographic Association

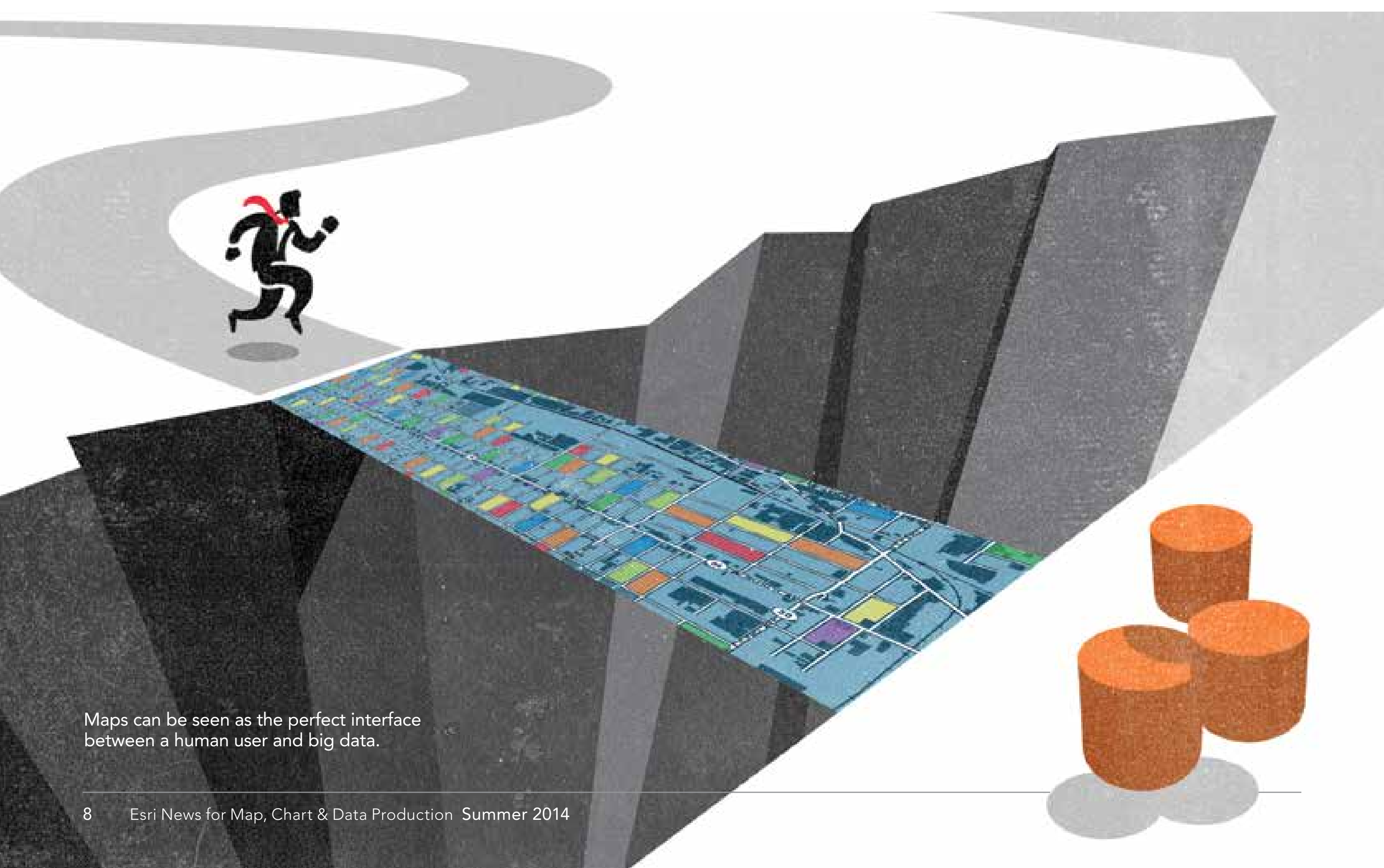
In the geospatial domain, we can witness that more spatial data than ever is being produced. Numerous sensors of all kinds are available, measuring values, storing them in databases that are linked to other databases being embedded in whole spatial data infrastructures, and following standards and accepted rules. We can witness also that we are not short of new, modern technologies for all parts of spatial data handling processes, including data acquisition (e.g., unmanned aerial vehicles), data modeling (e.g., service-oriented architectures, cloud computing), and data visualization and dissemination (e.g., location-based services, augmented reality). So where are we now with all those brave, new developments?

Obviously, we are not short of data in many ways. Clearly, we can state that rather the opposite is true. The problem is often not that we don't have enough data but rather we have too much. We need to make more and more effort to deal with all that data in an efficient sense, mining the relevant information and linking and selecting the appropriate information for a particular scenario. This phenomenon is being described as "big data."

We are also not short of technologies. It is rather the opposite situation; just as we are able to fully employ the potential of a particular data acquisition, modeling, or dissemination technology, newer technologies become available and need to be evaluated, addressed, and applied. Often, application development starts there. Because we have a new technology available, we make something with it. I call this a technology-driven approach.

However, the particular need, demand, question, or problem of a human user is often taken into account only when the data- or technology-driven application, product, or system has been built. Often, this causes problems or leads to products, systems, and applications that are not accepted, efficient, or even usable. By starting from the question, What are the demands, questions, problems, or needs of human users in respect to location?, we could eventually apply data and technology so that they serve a user-centric approach rather than determine the use.

But how can we better unleash the big potential of geoinformation in such truly interdisciplinary approaches? How can we make sure that spatial data is really applicable for governments, decision makers, planners, and citizens through applications, products, and systems that are not forcing users to adapt to the system but are easy to use and efficiently support the user?



Maps can be seen as the perfect interface between a human user and big data.

In this respect, maps and cartography play a key role. Maps are most efficient in enabling users to understand complex situations. Maps can be understood as tools to order information by their spatial context. Maps can be seen as the perfect interface between users and all that big data, enabling them to answer location-related questions, support spatial behavior, solve spatial problems, or simply become aware of space.

Today, maps can be created and used by any individual with even modest computing skills, from virtually any location on earth and for almost any purpose. In this new mapmaking paradigm, users are often present at the location of interest and produce maps that address needs that arise instantaneously. Cartographic data may be digitally and wirelessly delivered in finalized form to the device in the hands of the user, or the requested visualization may be derived from downloaded data in situ. Rapid advances in technologies have enabled this revolution in mapmaking. One such prominent advance includes the possibility to derive new maps immediately after the data has been acquired by accessing and disseminating maps via the Internet. Real-time data handling and visualization are other significant developments, as well as location-based services, mobile cartography, and augmented reality.

While the above advances have enabled significant progress on the design and implementation of new ways of map production over the past decade, many cartographic principles remain unchanged, the most important one being that maps are an abstraction of reality. Visualization of selected information means that some features present in reality are depicted more prominently than others, while many features might not even be depicted at all. Abstracting reality makes a map powerful, as it helps people understand and interpret complex situations very efficiently.

Abstraction is essential. Disaster management can be used as an example to illustrate the importance and power of abstract cartographic depictions: In the recovery phase, quick production of imagery of the affected area is required, using depictions that allow the emergency teams to understand the situation on the ground from a glance at the maps. Important ongoing developments supporting the rescue work in the recovery phase are map derivation technologies, crowdsourcing and neocartography techniques, and location-based services. The role of cartography in the protection phase of the disaster management cycle has always been crucial. In this phase, risk maps are produced, enabling governors, decision makers, experts, and the general public alike to understand the kinds and levels of risk in their surroundings. Modern cartography enables the general public to volunteer in modeling and visualizing the risks neighborhoods may suffer. Modern cartography also helps to quickly disseminate crucial information.

In this sense, cartography is most relevant. Without maps, we would be spatially blind. Knowledge of spatial relations and the location of objects is most important in order to learn about space, to act in space, to be aware of what is where and what is around us, or simply to be able to make good decisions.

Cartography is also most contemporary, as new and innovative technologies have an important impact on what cartographers are doing. Maps can be derived automatically from geodata acquisition methods, such as laser scanning, remote sensing, or sensor networks. Smart models of geodata can be built, allowing in-depth analysis of structures and patterns. A whole range of presentation forms are available nowadays, from maps on mobile phones all the way to geoinformation displayed as augmented reality presentations.

The successful development of modern cartography requires integrated, interdisciplinary approaches from such domains as computer science, communication science, human-computer interaction, telecommunication sciences, cognitive sciences, law, economics, geospatial information management, and cartography. It is those interdisciplinary approaches that ensure that we work toward human-centered application developments by applying innovative engineering methods and tools in a highly volatile technological framework. A number of important technology-driven trends have a major impact on how we create, access, and use maps, generating previously unimaginable amounts of location-referenced information and thus putting cartographic services at the forefront of research and development.

Where are we heading? What we can expect in the near future is that information will be available anytime and anywhere. In its provision and delivery, it is tailored to the user's context and needs. In this, the context is a key selector for which and how information is provided. Cartographic services will thus be widespread and used daily in a truly ubiquitous manner. Persons would feel spatially blind without using their map-based services, which enable them to see who or what is near them, get support and do searches based on the current location, and collect accurate and

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Transforming National Map Production continued from cover

A 5,000 Percent Savings in Time Needed for Map Production

Dutch Kadaster is the national land registry and mapping agency for the Netherlands. The organization surveys, registers, and performs land consolidation as well as provides mapping and information services for the country. Dutch Kadaster staff members have transformed their mapping process by implementing the ArcGIS platform to create and maintain standard topographic data and maps for the country. For years, Dutch Kadaster has maintained its Top10NL, a 1:10,000-scale topographic geodatabase of all of the Netherlands. Now the highly skilled geoinformation development team has adopted new innovation concepts in close cooperation with users.

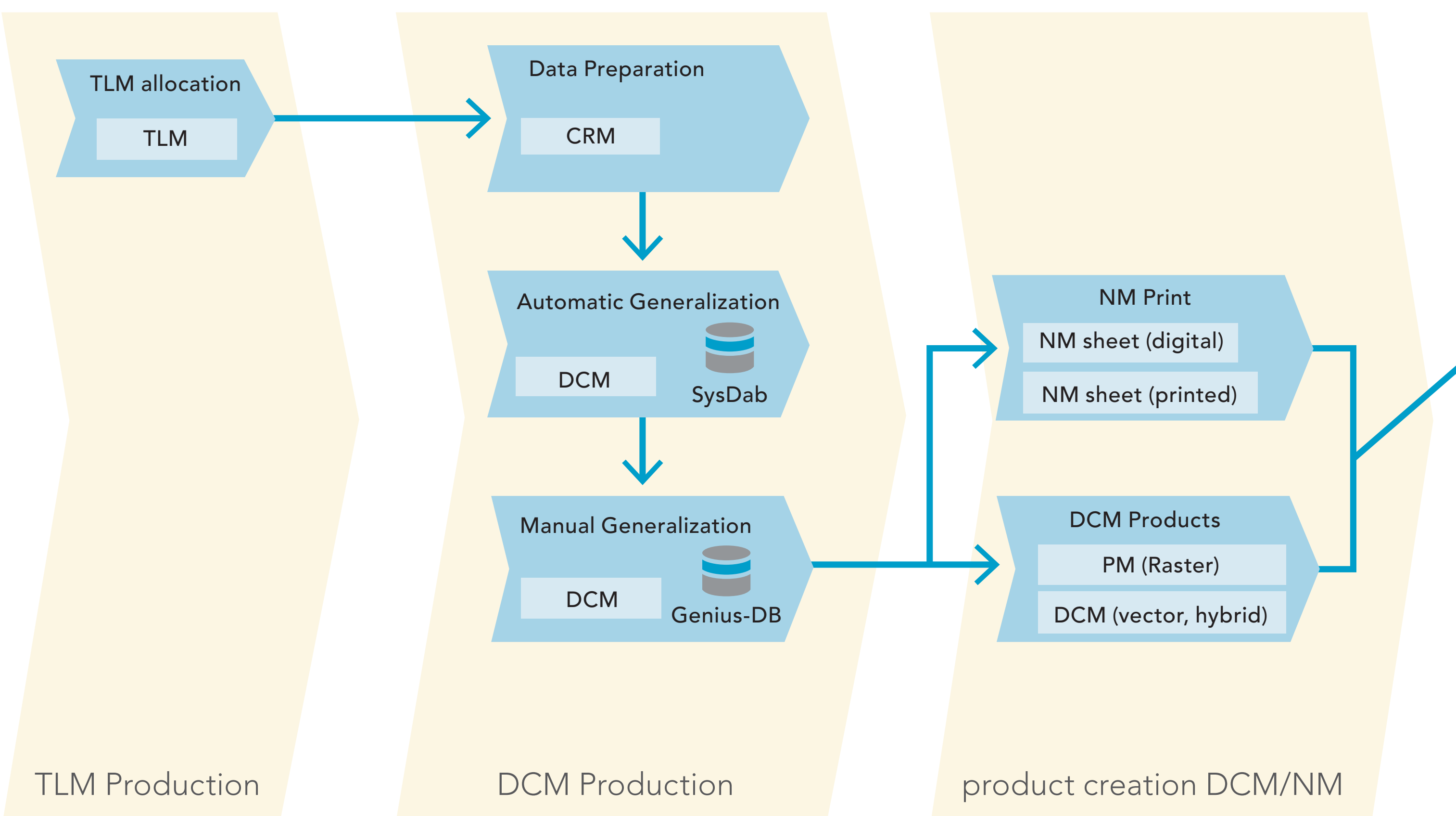
ArcGIS was configured out of the box to completely automate derived map production by creating sophisticated models that reflected the cartographer's vision with no customization.

Both Kadaster and its users benefit from the implementation of a fully automated generalization production workflow. The automation of manual cartographic labor led to a significant cost reduction. Using the new procedure, Kadaster produces the 1:50,000-scale map series at one-fourth of the original budget. Processing time has been reduced tremendously and has increased the update frequency of the derived map series from a six-year to a two-year cycle. This is fully in sync with base data acquisition—the source dataset at 1:10,000 scale and derived map series at 1:50,000 scale are released simultaneously five times a year. Map content itself is optimized by applying generalization algorithms consistently for the whole country and by improving the base dataset and algorithms after each development and production iteration.

Using ArcGIS, including tools for map automation and generalization, Dutch Kadaster realized a 5,000 percent savings in the time required by traditional cartographic methods for map production. Ultimately, the users are the real beneficiaries of this innovation: getting real maps more frequently at lower costs.

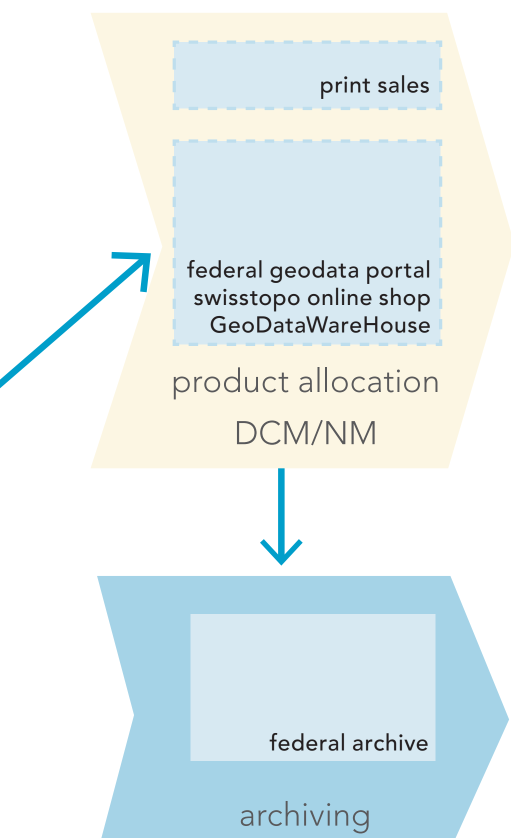
TLM = topographic landscape model
CRM = cartographic reference model
DCM = digital cartographic model

NM = National Map
PM = "Pixelmap" (swisstopo raster product)



↑ This workflow transforms detailed data into swisstopo's map and data products.

For more information, check out the poster (pages 12 and 13) to see eight important features both of these agencies used to define their map production processes to help usher in a new era to cartographic design and efficiency. Also, contact Mark Cygan, Esri (tel.: 909-793-2853, ext. 2333).



The Relevance of Cartography

continued from page 9

timely data on-site. Modern cartography applications are already demonstrating their huge potential and changing how we work, live, and interact.

In this situation, it is of high importance that those who are interested in maps, mapping, and cartography are working together on an international level. This is exactly the role of the International Cartographic Association (ICA). ICA (www.icaci.org) is the world authoritative body for cartography and GIScience. It consists of national members and affiliate members. Basically, we encourage every nation, company, government agency, or cartographer in the world to join the big family of cartography and GIScience, which makes the voice of ICA even more important.

I would like to summarize with three key messages:

1. **Cartography is relevant!**
   Modern cartography is key to humankind. Without maps, we would be spatially blind. Knowledge about spatial relations and location of objects is most important for enabling economic development, for managing and administering land, for handling disasters and crisis situations, or simply to be able to make decisions on a personal scale on where to go and how to get there.

2. **Cartography is modern!**
   New and innovative technologies have important impact on what cartographers are doing. Maps can be derived automatically from geodata acquisition methods, smart models of geodata can be built, and a whole range of presentation forms are now available.

3. **Cartography is attractive!**
   Maps and other cartographic products are attractive. Many people like to use maps, to play around with them on the Internet, for instance, or simply to look at them. We can witness a dramatic increase in the number of users and in the use of maps.

About the Author

Georg Gartner is a full professor of cartography at the Vienna University of Technology. He holds graduate qualifications in geography and cartography from the University of Vienna and received his PhD and habilitation from the Vienna University of Technology. He was awarded a Fulbright grant to the University of Nebraska at Omaha in 1997 and research visiting fellowships to the Royal Melbourne Institute of Technology in 2000, South China Normal University in 2006, and the University of Nottingham in 2009. He is dean of academic affairs for geodesy and geoinformation at Vienna University of Technology. He is a responsible organizer of the International Symposia on Location Based Services, editor of the book series Lecture Notes on Geoinformation and Cartography by Springer, and editor of the *Journal on LBS* by Taylor & Francis. He serves as president of the International Cartographic Association.

For more information, contact university professor Dr. Georg Gartner, georg.gartner@tuwien.ac.at, Research Group Cartography, Department of Geodesy and Geoinformation, Vienna University of Technology, Vienna, Austria.

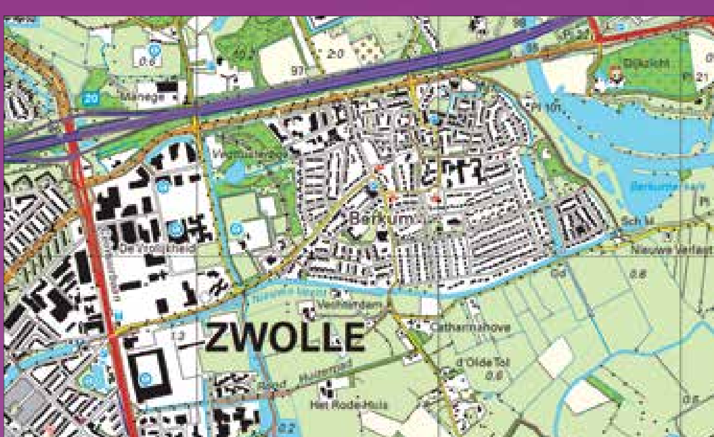
National Mapping in the 21st

Dutch Kadaster—Automating Production

The Dutch national mapping agency uses ArcGIS® for automated generalization and production of topographic data and maps. The organization configured out-of-the-box software to automate the generalization of the 1:50,000-scale maps from the TOP10NL dataset (1:10,000-scale topographic data). The new automatic generalization process replaces the earlier process used to create the old-fashioned 1:50,000 map. The results of this fully automated system save millions of euros and dramatically reduce production time from years to weeks.

100 Percent Automated Map Production

Kadaster started by translating the cartographer's designs for how the 1:50,000-scale map should look and function into a form of artificial intelligence to encapsulate how different features on the map needed to relate. The source data from TOP10NL was enhanced and enriched with this information. The resultant intelligent map data became the basis for automated symbolization and generalization workflows. Hundreds of individual models were leveraged, and over 70 ArcGIS geoprocessing tools were used to accomplish the processing tasks.



1:25,000 Scale

1:50,000 Scale

Automating Generalization

These examples illustrate the results of Dutch Kadaster's automated generalization process. Kadaster used a two-stage approach to automating generalization. The major roads network was first used as a basis to partition the country. This produced about 500 partitions that can be separately generalized in the second stage of the approach. Some datasets, such as administrative boundaries, railroads, and high-tension lines, could not be changed or divided and were processed as a whole, nationwide. The data within the partitions and the nationwide data were processed using the same three-stage model. The first stage was model generalization, which translates the types of information from the TOP10NL data into what would be represented on the map. Next came geometric changes and displacement that aligned, regularized, or simplified geometry. Last was graphical displacement to resolve visual conflicts between symbolized representations of features.

The Netherlands' Cadastre
Land Registry and Mapping Agency
www.kadaster.nl

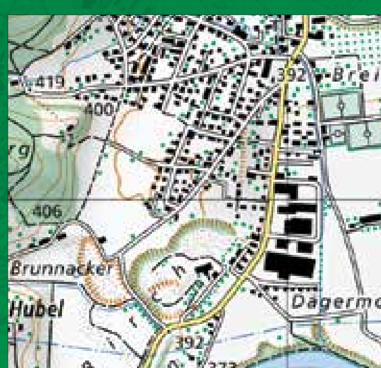
Century

swisstopo—Achieving Quality Cartography

The Swiss Federal Office of Topography (swisstopo) is responsible for creating and updating the country's topographic data and national map series. ArcGIS is the central production platform for the Topographic Landscape Model (TLM) and map production workflows. The TLM integrates photogrammetry and 3D GIS into the mapmaking process. This system is database driven so that when changes in the real world happen, swisstopo can easily maintain the currency and world-renowned quality of its cartographic end products. Each of these examples includes features from the rich, informative map design of swisstopo's 1:25,000-scale national maps.

Production PDF

swisstopo used ArcGIS to produce seven 2,520 dpi PDF files and six raster exports for the final prepress process. These files represent individual themes within the maps, such as vegetation or drainage. They were combined to create a single print-ready file for an offset printing press using eight colors, three process colors (black, magenta, and yellow), and five Pantone® spot colors. These PDF files took full advantage of capabilities added to the ArcGIS® 10.1 for Desktop Production Mapping extension, including color mapping, tint percentage, and overprint properties.



Symbol-Level Drawing and Layer Masking

This map used over 20 masking layers for annotation like "Hunzenschwil" or "Dorfbach," roads and railroad over/underpasses, and connections between various types of roads. Symbol-level drawing enabled each pairing of masks and features to be masked to be managed during production. Group layers managed those layers requiring symbol-level drawing, allowing the cartographers to define the drawing order for related groups of symbols.

CartoProcesses: Embankments

Esri Switzerland aided the effort by developing a collection of "CartoProcesses," one of which was used to create the hachures for embankment symbols. Two polyline features that defined the top and bottom of the embankment were the basis for this CartoProcess. The result was editable hachure features that could be rotated, lengthened, or shortened when needed to enhance their relationship with the underlying terrain. This allowed automated production of all embankment features without risk of errors or omissions.

Cartographic Representations with Overrides and Masking

Without cartographic representations, this map, in this form, would simply not be possible. Cartographic representations were used throughout the data model for features like embankments, orchards, and sports fields and even for the relatively simple mask symbols; this was due to an early decision to use a single, consistent symbol for each kind of feature.

All cartographic representations' many possibilities were fully exploited. Multisymbol layers are used, as are various geometric and global effects. Geometry overrides are also widely applied to set not only the size and rotation angles of point symbols but also the width, extremity, and caps for polyline symbols along with the grid angle on certain polygon symbols that are filled with markers.

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Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

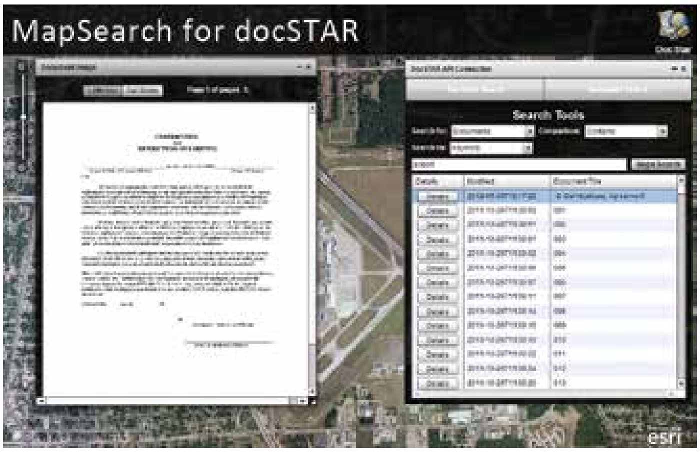
Swiss Confederation

Federal Office of Topography swisstopo
www.swisstopo.ch

Turning a Requirement into a Benefit

Enterprise GIS Helps Airport Use the Data It Collects

By Matthew DeMeritt, Esri Writer



↑ MapSearch for docSTAR associates documents to geographic locations. It can search by keyword or by clicking on the map.

The enterprise GIS developed by a Louisiana airport helps not only to meet federal reporting requirements but also to save money and better connect the airport with its customers.

Recently, the Federal Aviation Administration (FAA) began implementing NextGen data requirements for airports. *NextGen* is an umbrella term for the ongoing transformation of the National Airspace System (NAS) in the United States from a ground-based system of air traffic control to a satellite-based system of air traffic management. The NextGen initiative mandates that airports collect survey-grade datasets, called Airport GIS (A-GIS), so the FAA can manage the spatial data needed to support safe aviation. Although many small- to medium-sized airports without major IT resources are fulfilling the requirements of the FAA, many do not fully benefit from the A-GIS data they collect.

To address that concern, Baton Rouge Metropolitan Airport (BTR), located in the southeast portion of Louisana along the Mississippi River, partnered with GEO-Jobe GIS Consulting to extend the reach of its A-GIS data. With some grant money received through ongoing airport projects that can benefit from GIS, the airport was able to implement an enterprise GIS solution that includes Esri's Aeronautical Solution and ArcGIS Online.

Coordination Challenges and Cost Cutting

Like municipalities, airports comprise different departments and interact with various entities. Airports host multiple airlines, fixed-base operators (commercial businesses that provide aeronautical services), and retail tenants. Airports must maintain the highest level of coordination to ensure consistent revenue generation and comply with FAA standards and constantly changing land-use rules. In addition, to stay competitive, airports must execute expensive, multiyear airport improvement projects: runway extensions, obstruction analysis, pavement projects, and terminal improvements.

"To confront the rising costs, airport managers sometimes turn to IT consultants to implement 'improved' technology," said Eric Edmonds, vice president of marketing at GEO-Jobe. "However, once installed, many of their investments never actually get used by airport staff. Over time, the glamour and promise of technology wears off and staff just gets cynical."

↑ The Part 139 Inspection Dashboard provides in-office users with focused inspection information for monitoring activities throughout the day.

Building Trust

BTR wanted to avoid that situation. In 2010, the airport partnered with GEO-Jobe to perform a health check of its operations. Over the course of a week, GEO-Jobe met with airport personnel and found opportunities for GIS to play a critical role in the decision making and daily operations of the airport.

Enterprise health checks are rarely welcomed by a work force. Like a patient visiting a new doctor, departments can be suspicious of an outsider evaluating the inner workings of a familiar system. "Our initial presentation on basic Airport GIS wasn't well received by several administrators," said Edmonds. However, when GEO-Jobe staff met with department heads individually, managers relaxed and talked openly. Casual conversations with BTR staff revealed operational pain points. These interactions built trust and identified opportunities to make processes more efficient.

Initial Implementation

The solution born from GEO-Jobe's assessment was an enterprise GIS that allowed the airport to push its A-GIS to the FAA.

"We started by mining data and installing all the necessary hardware and software to host and serve it," said Edmonds. Collecting existing GIS datasets from local government agencies and adding them to the airport's geodatabase was a crucial first step.

To make all facility information accessible through the platform, Edmonds' team converted BTR's Airport Layout Plan and information, which included CAD drawings and blueprints of construction projects, into a format that could be added to a geodatabase. ArcGIS for Server, ArcGIS Online, and Esri Aeronautical Solution were used to give the airport a central platform for creating and sharing GIS data across departments and with the FAA.

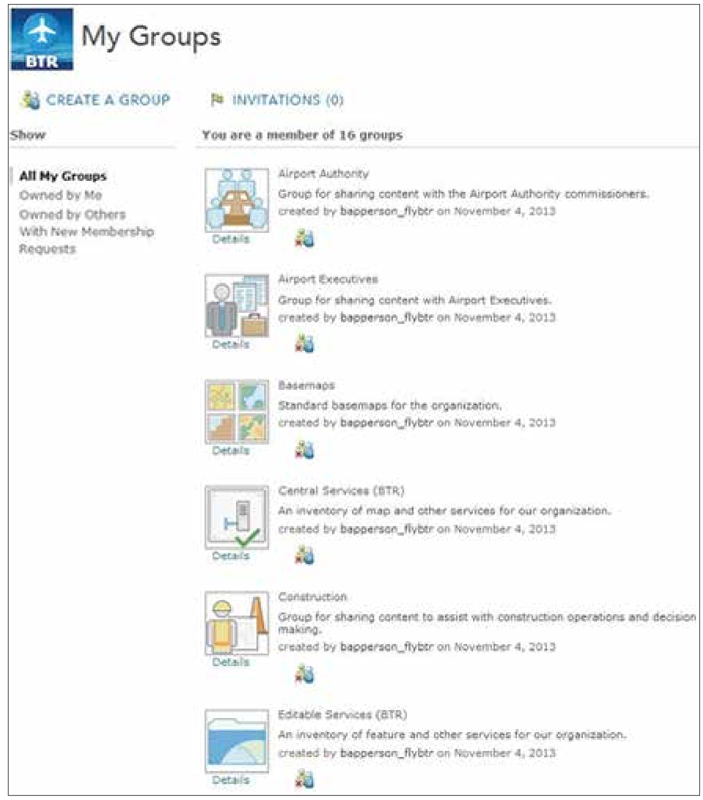
In the first show-and-tell meeting with the airport after the initial implementation, one of the staff members asked GEO-Jobe to calculate the area of a recently acquired parcel adjacent to the airport. The airport had just spent several days surveying the property even though it only needed submeter approximations. To show how even the simplest GIS tools can empower them, one of GEO-Jobe's staff members traced the same parcel using the measuring tool in ArcGIS Online. "It took less than 10 seconds to trace and calculate the area," said Edmonds. "The difference between calculations was only a few feet."

↑ Part 139 Inspection Mobile provides a single point for inspection, creation, dispatch, and completion in the field.

Simplifying Inspections

GEO-Jobe's evaluation of one of the airport's most critical procedures—Part 139 Inspections—came early in the needs assessment. (The FAA, under Part 139 of Title 14, Code of Federal Regulations, issues Airport Operating Certificates and conducts periodic inspections to ensure airports are meeting the requirements of Part 139.) Inspections were a major headache for the Operations Department. After carefully canvassing the runway and taking handwritten notes, inspectors would input their notes into a system in the office that generated new work orders. The status of these work orders was tracked on a whiteboard.

GEO-Jobe eliminated that cumbersome process by creating a Part 139 Inspection app that enables field crews to create, dispatch, and complete work orders and inspection reports on the fly. With the app, the operations manager can also track the status of inspections and work orders and locate his field crew at all times.



↑ BTR is strategically organized within ArcGIS Online through 16 defined groups.

Sensible Documentation Access

To reduce the generation of paperwork and archiving of paper documents, GEO-Jobe refined the airport's document management process by creating a location-based document management system. The system enabled instant classification of all paperwork, which was fully accessible via a web application to staff who had the necessary security clearances.

The system resembles a typical digital library catalog. All digitized documents are linked to features and areas on the airport's main map viewer. By clicking on a specific property, airport staff can quickly pull up documents such as lease agreements, construction bids, architectural drawings, proposals, building footprints, bid acceptance, and repair orders. Correspondence between the airport, its consultants, and the local government is also tracked in the application.

The later stages of the airport's GIS overhaul will involve creating additional apps for both the airport and the public. Several apps that are currently being registered with the airport's ArcGIS Online account include maps for airport information, marketing, construction status, and noise mitigation status. Through its partnership with GEO-Jobe, BTR has become a model for small- to medium-sized airports.

"The project has proved that, with the right platform, airports can comply with FAA standards and also use the data to build a full-scale GIS that can be used across airport departments and better serve travelers and the local community," said Edmonds.

An Interview with Mukund Rao

National GIS Is for People's Empowerment and Better Governance

↑ Dr. Mukund Rao

National GIS of India is an innovative program within the country's Twelfth Five Year Plan that has generated much interest. Spearheading many of its component efforts is Dr. Mukund Rao, member-secretary of the National GIS Interim Core Group and chairman of the GIS Task Force of the Karnataka Knowledge Commission. Rao has more than 32 years of experience in earth observation (EO) and GIS programs and building space activities. His unique experience—working in both government and the private sector and now in the consulting domain—brings impactful and effective practices. Over the years, he has also provided leadership to many national and international forums related to EO, GIS, and space. Recently, *ArcNews* had an opportunity to speak with Rao.

AN: What is National GIS?

Rao: National GIS is India's next-generation GIS program, envisioned as critical support to the national governance and empowering its citizens—thereby extending GIS to all levels of society. In the long term, National GIS is envisioned to build national capability in GI [geographic information] and enable India to maintain global leadership in GI. India has vast experience in mapping and GIS—systematic mapping has been carried out for more than 200 years; remote-sensing images have been used for the past 40 years, and GIS technology has been used for almost 30 years. India has realized that the true power of GIS can only be realized when GIS is embedded within governance and taken to every citizen.

AN: What is the significance of National GIS now?

Rao: First, as a nation, we are witnessing tremendous progress, and our economy will grow significantly in the coming 5 to 10 years. With such growth, society will demand very high efficiency in governance and quality services, and the government will depend on very efficient, guaranteed methods of nation building and bringing equity in quality of life for people—doing so with transparency, speed, and compassion. Immense amounts of analytics will be called for. Support data/information systems have to be ready to use and no longer limited by the need to start getting organized. As demand on governance is becoming anticipative and futuristic, the decision process must always be a step ahead of the people's demand. Similarly, democracy demands inclusiveness, and thus citizens must be able to participate in and judge every development option/decision or even demand specific [types of] development—this, too, National GIS should be able to provide. Thus, National GIS will not only improve the efficiency of governance but also enable citizens to participate in the development process.

AN: How is this different from GIS in India today?

Rao: I think the key differentiator is the shift from a data generators drive to a user demand or national needs drive. Meeting what the user needs (or what the nation wants) is the supreme goal rather than providing only what is available—most times, data generators seem to be driven by what technology can offer or make available, whereas user needs require ready-to-use authoritative GIS data; therefore, a wide gap emerges between these two ends. Thus, even though the nation has a long history of surveying and mapping, years of imaging, and many years of GIS project activities, the usage of images/maps/GIS has yet to be impactful and meaningful to grassroots levels. Until such GIS-ready and user-specific data for the whole nation is easily available, how can a user or governance mechanism or citizen make the best use of GIS technology in decision making, and how can citizens be really empowered? National GIS would bridge this wide gap and ensure that the GIS-ready data that is regularly updated as users require is made available.

Another differentiator is in the shift toward a mandated organizational structure for National GIS and away from just doing GIS projects—thereby critically aligning the existing multifarious remote-sensing and GIS activities to this national goal. Over the past 20–30 years, many GIS projects have been carried out by quite a few organizations—thus, while projects have been completed, these are contributing less to effective and efficient use in decision making and becoming part and parcel of good governance. We have realized that simply doing GIS projects is not leading us to this goal, and we need an organizational mandate at the national level—that way, GIS will get the responsibility and also bring accountability. To this important shift, the visualization of the Indian National GIS Organization is something critical and unique.

AN: What are the challenges for National GIS?

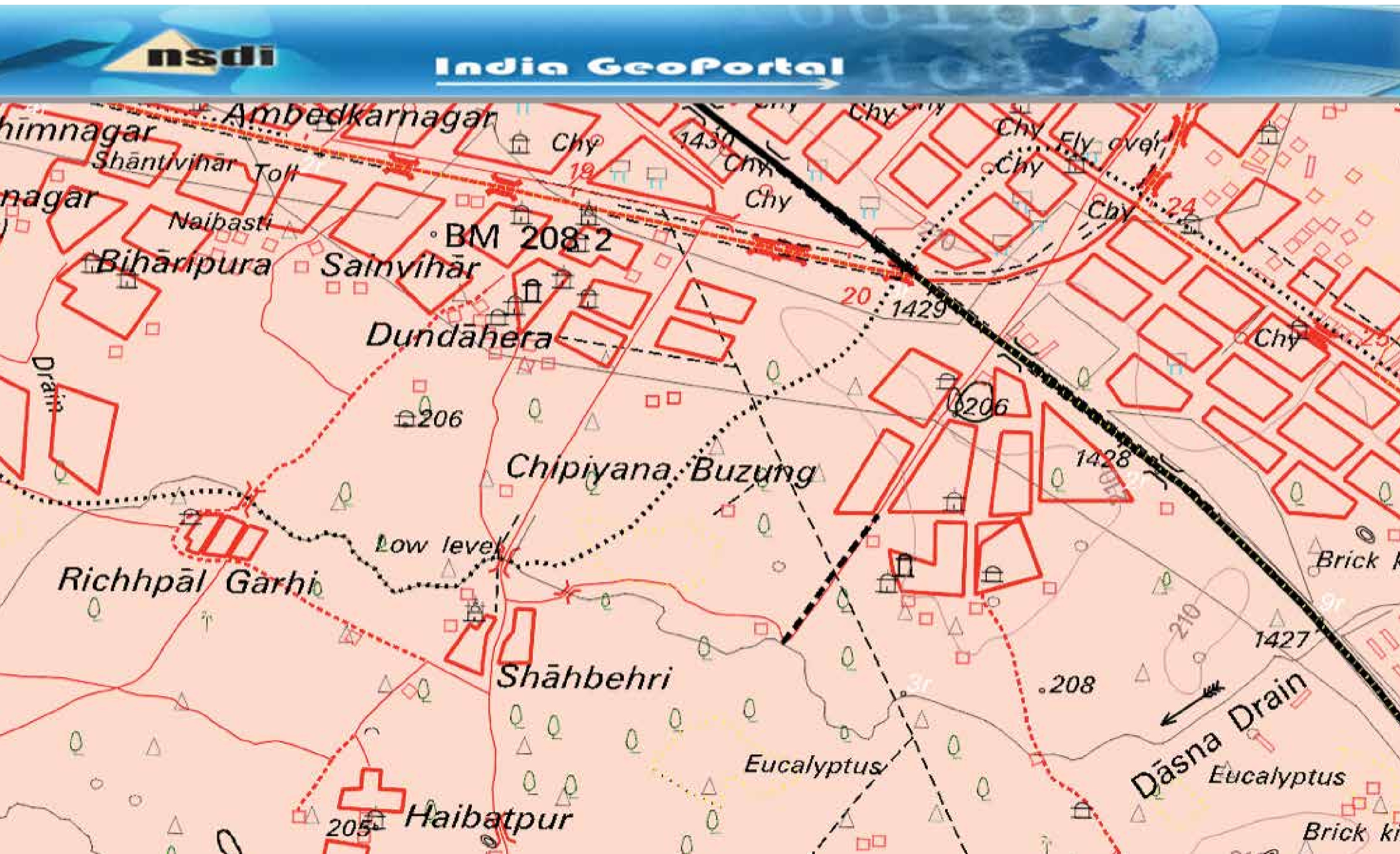
Rao: The biggest challenge is already behind us; that is, getting the concept debated/discussed and endorsed. This has happened very efficiently, thanks to the planning commission's efforts. Almost all ministries (in central and states), GIS industries, GIS academia, etc., have been consulted, and a wide range of discussions have taken place. This first round of consultations led to the vision document for National GIS [in October 2011]. Even after the vision document was prepared, the Indian government has undertaken another round of in-depth consultation for programmatic and financial approvals. Now National GIS has been marked down as a new initiative in the Twelfth Five Year Plan. As I gather, the last round of processing is in its final stage of approval by the Indian Cabinet. So I think now the issue is not what National GIS is or whether National GIS is required but when National GIS will become operational.

Workwise, there are many challenges, but none of these are insurmountable. Technically, one challenge is organizing the National GIS asset that is seamless, nationwide, and GIS ready. Getting almost 41 parameters of data organized into a national spatial frame is a challenge—India still does not have an authoritative spatial foundation framework, and this will have to be organized for the first time. Similarly, bringing in myriad sets of available survey data, maps, images, tabular development data with geotagging, cadastral data, etc., is also going to be a challenge—a voluminous challenge! Designing and developing a data updating cycle and creating a GIS warehouse for timeline GIS assets will also be important. Even as the GIS asset is organized for the first time, the importance of updating existing content, adding more content, and keeping the GIS asset live and updated will become a prime goal.

At the same time, creating an environment for the widest usage of GIS applications is yet another challenge—especially considering the wide variety of user ministry [at central and state levels] and citizen needs

continued on page 18

↓ India has a demonstration National Spatial Data Infrastructure (NSDI) portal that uses all the technology elements required for metadata and map data organization. (Source: India NSDI Portal.



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that will have to be met from a GIS perspective. Thus, a culture of National GIS apps has to be developed and positioned. Similarly, establishment of the GIS infrastructure and systems has to be undertaken.

There would be critical policy, access, and licensing issues that would have to be positioned. Already, some thought has been given to the GI policy [through a study undertaken by the National Institute of Advanced Studies], and tenets for a national GI policy have been worked out. Human resource development in states, central government, and citizens at large will also be important, and program elements for these have been defined in a report being prepared by the Ministry of Human Resources Development.

What will be also challenging (and proof of success) is to make all these elements work in tandem and establish an operational framework by which GIS data and GIS application services become a reality and for National GIS to be firmly embedded in the nation's information and governance regime.

AN: What about policy needs? You have also been associated with the GI policy study.

Rao: National GIS will need innovative policy instruments that are quite different from those available today in the five individual policies. Policy has to be determined in an analytical manner—defining the long-term "GIS ecosystem" goals and short-term achievements. Such an overarching GI policy should not only operationalize National GIS [in the short term] but also enable national GI excellence, industry participation, academic emphasis on GIS, and the nation's commitment to citizens for GIS. In a study undertaken in India, we have prepared a comprehensive, first-of-its-kind policy report that includes a draft of the national GI policy. The report has already been submitted to the government and is a major input for positioning National GIS.

AN: What about the Karnataka GIS?

Rao: When we completed the visioning of National GIS in October 2011, it was recognized that the success of National GIS will be exponential if states' GIS needs are also met; after all, states are a more direct mechanism for delivering governance and are directly closer to citizens. So, thanks to the government of Karnataka, we took up a task force study to logically drill down National GIS to a state requirement study. We conducted state-level discussions and workshops and stakeholder/user meetings and determined that states' needs would be much greater and quite different than what would be required in a national GIS. The GIS data needs comprise almost 60 parameters, and most of the GIS applications need to be linked to cadastres—that becomes very important at the state level.

What we also see happening is that if state GIS programs are organized, they not only achieve some key goals of National GIS but also trigger a set of GIS apps at the state level—thus, Karnataka GIS [and other state GIS programs] can become vehicles for quickly and systematically organizing an aligned GIS that not only serves state-level governance and citizen needs but also integrates well into National GIS. Many other states are also being primed to align their GIS tasks into the National GIS system. Now, with the vision of National GIS and the Karnataka GIS, we understand what it will mean to develop state systems and how the dovetailing to National GIS would happen. Now we see a GIS system of systems—meeting state and central government, citizen, and enterprise needs.

AN: What about schedule and budget and official sanctions?

Rao: National GIS is now part of India's Twelfth Five Year Plan. The proposal is to deploy National GIS in two stages and complete the establishment process [with many GIS data and app services also rolled out] in about three to five years—after which the operations and maintenance phase would be undertaken. As I said earlier, all the groundwork is now done, including financial approvals, and it is just the last step of cabinet approval that must be accomplished. Within the state of Karnataka, the schedule for Karnataka GIS is about two years, and here, too, the state-level processing is in its final stage.

Budgetwise, I can only say that, as the government of India [and state governments] is determined to implement National GIS, budget would not be an issue—especially for such a well-developed program that has endorsement at all levels.

Like many in India, I am keenly looking forward to National GIS becoming one core element of the development process and for GIS to be firmly embedded in every governance process and for empowering every citizen of India.

For more information, contact Dr. Mukund Rao, mukund.k.rao@gmail.com.

3D Rotterdam in the Cloud

3D Rotterdam is a collaboration between Esri, the city of Rotterdam, and mental images (a subsidiary of NVIDIA) with the goal to explore smart 3D city solutions based on GIS data, procedural modeling, and GPU-based rendering in the cloud.

Project Description

The project introduces a new pipeline for the creation, analysis, and visualization of photo-realistic 3D cities generated from 2D ArcGIS data with Esri CityEngine and RealityServer. The latter runs in a GPU-based cloud computing environment, enables the sharing and full remote interaction with complex 3D cities on mobile devices such as netbooks, tablets, or even the iPhone.

CityEngine to RealityServer Pipeline

In CityEngine, the scene can easily be exported to RealityServer (via the mental ray scene description format, .mi). For Rotterdam, the different scene elements have been exported per layer. This allows easy changes to the visibility of the corresponding groups of objects in RealityServer.

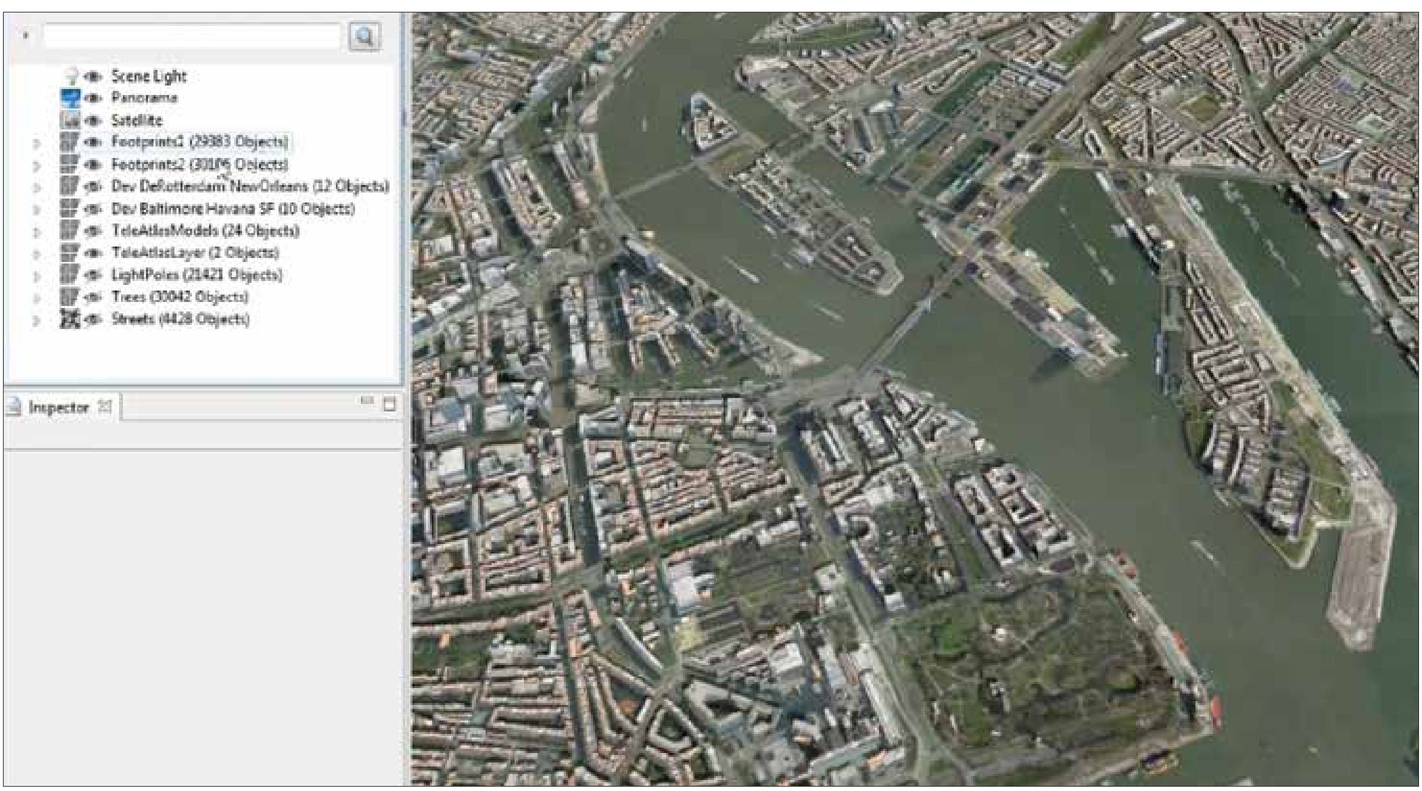
Credits and Copyright

Core data provided by City of Rotterdam (Copyright ©2011 City of Rotterdam). 3D models of existing buildings in inner circle of city provided by Tele Atlas (Tele Atlas Advanced City Models LOD4). 3D model aggregated, enhanced and extended by Esri. RealityServer renderings courtesy of mental images.

Imagery

The illustration below shows the data flow through the pipeline. 2D GIS data can be imported and processed in CityEngine and exported as 3D data to either ArcScene for further analysis with ArcGIS 3D Analyst or to RealityServer. With RealityServer, the generated city models can be directly uploaded and accessed in a browser for visualization and interaction.

↓ 2D GIS Data for the City of Rotterdam, the Netherlands.



Mapping Hurricane Sandy's Aftermath in Haiti

Insect-like Drones from SenseFly Provide Data Quickly for ArcGIS Technicians at IOM

By Karen Richardson, Esri

After Hurricane Sandy hit Haiti in October 2012, the International Organization for Migration (IOM), a leading intergovernmental organization in the field of migration, joined the international community in helping the Haitian people pick up the pieces. IOM uses Esri ArcGIS software to map out, assess, and respond to community needs all over the world. Since the landscape of Haiti had changed significantly due to flooding and storm surge, the agency discovered that map data needed to be updated. To meet the challenge, IOM turned to a unique, almost futuristic solution—insect-like drones—that could remotely capture this data quickly and safely. IOM GIS technicians could then supply aid officials with what they needed: a clear, accurate, real-time understanding of conditions on the ground.

Years of Disasters

Haiti sits in a hurricane corridor in the Atlantic Ocean, and as a result, tropical storms regularly wreak havoc on the Caribbean country. In recent years, Haiti has been inundated with natural disasters. A magnitude 7.0 earthquake shook the nation in January 2010. Two years later, Tropical Storm Isaac hit in August 2012, and a few months later, Hurricane Sandy snapped its tail at the country in October.

Each of these disasters had a devastating impact on the country and its inhabitants. Even though most of Hurricane Sandy was concentrated offshore, more than 20 inches of rain fell on the south and southwest coasts of Haiti in just four days.

The hurricane left as many as 200,000 people with damage to their homes. Add to this the 390,000 people still without homes after the January 2010 earthquake, and now, according to the United Nations's Office for the Coordination of Humanitarian Affairs, 3.5 percent of people living in the capital city of Port-au-Prince live in tents.

Many people have been killed by the events themselves or the health crises that resulted. For example, a terrible cholera outbreak occurred after the 2010 earthquake due to lack of clean water. Almost 6 percent of the population has been affected, and the disease has taken the lives of 7,500 people.

Hunger is another constant threat. Floods from Sandy washed away many crops, including plantain, maize, and sugarcane. Hurricane Sandy was, as Prime Minister Laurent Lamothe described, a disaster of major proportions.

These humanitarian emergencies are difficult to treat when the landscape keeps changing. Buildings crumble and roads disappear during such devastating events. Sandy turned dirt roads and paths into torrential flows of water. Refugees set up

↓ The drone's flight can be monitored from the field. (Photograph courtesy of Drone Adventures.)

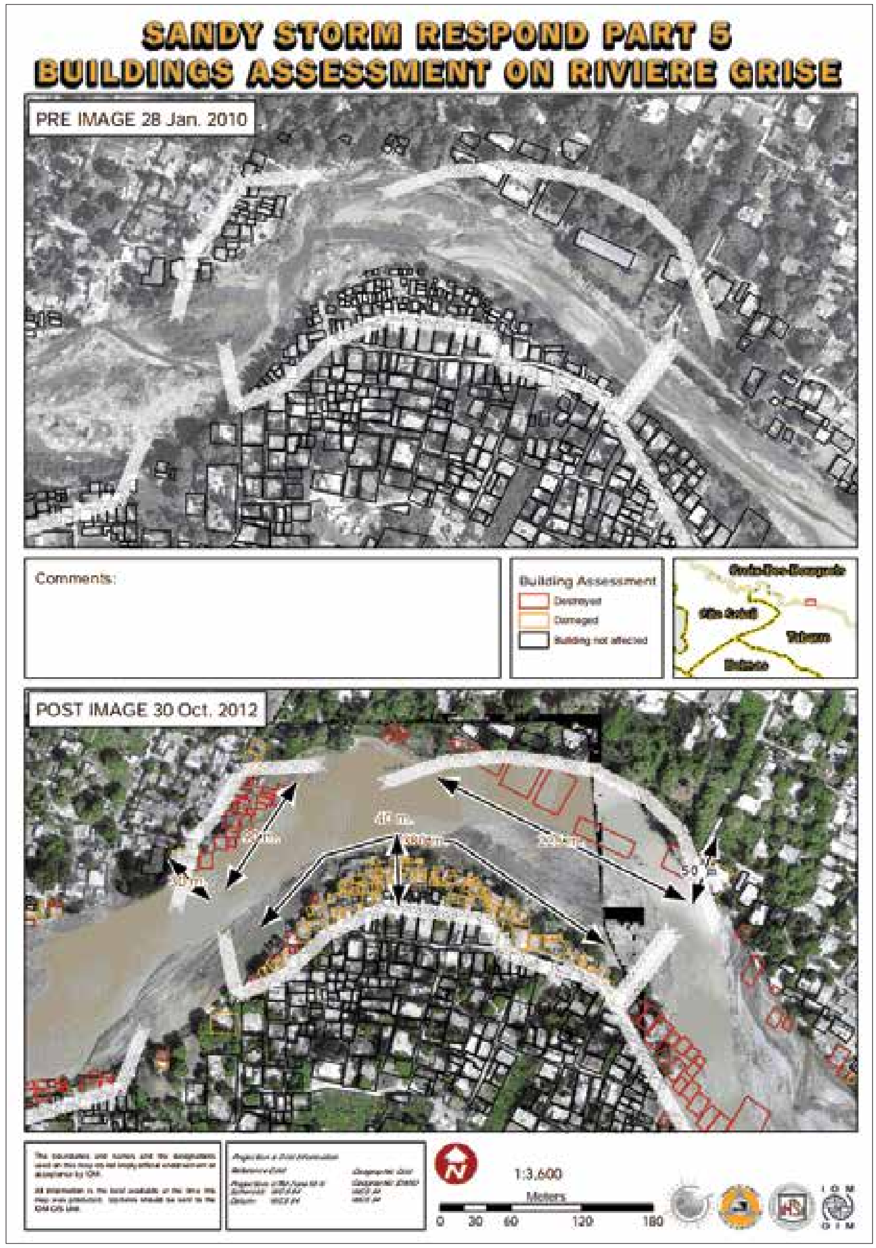
shelters and, in many cases, entire new cities in a short time. Mapping this changing landscape takes on an urgency that might not exist in more stable countries.

Do Like the Bees Do

That was the thought when IOM got to work in Haiti after Hurricane Sandy. IOM works to help migrants in need, including assisting the Haitian government's civil protection agency (DPC) and the Haitian Red Cross. IOM has been assisting in Haiti for many years and has made great strides in helping the country prepare to mitigate such devastating events.

For this particular event, IOM provided the logistics for Drone Adventures, a nonprofit organization based in Lausanne, Switzerland, to fly a mission using drones to collect imagery for up-to-date maps. OpenStreetMap France, a collaborative community of people and organizations that provide mapped information for anyone to use, requested the mission. And the imagery is freely available for anyone to use.

Autonomous ultralight flying vehicles (UFVs) created by SenseFly, a small company also based in Switzerland, were used to capture data in support of this mission. SenseFly is unique in that the founders of the company, a team of robotics researchers at the Laboratory of Intelligence Systems—also from Switzerland—first studied the behavior of flying insects, such as bees and houseflies, to understand how best to control and navigate the drones.



↑ Map Produced with ArcGIS Displaying the Area before and after Hurricane Sandy Made Landfall. (Map courtesy of IOM.)

Why insects? SenseFly researchers have found that by creating a highly integrated autopilot for the drone, it flies in a manner similar to how a fly or bee zooms about, making the drone more efficient, elegant, and lightweight and smarter.

Drones, Not Digitizing

Drones in general are being looked at more and more for acquiring map data that is needed quickly and have the advantage of collecting that data from areas that might be considered unsafe due to damage from natural disasters, much like in Haiti.

The artificial intelligence found on board the SenseFly drones allows them to fly autonomously and make decisions in flight, such as returning to base because of a low battery. They are also equipped with sensors that monitor the flight in real time. These include GPS, altimeter, and wind-speed sensors so the resultant imagery collected from the installed camera is highly accurate.

SenseFly's eBee drone comes equipped with a 16-megapixel camera that can shoot imagery up to three centimeters per pixel resolution. The eBee drone's battery allows it to fly for up to 45 minutes, so it can cover up to 10 square kilometers in a single flight. These images are then used to create maps with a precision of down to five centimeters.

In Haiti, Drone Adventures dispatched three eBees and mapped more than 45 square kilometers in less than a week. After each flight, SenseFly's image processing software,

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Mapping Hurricane Sandy's Aftermath in Haiti

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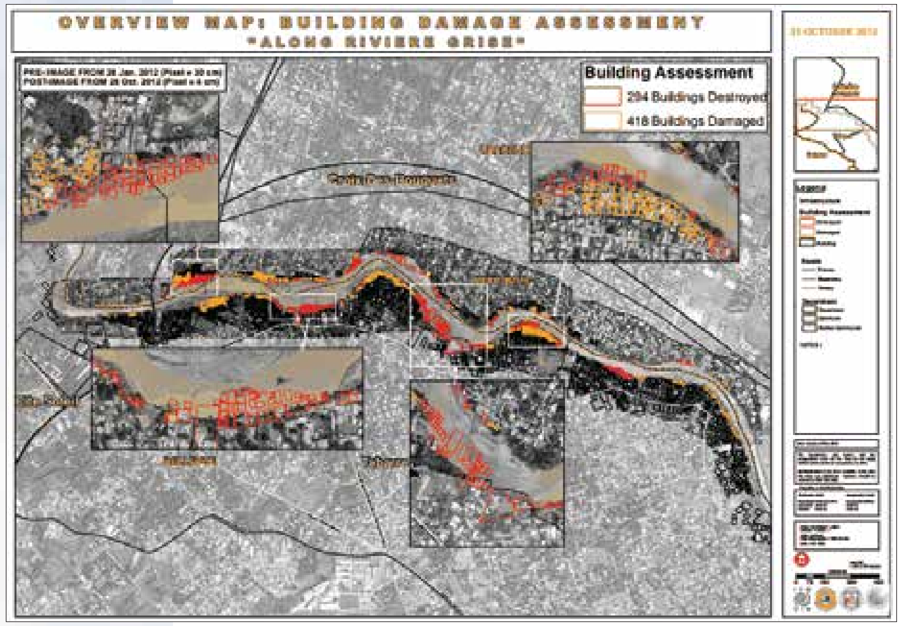
The Lightweight eBee Drone.
(Photograph courtesy of Drone Adventures.)



↑ Map Produced with ArcGIS Showing Damaged and Destroyed Buildings along the River Grise in Haiti. (Map courtesy of IOM.)

Postflight Terra 3D, generated a georeferenced orthomosaic as well as a digital elevation model. These were then imported directly into ArcGIS for mapping and analysis. IOM and Drone Adventures also made the data freely available to any other agencies that could benefit from it.

A Quick Response to Hurricane Sandy

IOM used this orthoimagery and 3D models to assess the damage done by Hurricane Sandy. Several dense shantytowns in Port-au-Prince were mapped, and this information was used to count the number of tents so a census could be taken of the population. This door-to-door census blanket of the community is the intensive first step in identifying what aid is required by the population and deciding how best to organize more permanent infrastructure to service the ad hoc neighborhoods.

3D terrain models of ravine beds that were too dangerous to visit and map on foot were also created. These models are being used to perform water-flow simulations and help decide where to build infrastructure to mitigate flooding, a very important part of IOM's mission in a country already ravaged by cholera.

IOM will continue to use ArcGIS software and the information gathered from the eBees to help improve water drainage and watershed management, conserving and enhancing forest cover, conserving soil, and mitigating hazards both through man-made structures and via the environment. For more information on how sensors are helping the mapping community, visit esri.com/lidar.

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Municipality in Canada Uses 3D Models and Datasets in GIS and Planning

The Regional Municipality of Wood Buffalo is located in Alberta, Canada, and occupies roughly 68,000 square kilometers (more than 26,000 square miles). Interests in the vast oil sands underlying the region have resulted in the strong economic growth as identified by a 125 percent growth in population since 2000; an average household income of $189,458 (Canadian dollars [CAD]); and an unemployment rate of 3.5 percent, which is half the national average.

The region is experiencing a large volume of activity, both industrial and residential/commercial. Given the pace, which is always in the thousands of permits per month, Wood Buffalo has utilized multiple 3D building model datasets from Pictometry to assist in GIS and planning projects. Leveraging the procedural and rule-based intelligence of Esri CityEngine has helped the municipality more acutely analyze the infrastructure requirements and other ramifications of proposed community changes and expansions.

Wood Buffalo has used the technology to accurately conduct predictive flood modeling and planning. 3D has also been incorporated as a critical component of the development progression modeling to visualize and analyze both the as-built conditions and proposed designs in the community plans. The CityEngine web scene technology allows for efficient sharing of 3D plans with other departments and stakeholders.

↓ Wood Buffalo, Alberta, Canada, is using Esri and Pictometry technology with imagery to help it manage its strong economic growth—125 percent growth in population since 2000, an average household income of $189,458 (CAD) and an unemployment rate of 3.5 percent, half the nation's average.

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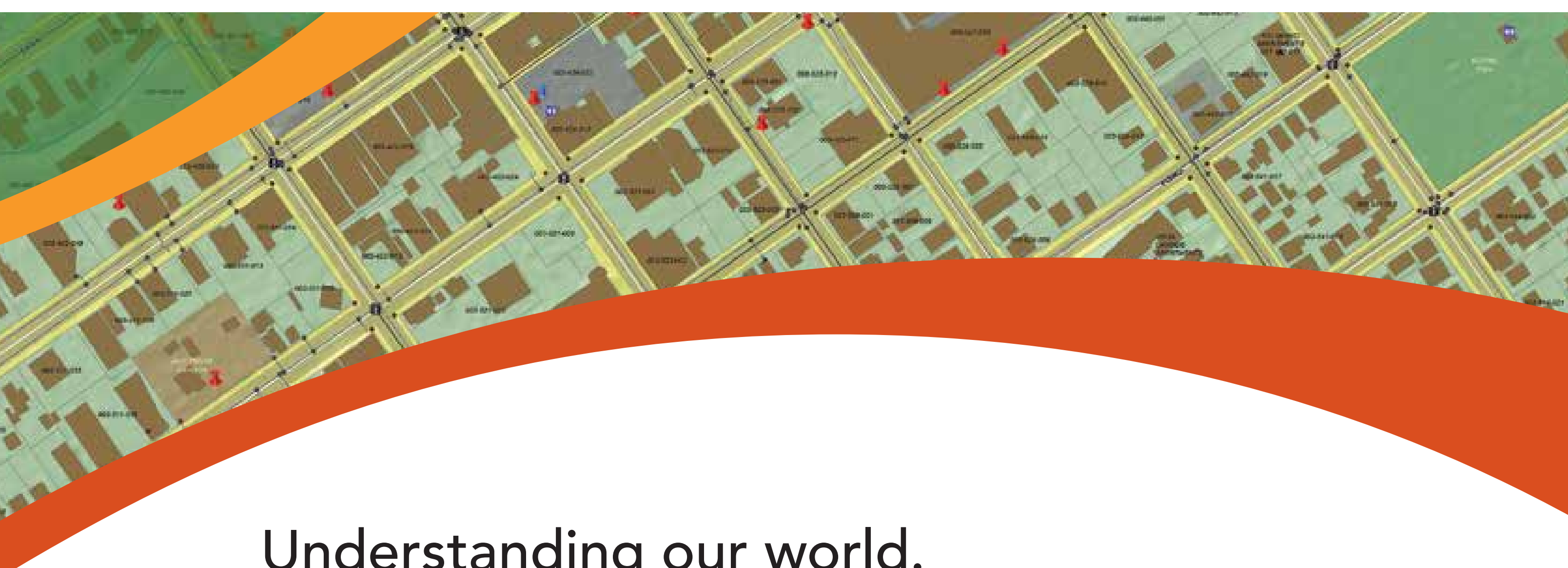

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