Maximizing Geospatial Workflows for Critical Applications

When it comes to humanitarian aid and disaster relief, effective collaboration and data integration can make the difference between life and death.

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Each year, natural disasters and civil unrest affect millions of people and destroy property worth billions of dollars around the world. Such incidents, including floods, hurricanes, tornados, wildfires, earthquakes and large-scale terrorist acts, bring unexpected and costly destruction. Just last year Hurricane Sandy devastated much of the U.S. East Coast, wildfires blackened millions of acres in Australia and civil unrest sparked a humanitarian crisis in Syria.

Key to recovery efforts, many U.S. federal government agencies support humanitarian aid and disaster relief (HA/DR) activities. These organizations have three priorities in the wake of a disaster: quickly assess damage, collaborate and share information with other agencies and public officials, and directly aid first responders.

Maximizing Geospatial Solutions

Accurate, timely and accessible geospatial information is critical to the assistance and relief efforts these organizations provide. A vast collection of satellite imagery, aerial photos, and light detection and ranging (LiDAR), radar and mapping data is extremely valuable, but such resources can add even greater value when seamlessly fused together and shared through open data formats and protocols.

The development of powerful geospatial products from this information, such as 3-D models, maps and reports, can support many critical activities, including visualizing damaged areas, understanding changes that have occurred over time, and planning relief supply deliveries, safe evacuations, and remediation and reconstruction efforts.

Often, however, the complexity and sheer volume of various types of geospatial information can hinder organizations and prevent them from realizing their maximum usefulness. Some geospatial data integration occurs among select organizations, but many agencies still rely on disparate and disconnected data to support their mission. A more integrated approach to managing, processing and analyzing geospatial data can improve disaster response effectiveness significantly.

For example, overhead imagery is useful, but it's much more valuable when viewed after being accurately draped over a detailed 3-D terrain model. Furthermore, properly combining LiDAR, radar, electro-optical imagery and elevation models provides a mechanism to identify potentially susceptible areas, such as where mudslides have increased following large periods of rainfall. Effective, efficient image processing and geospatial analysis tools can provide the ability to view, analyze and integrate these geospatial data types and can bring significant productivity enhancements to HA/DR efforts.


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Overcoming Data Integration Challenges

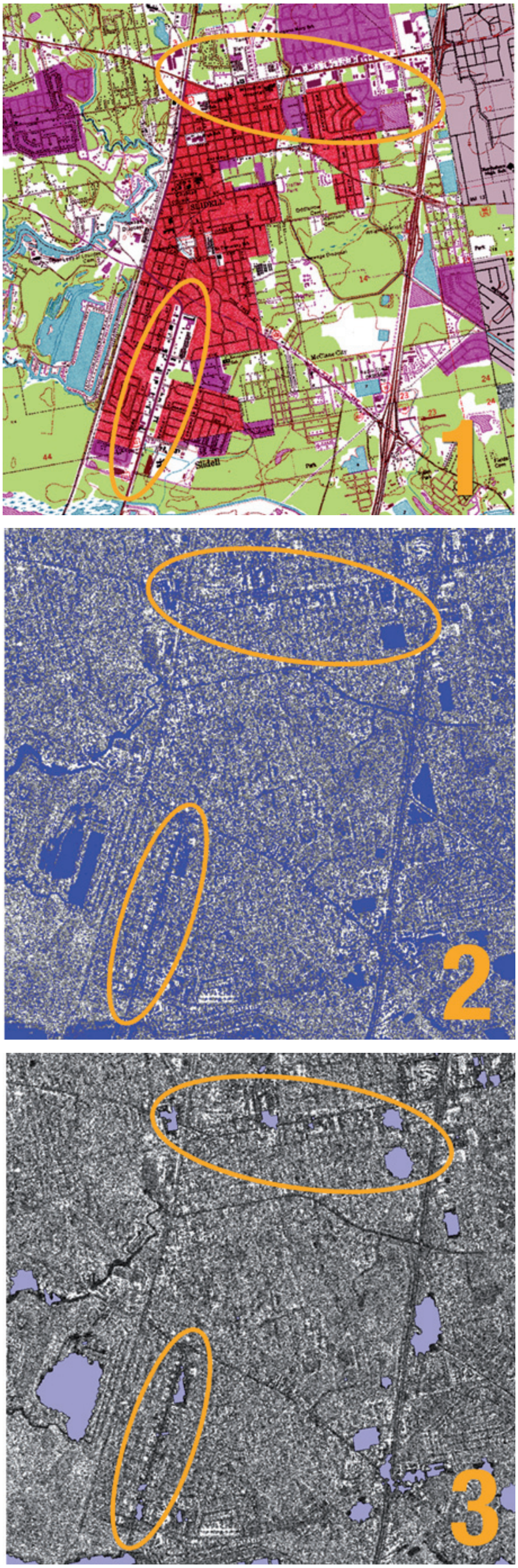
Distinct challenges of using geospatial information in an HA/DR event are the unpredictability of the environment, added stress, first-hand exposure to trauma and devastation, and the potential lack of critical resources such as communications and power. As a result, geospatial technology must be reliable and user friendly, not require specialized hardware and have the ability to function in a disconnected mode.

Identifying and assessing damage to buildings and infrastructure are critical post-event activities. Geospatial information, including imagery and LiDAR data, is invaluable to quickly and accurately determine overall damage to a wide area. Applying change detection algorithms as part of the workflow provides an analyst with a powerful depiction of the impact on human life and commerce in an area of interest.

Once such information has been derived, analysts can provide the results to rescue and relief planning activities. This helps responders calculate the number of affected citizens and the amount of reconstruction supplies that might be necessary. When applied to road networks, change detection can help compare before and after accessibility, coordinate detours and evacuation routes, and determine proper placement of law enforcement and emergency relief personnel.

During a major disaster, many organizations have the responsibility to collect and manage large amounts of geospatial data, such as recently collected overhead imagery, and then share that data in


High-resolution satellite imagery became available for analysis within days of Hurricane Ivan to assist with damage assessment reports.



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A map series near the northern boundary of Lake Pontchartrain, La., shows how ERDAS IMAGINE analyzed radar imagery of Hurricane Katrina flooding. Map 1 serves as a pre-hurricane reference map, map 2 shows the radar-sensed post-hurricane water areas (dark blue), and map 3 clearly identifies where large amounts of standing water exist onshore (light blue).

real time with a variety of other relief agencies. Therefore, a robust and scalable geospatial data management system that allows users to rapidly and sometimes automatically ingest and catalog geospatial data is critical. ERDAS APOLLO is an example of one such system that provides this type of scalable and robust geospatial data management.

Because the most important benefit of this type of data management system is the ability to support data discovery and sharing across geographic and political boundaries, federated access to information sharing is essential. When the correct system is in place, it saves a significant amount of time, especially for data interpreters and analysts. This ensures that end users who may not be directly trained in the system's use can interact efficiently. Improved searches automatically harvest metadata from image file headers and populate key search fields, such as collection date, geospatial extents, amount of cloud cover and many other parameters.

Ensuring Interoperability

Often in a disaster relief scenario federal, state and local organizations collaborate to bring about rapid results. This proves difficult, however, when each may have different desktop or mobile solutions for processing and analyzing geospatial data. Implementing an open-standard dissemination protocol serves data to a heterogeneous geographic information system (GIS) environment with multiple end-user systems, creating a streamlined data environment.

The key advantage of using Open Geospatial Consortium (OGC)-based protocols for sharing geospatial information is that they disseminate data in a vendor-neutral format. This maximizes the ability to share information with the broadest number of organizations and people possible. OGC standards, such as a Web Map Service (WMS), can improve the use of geospatial data services in low-bandwidth and offline networks to meet local and third-party needs. Such services also can be configured as real-time data feeds, which is crucial when the underlying data are dynamic, such as local traffic or weather. Because end users are able to make decisions using the most up-to-date information available, real-time data feeds greatly improve the level of confidence in the decisions they make.

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Taking Advantage of Remote Sensing

Overhead imagery has been used extensively in past HA/DR activities and will continue to be a vital geospatial asset. A growing number of data types, such as LiDAR and radar, are becoming more popular as the cost of these collection systems decreases and access to these data types increases. Because of these industry trends, it's essential that an organization's geospatial tool set can integrate a wide variety of data types.

LiDAR is an optical technology that produces detailed images of observations sometimes referred to as "point clouds." Essentially, point clouds are a vast collection of point data, sometimes billions of points, resulting from many individual laser beam collections.

LiDAR can be used to generate precise, 3-D representations of areas of interest on Earth's surface and its surface characteristics, so the technology is extremely valuable when used in post-event data collection and analysis. However, LiDAR datasets can be large and demand efficient image processing tools.

A key approach to using LiDAR more effectively and efficiently is allowing users to work with selected subsets of a large LiDAR collection rather than being restricted to loading the entire dataset into memory. Additionally, users ideally should be able to seamlessly integrate LiDAR processing with other remote sensing functions, such as editing point clouds and measuring distances in 2-D views. Software such as ERDAS IMAGINE offers an intuitive approach to these tasks, providing reliable results that can be shared easily with others.

Due to some natural disasters and an ever-increasing need to rapidly assess flooding, radar imagery exploitation is becoming more prevalent as radar data have become more commercially available (see "Empowering Broad-Area Disaster Management, page 32). Compared with LiDAR, radar data can be cheaper to collect because LiDAR data are relatively coarse with large pixel sizes.

In addition, radar data are uniquely suited for water mapping and flood analysis because they provide a flat return off water, making it quick and easy to extract water features. Perhaps the biggest advantage of using radar imagery is that it's independent of weather or daylight. Radar imagery can be obtained during a disaster and isn't subject to the same limitations as electro-optical data, which is affected by cloud cover and time of day. Radar signals penetrate cloud cover and can be shot at night. Also, because radar data can be collected rapidly, first responders can gain access to the data quickly.

In HA/DR workflows some commercial applications provide powerful functions for processing remote sensing data formats, but the algorithms themselves may be complex and difficult to apply in an appropriate manner, thereby limiting use. Once again, employing effective software, such as ERDAS IMAGINE, allows specialists to develop spatial models using an intuitive diagramming tool and then publish these models as an OGC-compliant Web Processing Service (WPS). Then a Web-based client can remotely execute these spatial models for an analyst who wants to have the model run against a specified data set.

For example, a WPS can be set up that allows users to select before-and-after LiDAR collections over a hurricane-damaged coastline. Then the user can perform a change detection to quickly visualize and measure elevation differences, making the data useful in a short amount of time. Built and published by a geospatial professional with a detailed understanding of data formats and processes, the WPS is made accessible to thousands of novice users who simply want fast, reliable results.

Creating an Effective Workflow

Often operating in stressful, dynamic environments, organizations chartered with humanitarian assistance and disaster relief need to react quickly and rely on accurate data. Such organizations must work with many types of data and integrate that information with information from other organizations supporting response and recovery efforts.

Access to effective geospatial software maximizes the ability of these organizations to integrate well with a wide variety of other geospatial applications, work with many types of geospatial information and ultimately collaborate with each other more effectively. Therefore, weaving these applications into HA/DR workflows enables high-quality analysis, quick turnaround and better informed decisions—all of which are critical to those responding to a disaster where such decisions truly make the difference between life and death.