Far Reaching Use

# Limitless Potential of Geospatial Imagery

By Peter McIntosh

Professionals across disciplines have over the past several years begun to use geospatial imagery more, as it becomes more readily accessible and cost effective. Its widespread availability, coupled with modern software packages which make it easier to uncover information down to the pixel level, has made imagery an integral element to a GIS, providing not just a visual backdrop to a map or visual context to GIS layers, but pertinent, current information about a geographic area of interest.

Traditional Uses of Imagery in GIS

Today, remotely sensed data such as satellite and airborne imagery is rapidly becoming a source of valuable input layers to a GIS. The increased use of imagery in GIS can be attributed to many factors: the increase of data acquisition by new and existing satellite and airborne sensors; the global coverage offered by many satellite sensors, which enables GIS professionals to use imagery to fill gaps in geospatial layers; the ability for modern sensors to gather critical data that is found outside the visible spectra such as RADAR imagery and elevation data; and, image analysis software advances which allow users to uncover the "hidden" information in an image.

Using imagery as a source of additional information beyond what can be seen by the human eye was once considered a distinct science, reserved for those with extensive knowledge of remote sensing and image analysis methods. In the past, GIS users did not have access to software that allowed them to easily extract pertinent data from an image and effectively integrate results into a GIS without expending valuable time and effort, learning advanced image analysis techniques from various unrelated software packages.

Recent software advances have removed the complexity and inconvenience from image analysis and the subsequent integration with an existing GIS. Today, software like ENVI
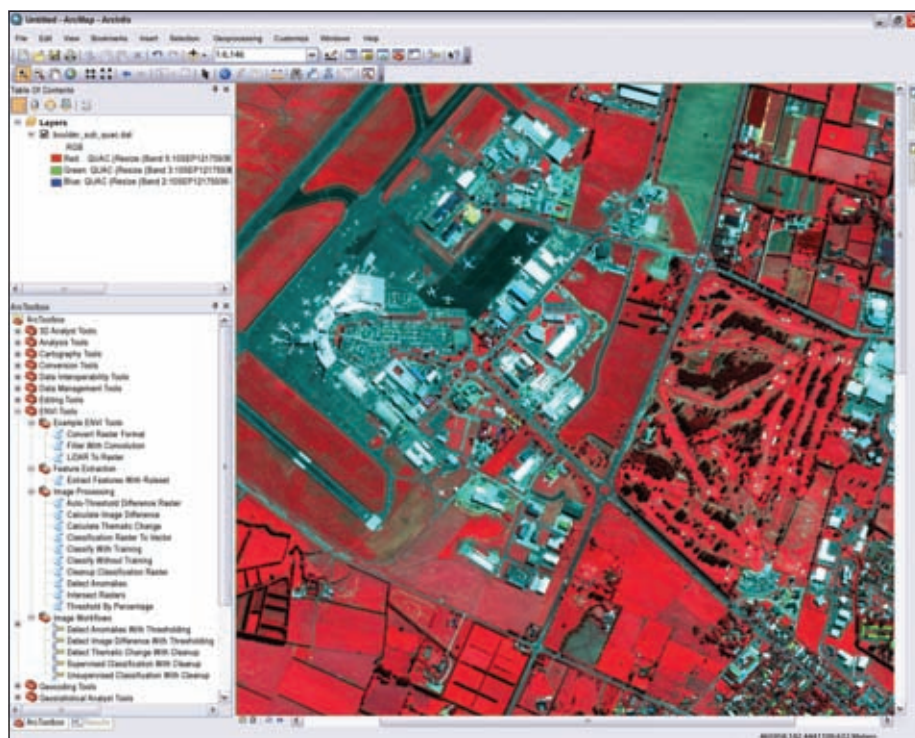
Defense and security is another discipline using the integration of geospatial imagery and GIS to aid in many types of missions.

from ITT provides ArcGIS users with wizard-like workflows allowing them to easily process and analyze geospatial imagery, providing information about an image and use results as an effective input layer and ultimately enhancing the GIS with rich data about a particular geographic area of interest. The results of image analysis processes in ENVI are uniquely easy to obtain since the software is designed to walk the user through each step of the process using pre-set parameters and prompts. Results maintain the scientific accuracy of previous, more complex processes, but can be derived in much less time and by professionals with far less training in the use of image analysis software.

Implementing time and effort saving workflows was the first key measure in allowing GIS professionals to add important information from imagery to a GIS. Now, technology found in the most current versions of ENVI software completes the marriage of the two, once distinct processes of image analysis

and GIS, providing revolutionary functionality that makes image analysis tools a seamless, inherent step in the GIS workflow.

Image Analysis as a Core Input to GIS

The integration of image analysis with GIS is a direct result of the development partnership between ITT Visual Information Solutions and Esri. The multi-year development effort delivers users of both products with a valuable time and effort saving solution: the availability of advanced ENVI image analysis tools in both the ArcGIS desktop and server environments. The innovative approach makes ENVI image analysis tools available directly from the familiar ArcToolbox, allowing users to perform a variety of advanced image analysis tasks, such as finding features of interest, classifying land cover, or detecting change between two images over time - without ever leaving the ArcGIS environment and the user's familiar workflow. Additionally, ENVI provides the

Today, geospatial imagery is a valuable source of information about the world around us. Its widespread availability provides us with timely and accurate data about virtually anything occurring on the Earth's surface, from natural phenomena and disasters to events caused by human activity, such as military operations. The use of imagery is far reaching, in both private industry and government applications - its value now being additionally enhanced as it becomes an effective source of input to GIS, allowing like never before the ability to verify the validity or quantity of field work, justify investment expenses and aid in decision making.
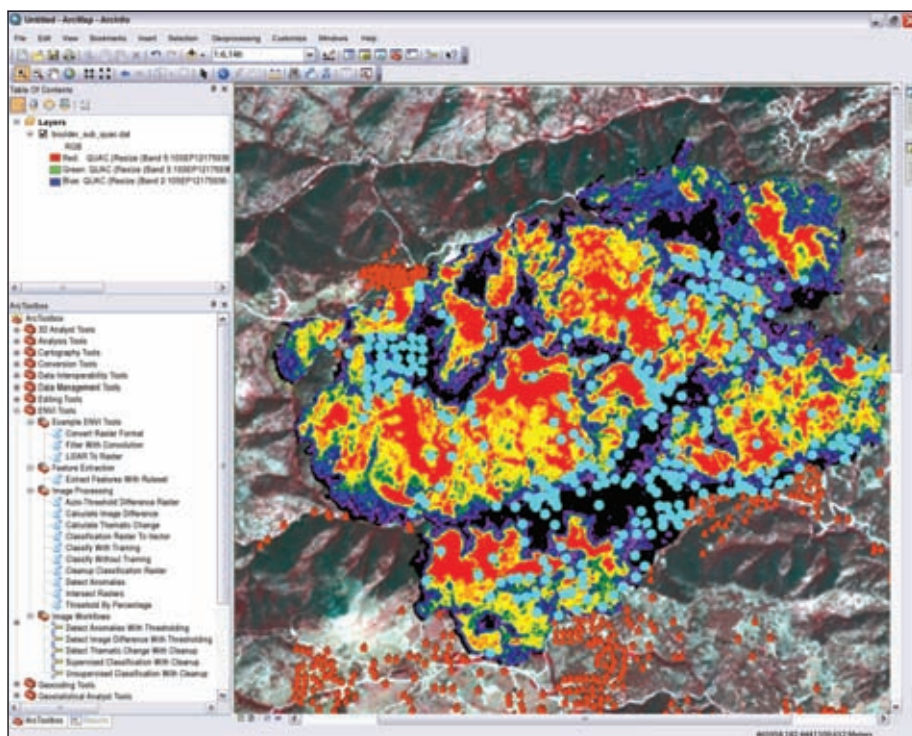
Fighting wildfires is a particular type of disaster where the application and benefits of using geospatial imagery together with a GIS can be clearly defined.

capability for ArcGIS users to easily build custom image analysis tools and models to meet unique needs.

Not only pertinent to just the desktop user, and in order to meet the growing need across industries to increase overall productivity and return derived data to a central, shared location, ENVI for ArcGIS Server, a new ENVI product, makes it easy to leverage server class resources, allowing ArcGIS Server users to distribute ENVI's advanced image analysis tools or custom tools and models to an entire workgroup or organization. ENVI for ArcGIS Server allows users to add image analysis capabilities to their existing tools and models, combine multiple tools that include image analysis functionality, and create new custom image analysis tools for their organization. Once tools and models are built, they can be published to the ArcGIS Server allowing users to access them from desktop, mobile and Web applications.

Imagery Aids in Disaster Management

Today, advanced image analysis tools can be easily and accurately applied within a GIS to provide timely, critical information to decision makers in manmade and natural disaster management situations. The integration of image analysis and GIS has become a major component in post-disaster relief efforts and has been effectively applied in recent situations such as the 2010 Haiti earthquake, the eruption of the Eyjafjallajökull volcano in Iceland, the Four Mile Canyon Fire in Colorado, and Hurricane Katrina. Fighting wildfires is a particular type of disaster where the application and benefits of using geospatial imagery together with a GIS can be clearly defined.

GIS technology is used by top firefighting agencies around the world to provide concrete data to responders who are both attempting to mitigate further damage and to measure its results. Successful operations use

ENVI and ArcGIS to create dynamic visual representations to aid in their efforts, such as maps showing the locations and status of active fires and incident briefing maps, which provide firefighters with tactical assignments and objectives. Satellite and airborne imagery analyzed with ENVI and included as part of a GIS provides a unique source of valuable data and helps to ensure accurate, informed and reliable decision making.

The unpredictable nature and subsequent destruction caused by wildfires is a problem faced by both those trying to help during a blaze, and those rebuilding in its aftermath. Every wildfire has its own unique circumstances that make mitigating damage difficult. Fuel loads, topography, wind, humidity and temperature are just some of the factors that affect the direction, severity and duration of a wildfire. The integration of advanced image analysis tools with a GIS can help address these challenges and allows firefighters to employ the operational power of remote sensing data without requiring image analysis expertise.

Recent advances in image analysis software are changing the ways geospatial imagery is being used for firefighting. Sophisticated image analysis tools like those found in ENVI that have been integrated into a GIS provide firefighters with critical information about fires increasing situational awareness and enabling firefighting agencies to more effectively utilize valuable resources. This allows disaster response personnel to make more informed and relevant decisions, preventing property loss, reducing injuries and potentially saving lives.

And, ENVI is used by firefighters to provide critical information about an area of interest potentially not attainable otherwise. ENVI can quickly "zoom in" and analyze an area of interest on a pixel by pixel basis, sharply increasing the number and accuracy of features identified. Other advanced tools within the software are employed to determine the locations of assets, lines of control, threatened property and other structures through smoke

and other visual interferences. ENVI also works with a variety of airborne sensors to measure information found in wavelengths beyond the optical region of the spectrum such as infrared, thermal and microwave wavelengths. Infrared measurements are particularly valuable in fire fighting because they can be used to determine hot spots and fire perimeters. Knowledge gained from image analysis and other data contained in a GIS are also used by firefighters and others to target clean-up operations efforts after fires have been largely contained. The tools within ENVI are used to measure and assess vegetation mass, classify land cover and determine the effects of fire on the geography.

Image analysis for Defense and Security

Defense and security is another discipline using the integration of geospatial imagery and GIS to aid in many types of missions. Defense and security personnel face a variety of challenges from monitoring infrastructure and assets to vulnerability analysis, which can be overcome with the help of information extracted from geospatial imagery. Data extracted from imagery can save time and manpower and increase the likelihood of achieving tactical and operational goals.

Imagery and other geospatial data are frequently combined in a GIS with other intelligence for a variety of security and defense purposes. Military and security personnel use a GIS to view, understand and visualize a geographic area, and now, thanks to the integration of the ENVI and ArcGIS packages, they can now also perform image analysis using a streamlined workflow delivering image analysis tools directly within a familiar working environment, eliminating the need to switch between multiple software packages. The integration of advanced image analysis tools in ENVI within the ArcGIS environment provides a unique capability that saves critical time and effort and gives warfighters and mission planners a tactical advantage.

As with other disciplines, ENVI is used in defense and security to accurately extract critical information from geospatial imagery and turn it into actionable intelligence. For tactical intelligence, surveillance and reconnaissance **(ISR)** operations, military analysts rely on ENVI for applications ranging from assessing the combat environment, to finding hidden tar-
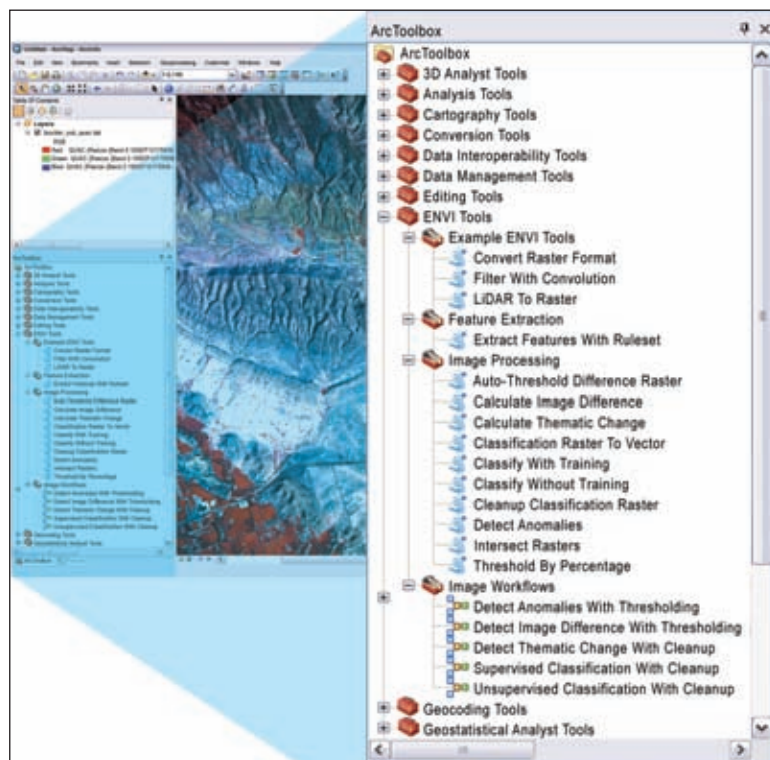
The innovative approach makes ENVI image analysis tools available directly from the familiar ArcToolbox, allowing users to perform a variety of advanced image analysis tasks.

gets and detecting changes in an area of interest taking place over time. ENVI can also be uniquely customized to solve challenges, making it a flexible solution for defense and security applications.

A common challenge faced in the industry is detecting and identifying targets. Targets such as vehicles, disturbed terrain or camouflaged objects that are not always visible can be detected with ENVI using spectral information. The target detection tool in ENVI combines advanced algorithms with a guided workflow to allow analysts to quickly find targets, regardless of their image analysis experience. ISR operations may also use imagery to extract features of interest from an overall image scene. The automated feature extraction tool in ENVI walks users through the process of finding similar objects throughout an image, and then extracting them as a vector layer for use in a GIS. Utilizing modern, object-based technology that integrates information about spatial, textural and spectral attributes of features in an image, the ENVI tool can be used to quickly extract buildings, vehicles, roads, coastlines, landing strips and other tactical land marks.

Defense and security personnel can also use imagery to detect and monitor changes occurring in a geographic area over time. From vehicle movement to new structure development, change detection tools in ENVI are appropriate for detecting change that is critical to mission success. ENVI not only maps the detected changes, but also creates reports

showing the area and percentage of changes, providing a selection of sophisticated tools for dynamically viewing the same location in two or more images simultaneously.

The ability to easily visualize topography is crucial for many defense and security operations. ENVI offers comprehensive topographic tools for tactical ISR operations so military analysts can visualize their data and understand the terrain ahead before making decisions about troop movement. With ENVI, analysts can produce dynamic three-dimensional models with imagery or vector data incorporated. They can then easily navigate through the models to visualize terrain from varying view angles, as well as create automated fly-through movies.

In addition to military applications, geospatial imagery can also provide relevant information which is suitable to other security operations such as border control, maritime security and piracy and illegal crop detection. The European Union has used imagery for years for these purposes in the Global Monitoring for Environment and Security (GMES) program, a progressive initiative to further the science of Earth observation.

Imagery's Limitless Potential

Uses of geospatial imagery continue to grow as the technology used with it is developed to meet specific, valid challenges for its application in each industry where it is employed. Its unique capability to provide information about a geographic area which is not always visually observable makes it a crucial tool, not only in disaster management and defense and security, but in applications like agriculture, natural resource management, forestry and urban planning. As software advances continue to develop in response to the individual needs in each industry and workflows are streamlined to save time and effort, new applications will continue to arise and call attention to the value of imagery to the world around us.

By Peter McIntosh,
Industry Solutions Engineer, ITT VIS.