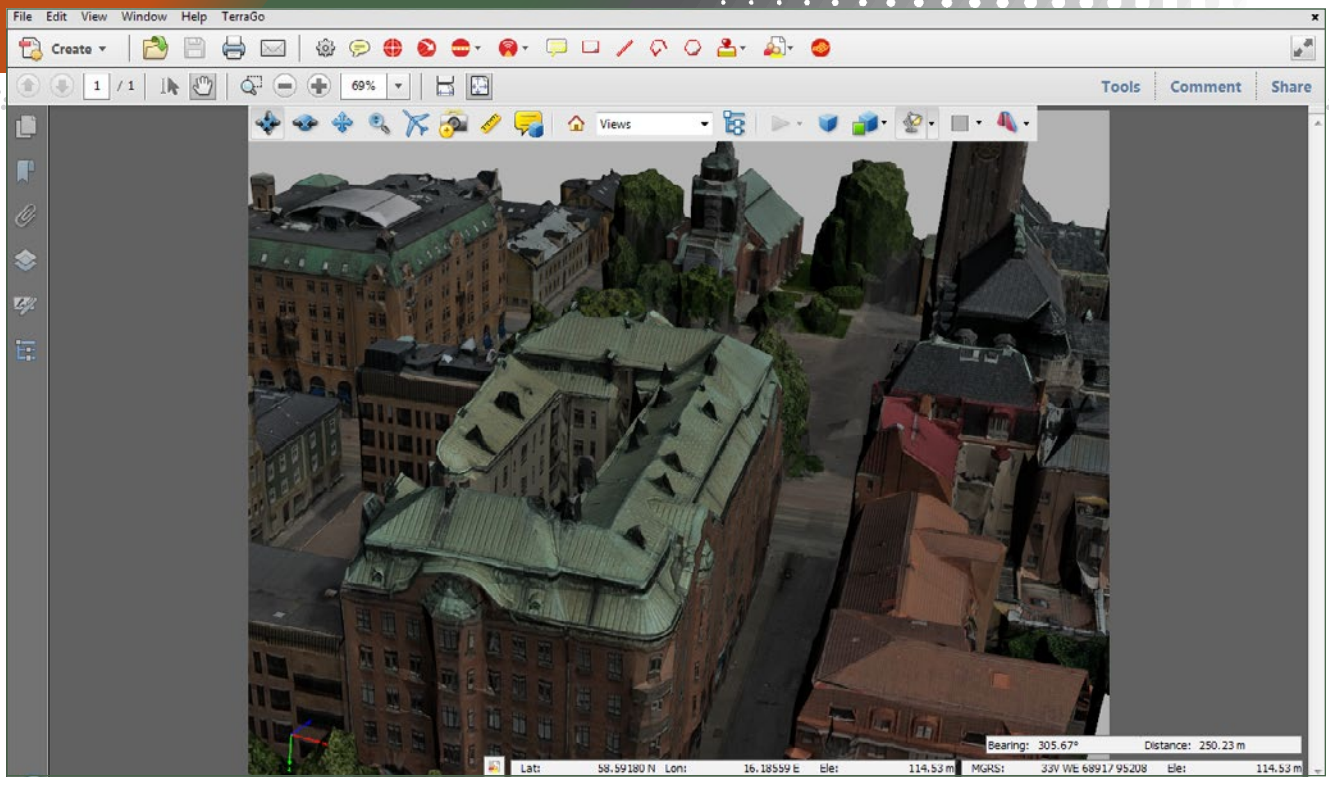


3D GeoPDF image of Norrköping—Sweden's tenth largest city and eighth largest municipality. The city dates back to the twelfth century and is home to the Swedish Transport Agency headquarters.

Bringing LiDAR Data to Life
with 3D GeoPDF Maps and Imagery

Forward-thinking organizations are increasingly embracing LiDAR data to enhance overall decision-making.

From applications in defense and emergency management to natural resources and beyond, LiDAR enables the creation of highly detailed 3D models of terrain, natural and manmade features, vegetation and other structures.

As the volume of increasingly high-quality LiDAR and other 3D data increases, so does the opportunity to share and leverage the information in a manner that is accessible and beneficial across the enterprise.

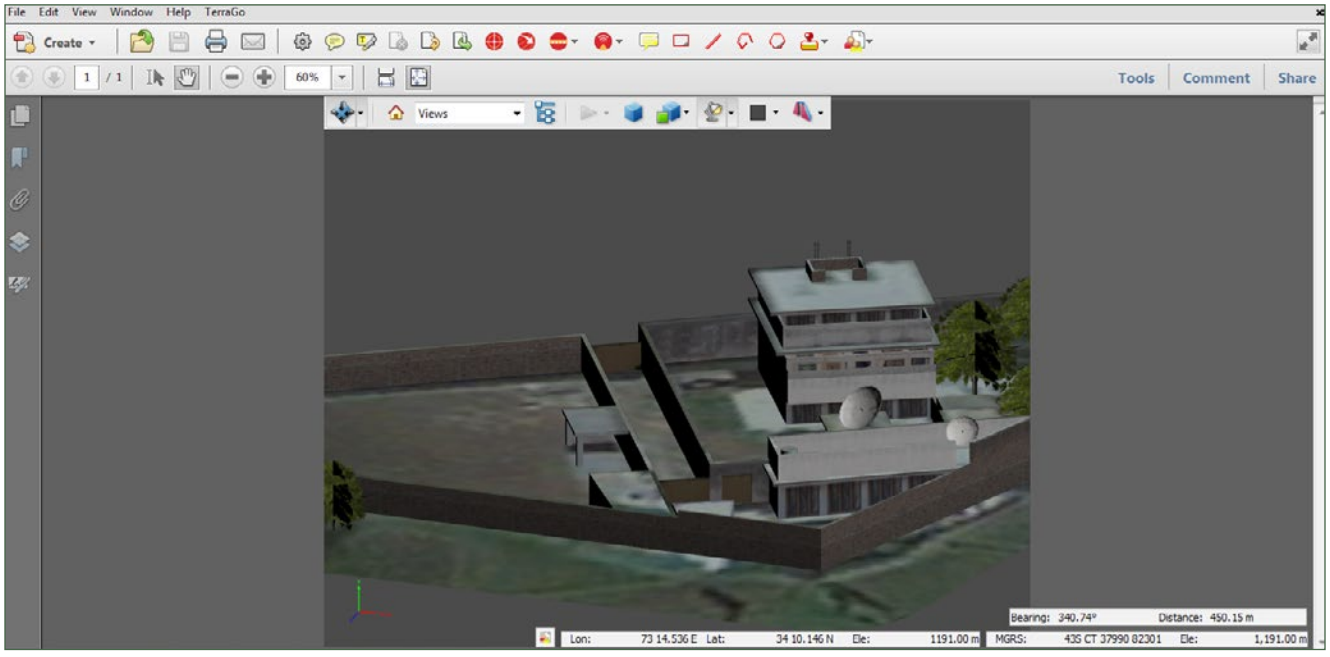
Meeting this challenge has traditionally been difficult due to the complexity of LiDAR and the sophistication of expert systems required to exploit the data. In addition, the large file sizes for 3D LiDAR data use up massive amounts of storage space and can be cumbersome to access and use.

In addition, 3D models can only be viewed and managed by trained GIS specialists who know how to interact with the data. For the untrained professional, it is nearly impossible to fully leverage LiDAR data analytic capabilities, which require complex geospatial systems for viewing the data. On top of this, geospatial data management software needs to be installed on the user's desktop.

In terms of data limitations, image and elevation data are typically stored as TIFF, IMG or SID and are often very large. Transferring and storing these data is often challenging for the casual user.

In many ways, these challenges have slowed down the speed of adoption when it comes to LiDAR.

BY MICHAEL BUFKIN



This Google SketchUp-based model of the Osama Bin Laden compound in Abbottabad, Pakistan was converted into a 3D GeoPDF image with TerraGo 3D Composer.

Thankfully new software solutions and 3D GeoPDF maps and imagery can now allow organizations to extend the value of LiDAR data and 3D geospatial information throughout the enterprise and to the field.

The Source of 3D GeoPDFs

Much like any key innovation that has been adopted in the larger enterprise setting, the origins of the 3D GeoPDF came from the military and Intelligence Community (IC).

In October 2008, the National Geospatial-Intelligence Agency (NGA) InnoVision - Advanced Development Office funded the LIDAR 3D Products Study and Demonstration project.

At that time, this research was aimed at investigating the feasibility of displaying high-resolution LiDAR derived digital elevation models (DEM) and urban modeling data using the free Adobe Reader and the no-cost TerraGo Toolbar.

Based upon the results of the initial prototype, TerraGo was tasked by the Army Geospatial Center in 2009 to integrate functionality into its free and licensed products for geo-registering and viewing of DEM.

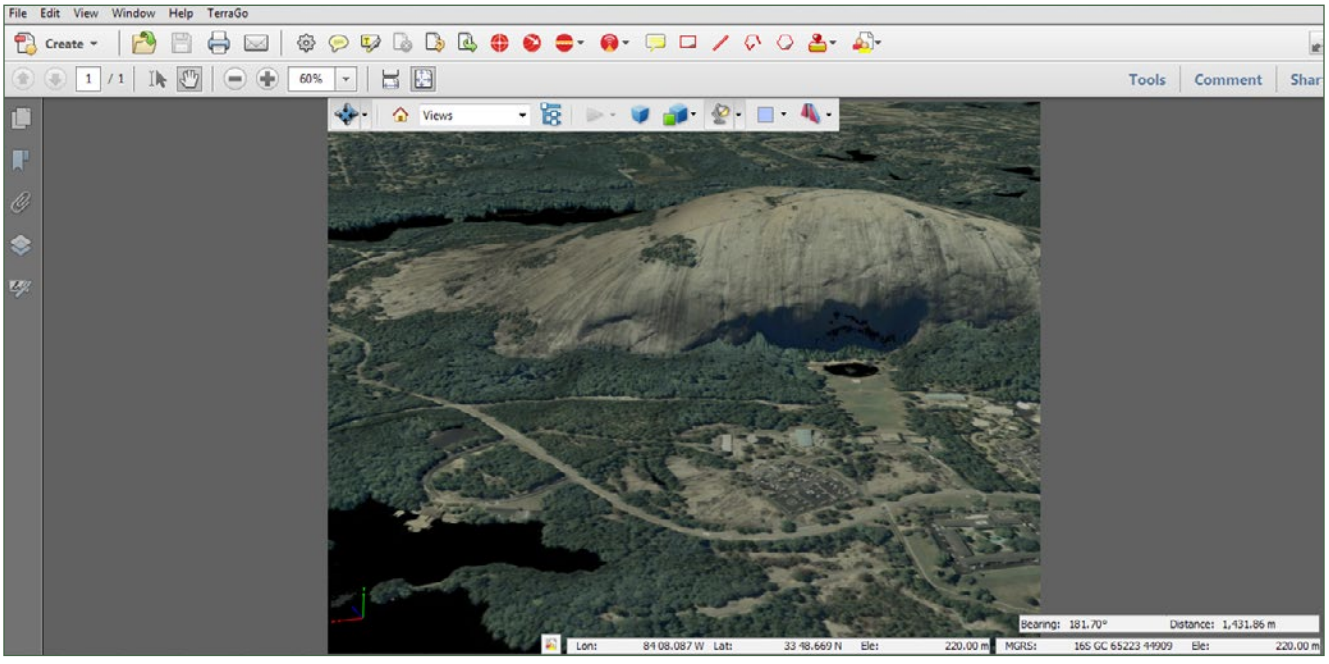
In terms of usage by the U.S. military, the best example was in dealing with the challenging terrain in Afghanistan and Pakistan. Through its BuckEye program, the Army has collected enormous amounts of LiDAR and imagery data in these areas, but has found that it is unable to furnish this data to those in greatest need of terrain awareness.

To address this problem, the Army Geospatial Center pursued the use of enhanced 3D PDF files to deliver 3D surface models and draped imagery as a terrain visualization tool.

In addition, in 2009, the Red River Basin of the upper Midwest underwent a 40,000 sq. mile LiDAR collection effort. At the time, this project currently had no method for providing the data to its non-professional constituents and considered using a GeoPDF-based solution.

Use Cases for 3D GeoPDF

One of the most common uses of LiDAR is the creation of digital terrain models (DTM) and DEMs for use in planning and design. DEMs show bare earth only, while DTMs may include vegetation and man-made structures. While this data often covers areas inhabited by hundreds of thousands, if not millions of people, very few of these will have access to these models for their own use in viewing their environment or planning events in their lives. The success of Google Maps, Virtual Earth and other publicly available imagery applications has demonstrated the public thirst for data about their own world and access to 3D models are likely to be similarly desirable.



3D image of a dam near Stone Mountain, which is well-known for both its geology, as well as the large bas-relief sculpture depicting Jefferson Davis, Robert E. Lee, and Thomas "Stonewall" Jackson, Confederate leaders of the Civil War.

Just as the results of aerial imagery surveys have been made available for download via the web, the public has a reasonable expectation that the results of LiDAR collections will also be made available. Of course, providing LAS data will defeat that purpose, but 3D GeoPDF maps can be consumed by almost anyone who can connect, and the small additional cost of the conversion can be included in the project budget.

Or consider a more specific use case for leveraging LiDAR to enhance the value of the collection effort: that of levee maintenance and inspection. Most major river systems subject to flooding have authorities for ensuring the effectiveness of the protective levee systems. These organizations are responsible for the safety of millions of people and billions of dollars of property. Many of them are now employing LiDAR to create a more accurate model of the levees and surrounding terrain.

While the LiDAR model is invaluable to engineers in creating design models, very few of the people needing to visualize the levee system will be able to view it unless the data is provided to them in some simpler format. Levee board members, county and municipality executives, business leaders and voters will be completely dependent on the expressions of specialists for making critical and expensive decisions regarding flood protection unless they also have access to the models.

LiDAR Data for Anyone, Anywhere

Much like 2D GeoPDF products, 3D GeoPDF maps can be used by anyone, anywhere, without access to complex tools or deep geospatial expertise. This provides enhanced situational awareness, improved collaboration and facilitates better decision-making.

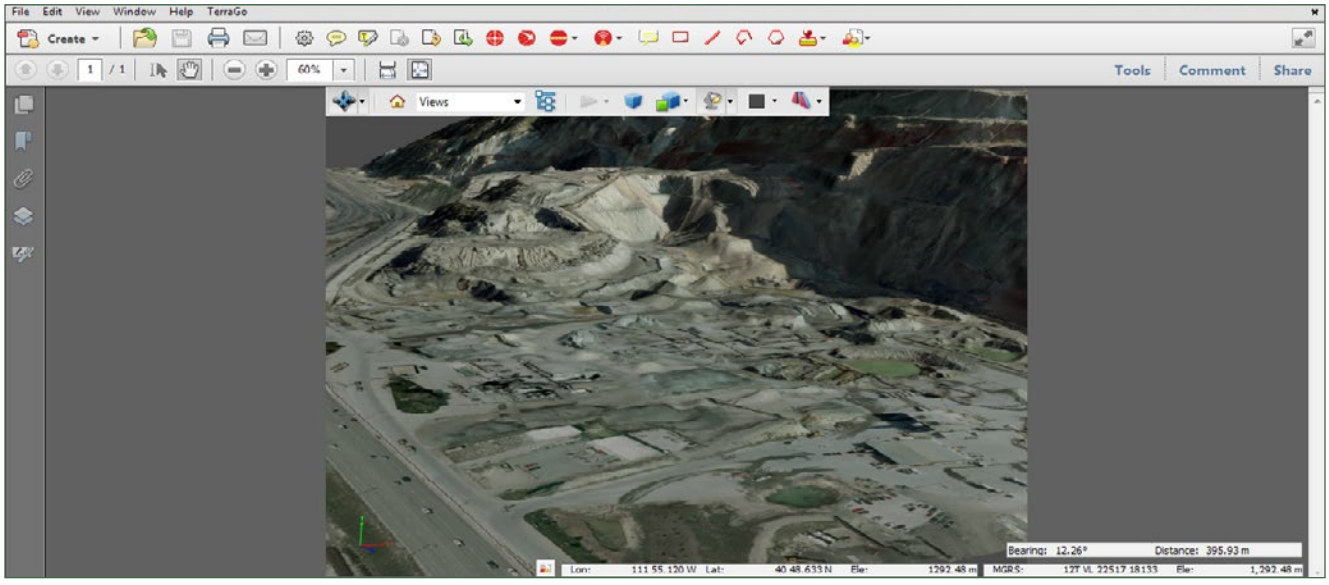
In addition, TerraGo recently added enhancements to the TerraGo 3D Composer for Adobe Acrobat to help maximize return on investment in geospatial assets by dramatically increasing the use of 3D maps and imagery throughout the enterprise.

Viewing 3D Models

The current 3D GeoPDF Viewer allows users to dynamic display the X, Y, and Z coordinates and offers user selectable coordinate systems and linear units. It also provides multiple coordinate displays and zooms to specific coordinates. Users can also leverage linear measurement between two points and access distance and bearing display from view point to focus point.

Creating 3D GeoPDFs

Most LiDAR data exists in the form of either LAS files or gridded GeoTIFF files.



3D GeoPDF image of a quarry in Utah.

Often poorly suited for display, these formats are intended to store detail data about either individual points or pixels.

For visualization, the points must be processed to create surfaces, a processor-intensive activity that requires both CPU power and time. By storing the surfaces, rather than the points, 3D viewers can provide very rapid translation, zooming and rotation, as well as location of points on the surfaces for measurement functions. The challenge is in generating these layers and in applying geospatial coordinates to the model.

Most LiDAR processing software provides the ability to render point data to surfaces in the form of VRML, which is one of the import formats supported by Adobe's 3D translator. Once the 3D model is available as a PDF, TerraGo then applies a projected coordinate system and utilizes the GeoJavaScript functions within the TerraGo Toolbar to transform the projected coordinates of the original model to any other available projection and datum for display.

In terms of creating 3D GeoPDF maps, there are two common methods. First, for simple models, users can leverage TerraGo's Composer 3D to drape an image onto a Digital Elevation Model (DEM) though users are currently limited to small tiles with UTM projection.

The second method, for more complex models, requires users to leverage a 3D modeling application like Virtual GIS, ArcScene or Socket GXP. From there, they can create a surface model using any of the available LiDAR processing products. Then, they can export the surface model to VRML or Colada and convert the surface model to 3D PDF using Adobe Acrobat and Tetra 4D. Users can also apply geo-registration with TerraGo 3D Composer.

The next generation of this offering includes improved 3D GeoPDF creation capabilities, which include enabling 3D GeoPDF export for partners, enhanced viewing with the TerraGo Toolbar, side-by-side view and place viewer.

Conclusions: LiDAR for the Masses

As the need for geospatial solutions is ever increasing, so too are the new innovations that are driving ease of use with technology. From consumers to businesses to government agencies, the next generation of solutions will focus on more simplified offerings that will spread geospatial innovations to near ubiquitous levels.

While managing and using LiDAR data can be very complex, there are new ways to leverage this data by anyone and in any location—whether at the desktop or out in the field.

Thankfully, the barriers to full organizational adoption of LiDAR data are about to breakdown and this unique geospatial solution will also achieve much wider adoption.

Michael Bufkin, TerraGo Co-Founder and Chief Solutions Architect. A founder of TerraGo and co-patent holder for the process that creates a georeferenced PDF, he has been involved in the evolution of TerraGo GeoPDF and the products that produce and display GeoPDF maps and imagery.