# LiDAR Data Management and Exploitation

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**Key Words:** Remote Sensing, LIDAR, point clouds, matching of point clouds, LAS, point clouds in remote sensing/information extraction, manage LAS data

## Abstract

*Is your agency utilizing or considering using LIDAR data? If so, you know that LIDAR technology has become a valuable tool in a variety of applications where an accurate surface model is required. The availability of LiDAR data is resulting in a profusion of very large datasets requiring solutions for management and exploitation. In this paper, we will highlight the benefits of LiDAR data, and explore local, state, federal and DOT workflows using LiDAR data (and other data types) in response to a natural disaster. We will demonstrate the managing, exploitation and dissemination of LiDAR in emergency planning, recovery and rebuilding.*

## 1. Introduction

LIDAR data as LAS format or photogrammetrically (stereomatching) derived very dense point clouds are meanwhile the third, main geospatial data type beside raster and vector data. These data contain an immense information amount. It is not only the point position in 3D (x,y,z) but also attribute information like intensity, number of return, classification (bare earth, vegetation, building etc.) or the rgb value of an potential image pixel source.

In addition these point clouds can be as dense as the resolution of a stereo image pair, if the point cloud was calculated by using very dense image matching techniques and not an active airborne laser sensor.

- How to easily handle these data?
- How can these data be displayed, analysed and used in combination with raster data or vector data information?
- How can these data easily and automatically be catalogued and managed?

The following hypothetical story or use case example will tell you about this and answer the above questions.

## 2. Story / workflow / use case

Here's a hypothetical situation that happens all too often. Sam has been tasked with developing a map of the floodplain of a local river to help insurance companies and other decision makers prepare for a season of expected high rainfall. The LiDAR data for the entire state has been captured, which is the good news, but finding the specific data for this project is another story.

The spreadsheet with tile numbers and the DVD names never seem to match. After putting in some tedious man hours, Sam resolves the spreadsheet issue, finds the DVD and gets to work. Of course no good deed goes unpunished and he quickly finds that one tile in the centre of the project is on a corrupt DVD.

Although inconvenient, this can be resolved because imagery was also acquired. After getting IT to issue a license from the mapping department and getting re-acquainted with the photogrammetry GUI, Sam manages to generate a stereo pair and he is able to create a dense RGB encoded point cloud… but he can do nothing more without switching applications again. In doing so, Sam discovers that, with recent budget cuts, the department hasn't purchased the necessary add-on module required to work with LiDAR data. But it's an important project; the insurance companies need this data in preparation for the rainy season. He prepares a request and submits it to his supervisor.

The requisition is subsequently approved and Sam is back on course in a few days. Until he realizes the photogrammetry software tweaked the format and dropped the projection information and he doesn't know who to call. Should he call the photogrammetry vendor or GIS vendor for technical support? Despite the setback Sam is glad his supervisor didn't choose the open source software where the web forum only offers dozens of "suggestions" to work around the problem.

Figure 1. LIDAR / point cloud data can be discovered with a simple web browser

Finally, he gets the situation resolved and is able to access the data. It's easily visualized, allowing him to draw cross-sections and view the data in 3D. His frustration grows, however when he can't open and view the points with the raster and vector layers. He struggles to get a real feel for the project area and cannot determine which vector layers need updating.

As Sam inspects the data, he also starts to notice a few errant outliers, which happens to be of all things: birds. Wasn't the data supplier supposed to clean that up? Although he is new to LiDAR processing, Sam assumes that deleting a few points should be simple.

This is exactly the type of challenge that many state and local government employees face across the nation. Fortunately, there are solutions that allow government employees like Sam to exploit geospatial data and provide information to decision makers that is timely, relevant and actionable. One of these solutions is Intergraph's ERDAS APOLLO.

Once the LiDAR survey is complete and the digital tiles are delivered a geospatial catalog in ERDAS springs into action. The scheduled crawlers search the data directories for new LIDAR files, harvest the metadata, create user preferred overviews, set permissions and build the catalog.

Sam's first task it to find the data for the project area. He opens his web browser and zooms in on the area of interest He then draws a bounding box. It turns out the Mapping Department has already created the ortho mosaics of the project area. The project manager found some historical documents that reference previous high water levels and some video footage from a local news channel, which were also catalogued on the server—providing Sam with valuable reference material.

For now, he just needs the LiDAR data. As such, he refines the search using the key word 'LiDAR.' The corresponding files show up in the browser map view and Sam can do a quick quality check. He notices a missing tile and will need to fill the gap photogrammetrically. Using the clip-zip and ship routine in ERDAS APOLLO, all the necessary files are delivered to his workstation. His photogrammetry tools are fully integrated and use the same ribbon interface as the remote sensing and LiDAR capabilities. And, within no time Sam can recreate the missing data using dense matching.

After opening the LiDAR data, Sam notices that the data supplier did not remove the outliers. The box selection and delete in the profile view allow him to remove these. To start the report and provide context for the project, Sam adds a Bing Maps layer to the view and then clicks the 'send to PowerPoint' button.

It's the end of the day but before he goes home there's one more thing to do. The missing tile created using dense matching is RGB encoded and Sam feels this will make the data far easier for the insurance people to understand. So he sets up a batch process to encode all the LiDAR tiles with the ortho imagery overnight. And since nobody will be at the office tonight, he decides to distribute the work to a few more machines using their Condor installation.

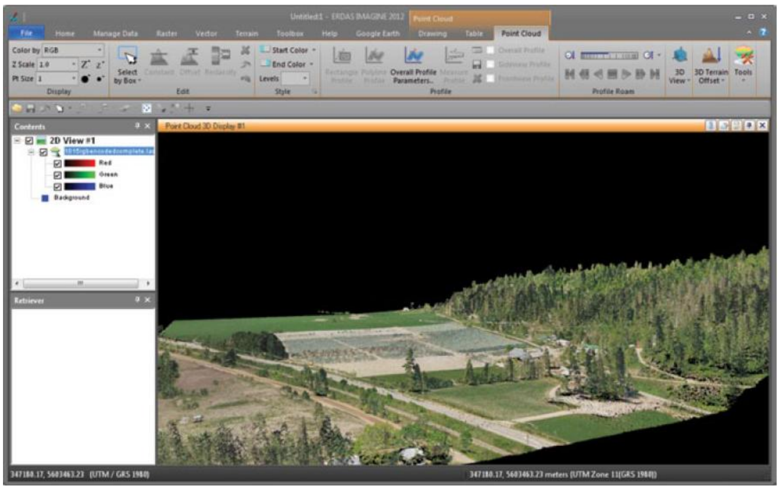

Figure 2. Airborne LIDAR after RGB encoding

In the morning, Sam continues to clean up the data. Using the area operators like constant value and bias he easily flattens out the lake and removes noise like cars. From there, using the LiDAR and imagery, he edits the existing vector layers and creates a new layer with all the vegetation extracted from the LiDAR.

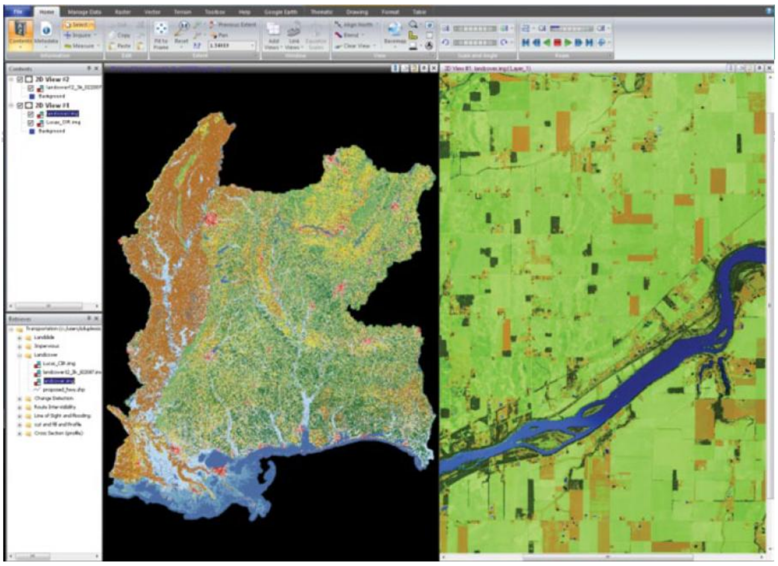

Figure 3. Land use classification with linked overview

He also makes use of an auto roaming capability to examine the river corridor. Sam then measures the grade along the length of the profile and makes notes and measurements of overhanging trees and bridges, which are easily visible in the side and front views. Sam can also interrogate the newly installed monitoring system that detects tiny movements in the dam and automatically alerts the authorities if the tolerances are breached.

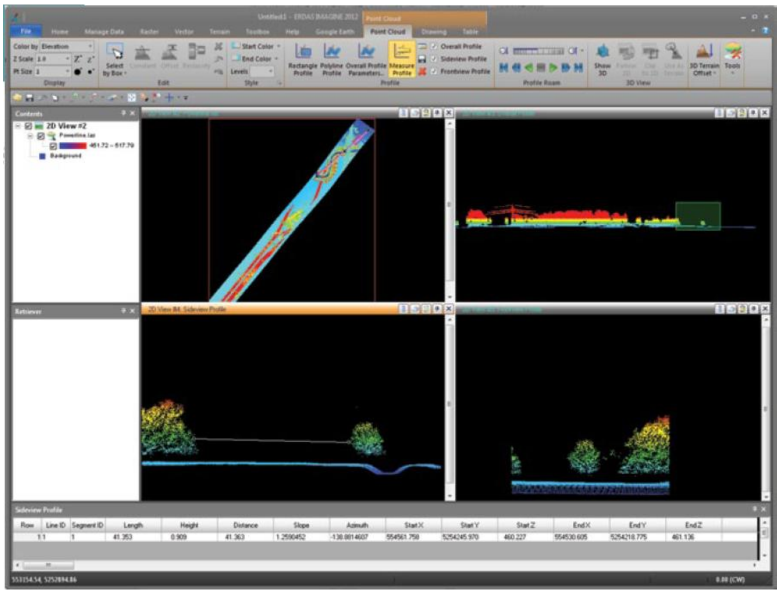

Figure 4. Automatically roam the corridor and take measurements while getting multiple linked profile views of the data

Further downstream, a covered bridge, which happens to be a historical landmark, has been scanned in detail so engineers can inspect it for flaws—allowing it to be exactly rebuilt if the flooding destroys it. This scan is easily incorporated into the airborne point data to create a comprehensive view of the area.

Using the color infrared imagery, Sam then generates a land use classification within a 10 mile buffer of the river. This will be useful in determining where land use practices may impact water quality and run-off. Then using the LiDAR as a surface, and combining it with a land cover classification, all the areas vulnerable to landslides are detected and marked.

To determine where a breach in the levee will have the biggest impact, Sam constructs a least cost path spatial model. Since the inputs to this model may change over time he decides to publish the model to the server with a description of its application and the ability to automatically detect appropriate inputs. Now others can use his expertise through a web client when the need arises.

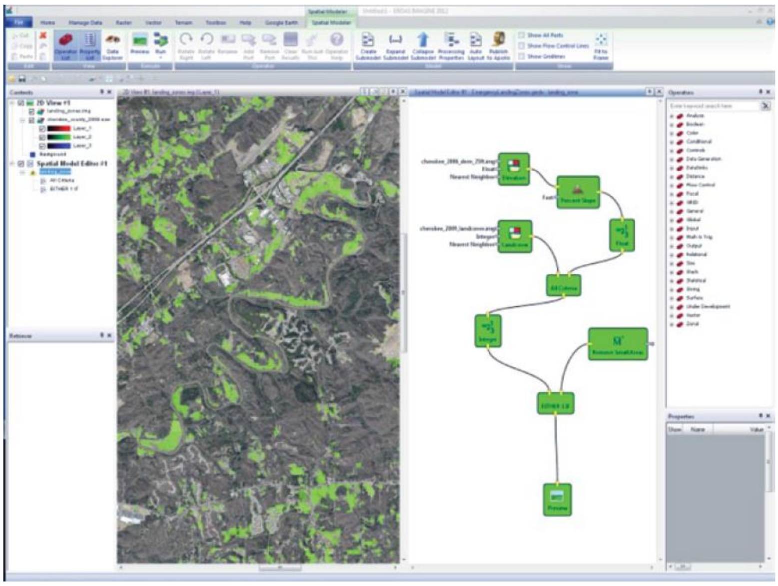

Figure 5. Spatial Modeling with real time feedback to refine the model

The analysis automatically updates and creates new attributes in Sam's GIS layers. Then, the GIS software incorporates the remote sensing and LiDAR analysis to provide the insurance company with a list of all the property owners in the floodplain, each with a risk potential based on the available data. And since we now know which properties are at risk, an automated notice will be generated and sent to the property owners.

Finally a high quality tourist map of all the biking and walking trails is created for the Parks Department. And, once the project is complete all the new data is put back on the server for other to access.

## 3. Conclusion

This hypothetical example shows how photogrammetry, LiDAR, remote sensing and GIS can all easily and efficiently work in concert. Sam was able to quickly access the right data to effectively plan for a natural disaster situation that requires information for the insurance companies, homeowners and much more. When it comes to life-or-death situations, geospatial solutions need to be fast, accurate and reliable. Fortunately for Sam and other geospatial professionals, it is possible for all of these mapping elements to work together in harmony. The right information gets into the hands of decision makers and Sam gets to be the hero.