Photogrammetric Data Capture

CASE STUDY

University uses photogrammetric software to track glacial activity in Svalbard, Norway

Customer: Swansea University, U.K.

Industry: Photogrammetric mapping, digital elevation model (DEM) creation

Background
Based on historical tidal records, global sea levels have risen by approximately 0.15 meters since 1900, and recent predictions estimate that this trend will continue. Excluding thermal expansion, it is believed that 20% to 30% of this increase was caused by the melting of small glaciers, such as those in Svalbard, Norway, an area expected to make a disproportionate contribution to future sea-level rise because of its sensitivity to climate change.

In the summer of 2004, a group of researchers, including a team of scientists from Swansea University, U.K., participated in a field study named The Sea Level Rise from ICE in Svalbard (SLICES) project, designed to measure and calculate past and future sea-level rise in Svalbard. The purpose of the study was to gather historic topographic data sets for comparison with current records of the same area.

The challenge
Because of logistical difficulties and a lack of knowledge pertaining to how the world's glaciers are changing, measuring and forecasting global sea-level rise is no small task—and there are few long-term mass balance studies for historical comparison. However, while it is impossible to pinpoint exact timetables, advanced tools for collecting and analyzing information give researchers renewed optimism to expect more precise results than ever before.

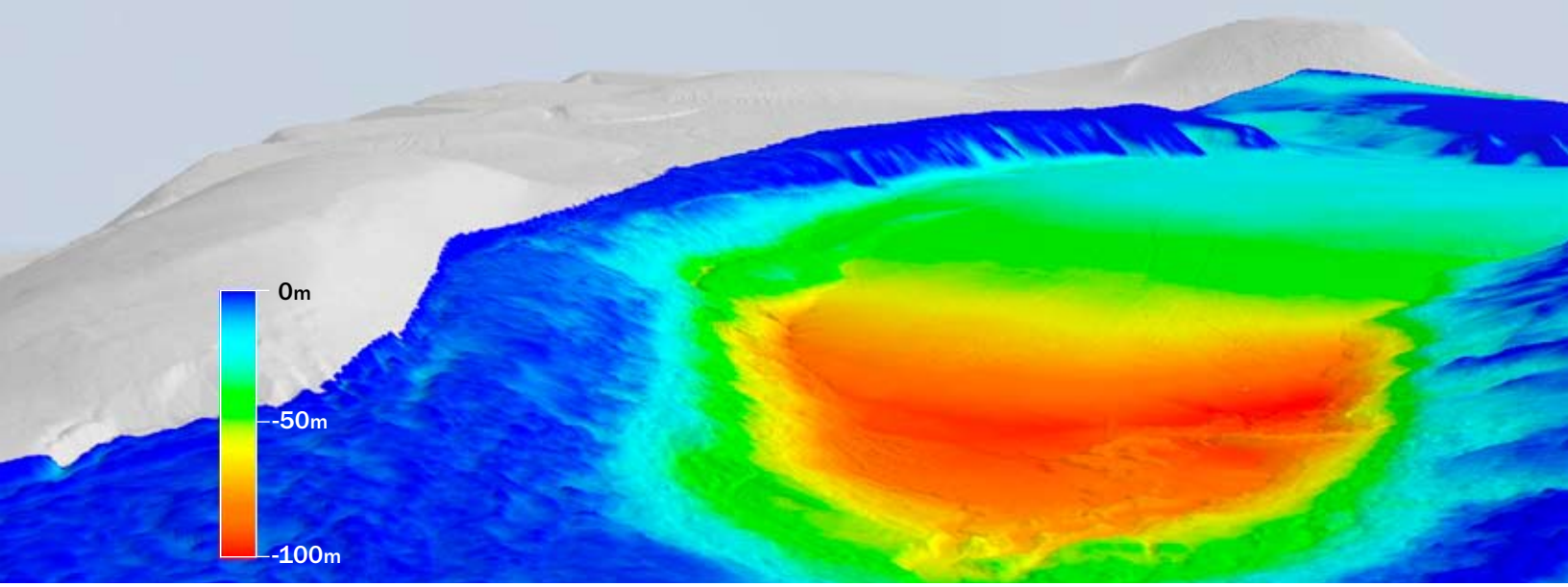
The evaluation
The SLICES team, led by Professor Tavi Murray from the School of Environment and Society, Swansea University, includes a host of prestigious co-investigators and partners such as the Universities of Bristol and Newcastle upon Tyne, the Norwegian Polar Institute, British Antarctic Survey, NASA, University of Silesia, and the Russian Academy of Sciences.

Between 2003 and 2005, the team collected accurate GPS control data, aerial photography, LIDAR, and optical data of nine benchmark glaciers around the Svalbard archipelago. Statistics from other expeditions, collected during the same timeframe, were also available. The primary goal was to measure volume changes of the benchmark Svalbard glaciers, using LIDAR and photogrammetrically derived digital elevation models (DEMs), to provide a strong baseline for continued monitoring in the area. The findings were applied to the entire archipelago with a regional mass balance model, which was used to derive 20th and 21st century contributions to global sea-level rise in Svalbard. There were four main objectives:

1. Address the baseline length limitation of LIDAR collection, i.e., the decay in the accuracy of post-processed data caused by the distance between the aircraft and the nearest GXP reference station, and to overcome the logistical limitations of working in remote areas.
2. Derive estimates of historical mass balance for the 20th century for a representative sample of Svalbard glaciers.
3. Scale the results to arrive at an estimate of sea-level rise contribution for the archipelago.
4. Forecast sea-level rise contributions for the 21st century under different climatic scenarios.

"Ice masses around the world are changing rapidly. The Glaciology group within the School of Environment and Society at Swansea is using advanced digital terrain modeling techniques to improve the quantification and our understanding of these changes. The group has chosen SOCET SET® as our key photogrammetric data capture package."

Dr. Timothy James
Scientist, Swansea University, U.K.



The solution

Following the relocation of the Glaciology group from Leeds to Swansea in 2005, there was an opportunity to select new photogrammetric tools to assist with mapping projects. There are no systems on the market designed to measure and map glacial activity. Therefore, the team was challenged to secure a multipurpose application that could work equally as well with new and century-old data. The researchers chose BAE Systems' SOCET SET software for geospatial analysis, photogrammetry, and mapping. SOCET SET's Automatic Terrain Extraction (ATE) and Interactive Terrain Editing (ITE) modules offer a combination of automated and manual tools for building terrain and surface models.

Stereo matching on surfaces such as glaciers with repeating patterns and a lack of texture is notoriously difficult. Through the use of backmatching algorithms in ATE, the scientists have been able to eliminate many of the blunders that are normally associated with stereo matching on such surfaces, and thus obtain a better automated DEM with far less manual correction required. Occasionally, in extremely steep areas, or areas where fresh snow cover makes stereo matching difficult, users implement a hybrid approach, which involves manually measuring DEM points or breaklines in ITE, then using these as seed points in ATE. If stereo matching is unreliable, for example in areas of fresh snow with little texture, it is preferable to have a hole in the data, as opposed to blunders. A TIN DEM, produced in ATE with backmatching, yields much better results; it will identify such points as blunders and throw them out.

Conclusion

Prior to acquiring SOCET SET, the Swansea team used various systems that were available through the University. SOCET SET was selected primarily because of its reputation in the industry as a stable, reliable application that can manage numerous photogrammetric tasks. Shortly after implementing the system, Swansea's scientists were impressed at its rigorous processing capabilities, capacity to handle relatively large images seamlessly, and most importantly, individual user control. Having the power to run the application according to project specifications is a significant advantage. For example, for the SLICES project, there were many large images that had been captured at 1:50,000 scale and scanned at a high resolution to maximize DEM resolution; SOCET SET handled these flawlessly. SOCET SET's flexibility, especially in terms of input file formats and ASCII files was also a major advantage.

Although Swansea researchers do not run standard workflows like many typical SOCET SET users, there has been a dramatic reduction in the time it takes to complete laborious photogrammetric tasks, an improvement they attribute to SOCET SET's stability, versatility, and speed. Consequently, there is more time for analyzing results and collaboration with industry peers. This is critically important, since climate change is a cause for concern to the scientific community and the general public.

Image above: Perspective view (looking northeast) of a glacier in Svalbard, Norway called Slakbreen. Image, from 2003, shows a shaded-relief, LIDAR DEM interpolated to 2 m, overlaid with a change map relative to a 1961 DEM generated photogrammetrically in SOCET SET. The image highlights the dramatic loss of ice over this 42-year period with maximum elevation loss of over 100 m. The majority of the melt has happened in the past 10 years. Evidence suggests that this is characteristic all over the Svalbard archipelago. Mass balance measurements of selected benchmark glaciers in Svalbard were made using contemporary and historical aerial photographs controlled using contemporary LIDAR DEMs. This approach provides both well distributed and long-term mass balance measurements.

LIDAR data courtesy of the Natural Environment Research Council Airborne Remote Survey Facility. Aerial photographs were provided by the Norwegian Polar Institute.

The figure was created in QT Modeler from Applied Imagery.

For details on the SLICES project, please visit: http://geography.swan.ac.uk/glaciology/slices/