



# Reacting to Climate Change

by Konrad Saal

**'Sweden facing climate change – threats and opportunities' is the title of final report SOU2007:60 presented by the 'Swedish Commission on Climate and Vulnerability' in 2007. Appointed by the Swedish government in 2005, the commission's task is to assess the impact of global climate change on the country. Over the last decades Sweden has suffered from significantly rising numbers of floods, landslides, and erosion. The persistent and increasing risk will affect buildings, roads, and many other infrastructure facilities. The Swedish government has granted a considerable amount of money to protect Sweden's society, infrastructure, industry, and agriculture. One of the preventive measures is a new digital elevation model delivering highly accurate elevation data of Sweden.**

As the Swedish mapping, cadastral, and land registration authority, Lantmäteriet is responsible for the national co-ordination of the production, cooperation, and development of geo-data. In 2009,

Lantmäteriet received a special grant from the government to start the new terrain elevation database using airborne laser scanning technology. "The existing national Digital Elevation Model (DEM) database covering Sweden is unsuitable for most of today's tasks. It was initially created only for in-house production of orthophotos. Over time, it has become obvious that a better DEM database is of great importance for many required activities in the coming years," states Gunnar Lysell, Business Developer at Lantmäteriet. Furthermore, the existing model provides a height accuracy of only  $\pm 2\text{m}$  and has a 50m grid spacing.

## **Highly Accurate LiDAR Data Acquisition**

In summer 2009, Blom Sweden AB, a subsidiary of Norway based Blom ASA, started the five-year project. They were chosen to provide LiDAR data to Lantmäteriet, but before the project could start the Swedish mapping authority needed to verify the LiDAR data from test flights. Among the equipment chosen for data capture was a Leica ALS60 airborne laser scanner. It delivered outstanding results that fully met Lantmäteriet's expectations.

## Visualizing Historical Shorelines

A first processing of the data has disclosed patterns of historical shorelines after hiding the vegetation. "These shorelines are remains of the raised sea level after the last ice period some 10,000 years ago. Ice melting caused an uplift of the land, up to almost 300m in some parts of Sweden," explains Lysell. "Before the new, accurate elevation data, this pattern could only be found through field research, but now we can see it easily by viewing the elevation model on our computer screens." The old elevation model with 50m grid and a height accuracy of approximately  $\pm 2$ m could not resolve the patterns. Even today, the land is still rising at a rate of approximately 1 cm per year in the central part of Sweden.



BLOM Group is a leading international company specializing in the collection and processing of high-quality geographic information using airborne sensors and the development of software applications and services. Andreas Holter, Head of Resources at BLOM, says: "LiDAR has become an efficient technology to create digital terrain models of large areas. The Leica ALS60 meets Lantmäteriet's specifications, delivering a height accuracy on hard and well defined surfaces of 20cm or better." BLOM uses Leica AeroPlan60 to set up the ALS60, and the Leica FPES software for cost efficient and detailed flight planning and evaluation. The software computed a total flight length of 550,000km in approximately 12,500 lines for the entire project.

According to the flight plans created in FPES, the sensor is automatically activated for data acquisition by the Leica FCMS Flight & Sensor Control Management System. Up to 70,000 "shots" are captured per second. The collected data is geo-referenced via GNSS base stations which provide ground control points. This data is post-processed through different software, such as Leica IPAS Pro, NovAtel's GrafNav/GrafNet, Leica ALS Post Processor, Terrasolid's TerraScan/TerraMatch, and BLOM's own TEPP software, and finally converted into ground coordinates including latitude, longitude, elevation, and intensity values. Andreas Holter confirms, "We are very satisfied with the support from Leica Geosystems in the integration of Leica ALS Post Processor with our own software TEPP. This has sped up the processing workflow. The accuracy of the final processed data is very good, mainly because of the high accuracy

Inertial Measurement Unit (IMU). This, combined with good flight and processing procedures, including strip adjustment and ground truth verification, has produced very good results."

### Great Benefits for Many Organizations

Lantmäteriet uses the geo-referenced point cloud data to calculate the new digital elevation model. "The benefits of the project appear to be many. We have noticed a great interest from potential users of both the DEM database and of laser data," says Gunnar Lysell. "The data can be used for almost anything. We expect all Swedish Municipalities will use it for their planning of new infrastructure and for flood protection planning." The data can also be imported into GIS software suites and advanced software packages to simulate floods for future infrastructure planning. "The forestry industry will definitely use the laser data for investigations on the wood yield of Swedish forests," continues Lysell, "and even Swedish orienteering clubs will use it for production of orienteering maps."

For public authorities, municipal and governmental, the elevation data will be available as part of the European wide "Inspire" project. "When the new data is available to end users, we will publish references on our website to various applications where the data is being used," concludes Gunnar Lysell. Of course, Lantmäteriet will use the data to update their orthophoto production and to put height values on cartographic features mapped in 2D. ■