Lidar Interpretation in Haines, Alaska

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What is lidar?

"Lidar, which stands for Light Detection and Ranging, is a remote sensing method that uses light in the form of a pulsed laser to measure ranges (variable distances) to the Earth. These light pulses—combined with other data recorded by the airborne system—generate precise, three-dimensional information about the shape of the Earth and its surface characteristics.

A lidar instrument principally consists of a laser, a scanner, and a specialized GPS receiver. Airplanes and helicopters are the most commonly used platforms for acquiring lidar data over broad areas. Two types of lidar are topographic and bathymetric. Topographic lidar typically uses a near-infrared laser to map the land, while bathymetric lidar uses water-penetrating green light to measure seafloor and riverbed elevations." (NOAA, 2024)

What can we do with lidar?

One of the products created with lidar data is a digital elevation model (DEM), which captures the bare earth's surface (topography) or the ocean floor (bathymetry). The Department of Geological & Geophysical Survey (DGGS) uses DEMs for many applications, including geologic mapping, landslide and shoreline mapping, and avalanche and other geologic hazard studies.

Depending on the intended usage, lidar data is collected at different times of the year. Late summer or early fall collections allow us to generate DEMs that best represent the bare ground because snow has often melted from higher elevations and leaves have fallen from trees. In contrast, late winter or early spring collection times are used to generate DEMs that represent the snow's surface when areas of interest have peak snow accumulation.

Digital terrain models (DTM) are augmented DEMs that have added breaklines and better represent the ground surface.

Digital surface models (DSM) are also created from lidar data. They are generated from the "first return" points and represent the tops of trees and man-made structures such as buildings.

See the inset images on this poster for a few examples of how we use lidar in the Haines area.

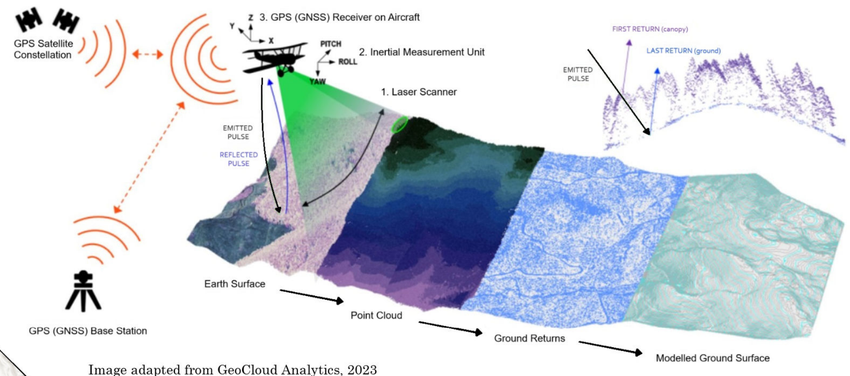
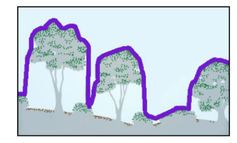
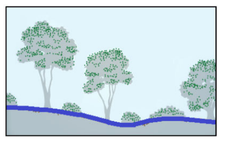


Image adapted from GeoCloud Analytics, 2023



Pulses that reflect off the tops of trees, leaves, and buildings are used to create the DSM.



Pulses that pass between leaves and reflect off the bare ground are used to create the DEM and DTM.

Images adapted from NEON Science, 2024

Beach Road landslide

Datasets from different years can be compared to see what changed (Quantum Spatial, 2014, Daanen and others, 2021).

In the image above, areas that lost material (had a lower elevation in Dec. 2020 as compared to May 2014) are shown in yellow. Areas that gained material (had a higher elevation after the landslide) are dark purple. In this case, material that deposited in the inlet was "lost" in the lidar because the lidar pulses did not penetrate the water's surface.

A paleo-landslide scar is visible in a DTM-derived hillshade raster (Zechmann and others, 2024).

The same paleo-landslide scar is obscured by vegetation in Esri's World Imagery layer.

Lidar data starts out as thousands or millions of points. The points are connected to create the elevation models. Sometimes points may have incorrect elevations and the resultant elevation models have spikes or dips. The geometric shapes in this image do not represent the real ground surface and would be removed before analysis.

Digital elevation models can be use to generate contour lines (50 meter intervals in this image; Zechmann and others, 2024).

This image enhances visualization of the Haines Highway milepost 19 to 23 debris flow fans using a 3D scene, layered colors, layer blending, and masking. The raster image was derived from Zechmann and others (2024) and is shown over Esri's World Imagery layer. Layers were exported from ArcGIS Pro and edited in Photoshop.

This DTM-derived slope raster shows paleo-shoreline beneath the vegetation. These features indicate isostatic rebound (the ground has risen after being depressed by the weight of ice sheets during the last glaciation).

The same slope raster, but classified into three categories: 7 degrees and less (blue, flat), 8-64 degrees (white), and greater than 65 degrees (magenta, very steep).

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