# (LiDAR) 3D Point Clouds and Topographic Data from the Chilean Coastal Cordillera

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## 1. Licence



## 2. Citation

**When using the data please cite:**

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# 3. Data Description

The DFG Priority Program 1803 “EarthShape” (www.earthshape.net) investigates Earth surface shaping by biota. As part of this project, we present Light Detection and Ranging (LiDAR) data of land surface areas for the four core research sites of the project. The research sites are located along a latitudinal gradient between ~26 °S and ~38 °S in the Chilean Coastal Cordillera. From north to south, the names of these sites are: National Park *Pan de Azúcar*; Private Reserve *Santa Gracia*; National Park *La Campana;* and National Park *Nahuelbuta*.

The three datasets contain raw 3D point cloud data captured from an airborne LiDAR system, and the following derivative products: a) digital terrain models (DTM, sometimes also referred to as DEM [digital elevation model]) which are (2.5D) raster datasets created by rendering only the LiDAR returns which are assumed to be ground/bare-earth returns and b) digital surface models (DSM) which are also 2.5D raster datasets produced by rendering all the returns from the top of the Earth’s surface, including all objects and structures (e.g. buildings and vegetation).

The LiDAR data were acquired in 2008 (southernmost *Nahuelbuta* [NAB] catchment), 2016 (central *La Campana* [LC] catchment) and 2020 (central *Santa Gracia* [SGA] catchment). Except for *Nahuelbuta* (data already was available from the data provider from a previous project), the flights were carried out as part of the "EarthShape" project. The LiDAR raw data (point cloud/ *.las files) were compressed, merged (as *.laz files) and projected using UTM 19 S (UTM 18 S for the southernmost *Nahuelbuta* catchment, respectively) and WGS84 as coordinate reference system.

A complementary fourth dataset for the northernmost site in the National Park *Pan de Azúcar*, derived from Uncrewed Aerial Vehicle (UAV) flights and Structure from Motion (SfM) photogrammetry, is expected to be obtained during the first half of 2022 and will be added to the above data set.

## 3.1 Data Acquisition

The data from the *Nahuelbuta* area (2008) was gathered using a RIEGL LMS-Q560 LiDAR scanner, the *La Campana* (2016) and *Santa Gracia* (2020) data were both captured using a RIEGL LMS-Q680i scanner. Both systems are full waveform laser scanners which support Pulse Repetition Rates (PRR) from 240 kHz (LMS-Q560) to 400 kHz (LMS-Q680i). All LiDAR flights were performed by a private Chilean geodesy company (DIGIMAPAS CHILE, https://digimapas.cl, last access: 2021-12-10). Depending on the flight altitude (and the degree of vegetation cover) the high PRR (400 kHz for SGA and LCA, 240 kHz for NAB) resulted in an average surface point density between 3.6 (2.8) and 9.0 (8.7) returns per square meter [returns/m²] (values in brackets are for the last returns). The return densities were high enough to calculate DSMs as well as DTMs in 1 m spatial resolution for each catchment and were high enough in the *Santa Gracia* catchment to compute elevation models in higher resolutions, i.e. 0.5 m cell size.

Digital image data for the *Pan de Azúcar* catchment will be gathered using a DJI Phantom 4 RTK drone with a 20 MP camera and the calculation of the elevation data (3D point cloud) will be achieved by using Structure from Motion photogrammetry. Due to the very sparse vegetation cover (~2%) in the *Pan de Azúcar* region (Bernhard et al., 2018; Schaller et al., 2018) and the cost-effectiveness of the SfM photogrammetry procedure, it is a well-established alternative to airborne (and terrestrial) LiDAR scans (Johnson et al., 2014)

## 3.2 Data Processing

Several post processing steps of the raw LiDAR point cloud data were applied using '*rapidlasso LAStools'* software (https://rapidlasso.com, last access: 2021-12-10), to derive the following raster data products which are often referred to as 2.5D data because the location is defined by the grid cells projected *xy*-value and the elevation (*z*) is stored in the raster cells value:

1. Digital terrain models (DTM) with a relatively high resolution of 1m x 1m.
2. Digital Surface Models (DSM) with the same 1m x 1m resolution.

In each of the sites the point cloud tiles (*.las-files) were merged into a single *.laz-file and rectified. In a second step, the point cloud was filtered to remove spurious returns by truncating the elevation (z-value) histogram at both ends after the occurrence of gaps, which are considered unusual in natural environments. The filtering was followed by classifying the data into ground and non-ground points (returns), where only the last or single returns were considered as ground returns. To obtain the DTM raster datasets only the ground returns were then triangulated, rasterized to a grid with a spatial resolution of 1 m, and saved as a GeoTIFF. DSMs were derived by triangulation of only the first and the single returns of the filtered point cloud data, before computing the surface model's GeoTIFF.

For the Pan de Azúcar site, a DTM will be calculated with a 0.5m spatial resolution or higher with the same procedure as above, but based on the SfM-provided point cloud.

# 4. Data Properties

The properties of the individual datasets for each of the four* field sites are summarized as follows:

| **Catchment Name** | **Pan de Azúcar*** | **Santa Gracia** | **La Campana** | **Nahuelbuta** |
|---|---|---|---|---|
| **Covered Area** | ~ 23 km² | ~54 km² | ~39 km² | ~46 km² |
| **Location: lat, lon (WGS 84)** upper left/lower right corner of bounding box | -26.108080, -70.561901/ -26.172998, -70.484228 | -29.66491, -71.178503/ -29.788253, -71.087982 | -32.919973, -71.120547/ -32.990682, -71.011056 | -37.782553, -73.033733/ -37.827784, -72.917895 |
| **UTM Zone** | 19 S | 19 S | 19 S | 18 S |
| **Capturing Method** | UAV/ SfM | LiDAR | LiDAR | LiDAR |
| **Capturing Year** | expected in 2022 | 2020 | 2016 | 2008 |
| **Point Density [points/m²]** | > 100 | ~ 9 | ~ 3 | ~ 3 |
| **Spatial Resolution of Derived Products (DTM/DSM)** | 1 m x 1 m computation of very high resolution (< 0.1 m x 0.1 m) feasable | 1 m x 1 m computation in higher resolution (0.5 m x 0.5 m) feasable | 1 x 1 m | 1 x 1 m |

* The data of Pan de Azúcar are not included in this version of the data publication (expected in 2022).

## 4.1. File and Folder Content

| ZIP Folder | Catchment Name | File/Folder Size | File Names | Data Format | Content |
|---|---|---|---|---|---|
| | Pan de Azúcar* | **T**o **B**e **A**nnounced | 2022-002_Kuegler-et-al-PDA-Point Cloud | *.laz | Compressed Point Cloud (Raw Data) |
| | Santa Gracia | 4.41 GB | 2022-002_Kuegler-et-al-SGA-Point Cloud | *.laz | Compressed Point Cloud (Raw Data) |
| | La Campana | 857 MB | 2022-002_Kuegler-et-al-LCA-Point Cloud | *.laz | Compressed Point Cloud (Raw Data) |
| | Nahuelbuta | 762 MB | 2022-002_Kuegler-et-al-NAB-Point Cloud | *.laz | Compressed Point Cloud (Raw Data) |
| 2022-002_Kuegler-et-al-PDA-Raster_Data.zip | Pan de Azúcar* | TBA | 2022-002_Kuegler-et-al-PDA-DTM/DSM-1m.kml | *.kml | Layer Extent |
| | | TBA | 2022-002_Kuegler-et-al-PDA-DTM/DSM-1m.tfw | *.tfw | World File |
| | | TBA | 2022-002_Kuegler-et-al-PDA-DTM-1m.tif | *.tif | DTM |
| | | TBA | 2022-002_Kuegler-et-al-PDA-DSM-1m.tif | *.tif | DSM |
| 2022-002_Kuegler-et-al-SGA-Raster_Data.zip | Santa Gracia | 1 KB | 2022-002_Kuegler-et-al-SGA-DTM/DSM-1m.kml | *.kml | Layer Extent |
| | | 1 KB | 2022-002_Kuegler-et-al-SGA-DTM/DSM-1m.tfw | *.tfw | World File |
| | | 300 MB | 2022-002_Kuegler-et-al-SGA-DTM-1m.tif | *.tif | DTM |
| | | 300 MB | 2022-002_Kuegler-et-al-SGA-DSM-1m.tif | *.tif | DSM |
| 2022-002_Kuegler-et-al-LCA-Raster_Data.zip | La Campana | 1 KB | 2022-002_Kuegler-et-al-LCA-DTM/DSM-1m.kml | *.kml | Layer Extent |
| | | 1 KB | 2022-002_Kuegler-et-al-LCA-DTM/DSM-1m.tfw | *.tfw | World File |
| | | 134 MB | 2022-002_Kuegler-et-al-LCA-DTM-1m.tif | *.tif | DTM |
| | | 134 MB | 2022-002_Kuegler-et-al-LCA-DSM-1m.tif | *.tif | DSM |
| 2022-002_Kuegler-et-al-NAB-Raster_Data.zip | Nahuelbuta | 1 KB | 2022-002_Kuegler-et-al-NAB-DTM/DSM-1m.kml | *.kml | Layer Extent |
| | | 1 KB | 2022-002_Kuegler-et-al-NAB-DTM/DSM-1m.tfw | *.tfw | World File |
| | | 112 MB | 2022-002_Kuegler-et-al-NAB-DTM-1m.tif | *.tif | DTM |
| | | 114 MB | 2022-002_Kuegler-et-al-NAB-DSM-1m.tif | *.tif | DSM |

* The data of Pan de Azúcar are not included in this version of the data publication (expected in 2022).

## 5. Additional Information

The DFG Priority Program 1803 "EarthShape - Earth Surface Shaping by Biota" (2016-2022) explored between scientific disciplines and includes geoscientists and biologists to study from different viewpoints the complex question how microorganisms, animals, and plants influence the shape and development of the Earth's surface over time scales from the present-day to the young geologic past. All study sites are located in the north-to-south trending Coastal Cordillera mountains of Chile, South America. These sites span from the Atacama Desert in the north to the Araucaria forests approximately 1300 km to the south. The site selection contains a large ecological and climate gradient ranging from very dry to humid climate conditions.

For more information visit: www.earthshape.net

## 6. References

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