

Procesado de datos LiDAR en QGIS con SPDlib

Roberto Antolín¹, Pete Bunting² y Juan Suarez¹

(1) Forest Research, Northern Research Station, Roslin EH25 9SY, UK

(2) Department of Geography and Earth Sciences, Aberystwyth University, Aberystwyth, Ceredigion, SY23 3DB, UK

E-mail: Roberto.antolin@forestry.gsi.gov.uk

Twitter: @Tolanss



Resumen

1. Motivaciones

- Qué es el LiDAR?
- Herramientas actuales LiDAR

2. SPDlib

- Nuevo formato SPD: Por qué?

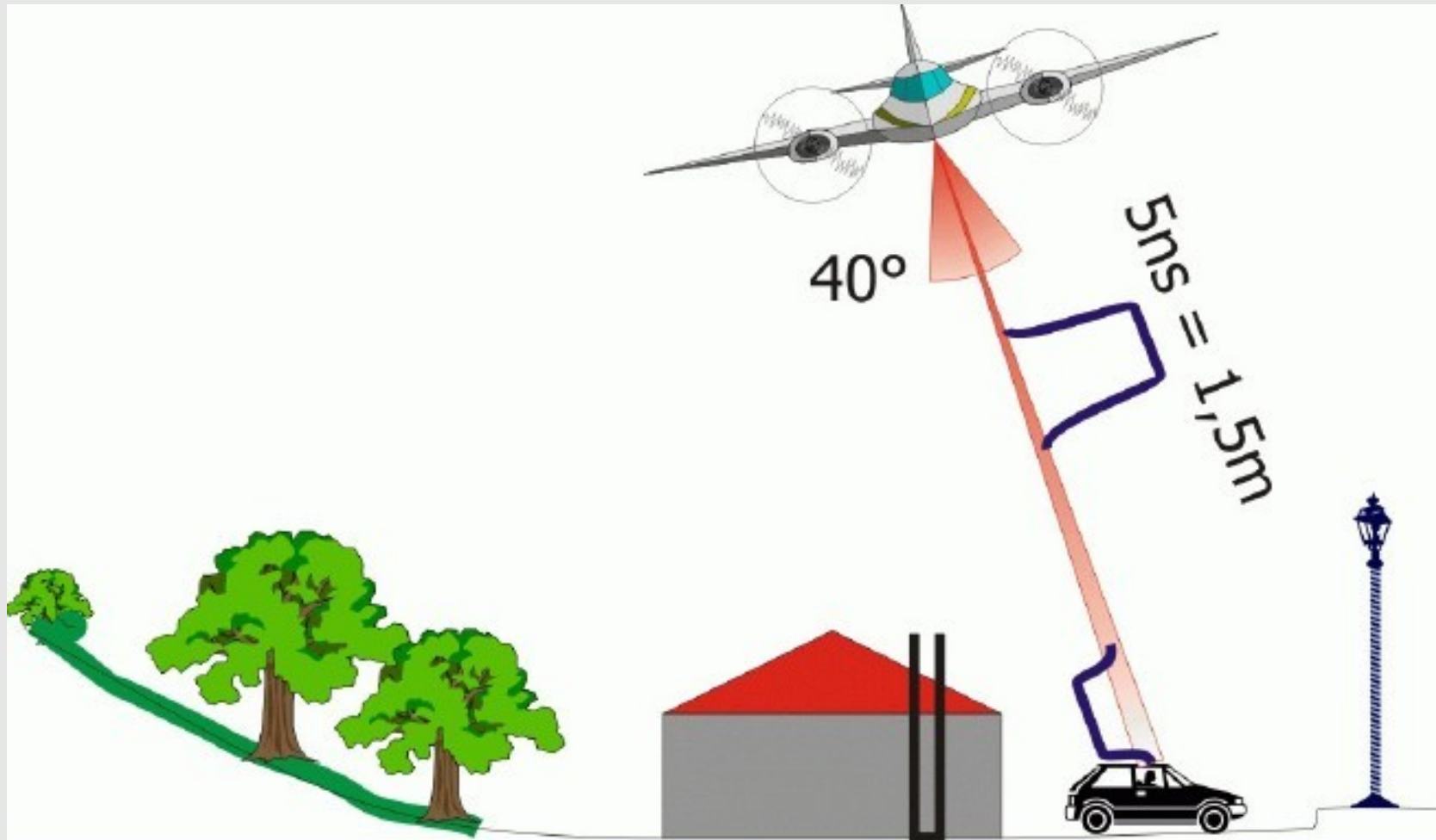
3. Plugin en QGIS

- Flujo de trabajo LiDAR
- Módulos

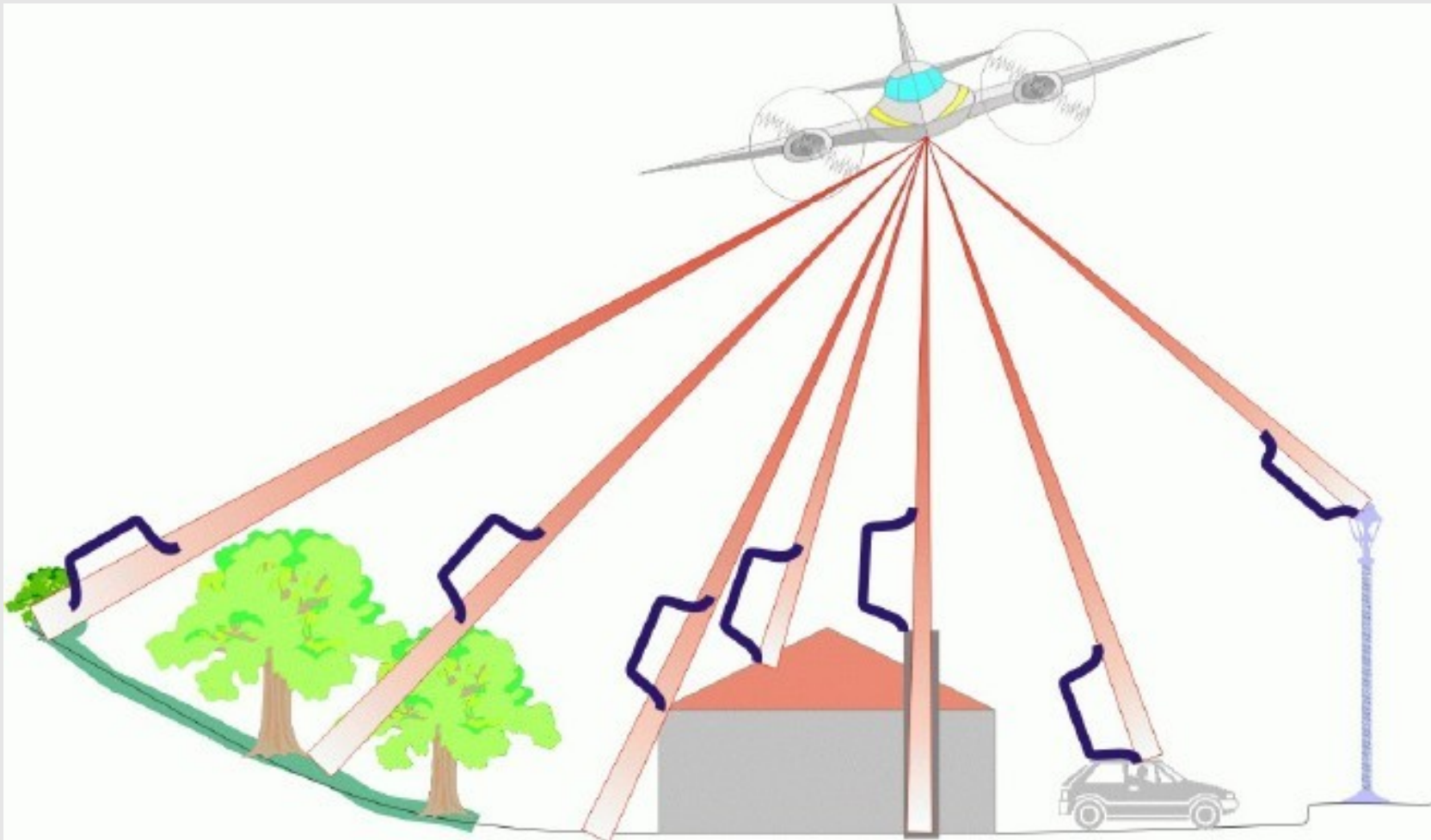
4. Conclusiones

MOTIVACIONES

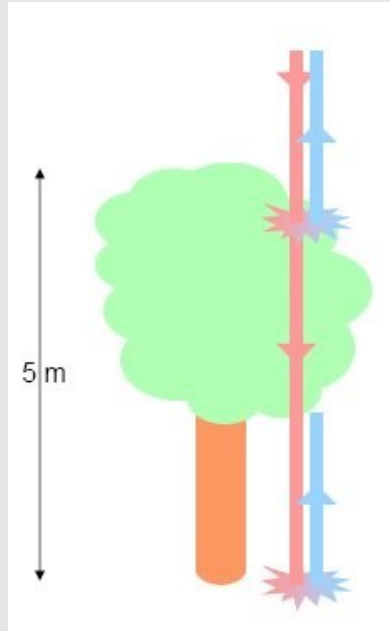
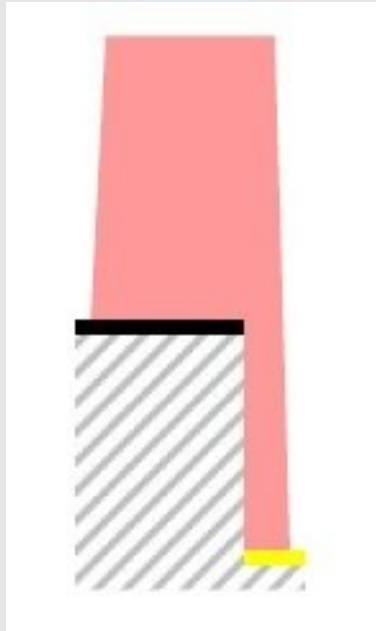
Qué es LiDAR?



Qué es LiDAR?



Qué es LiDAR?



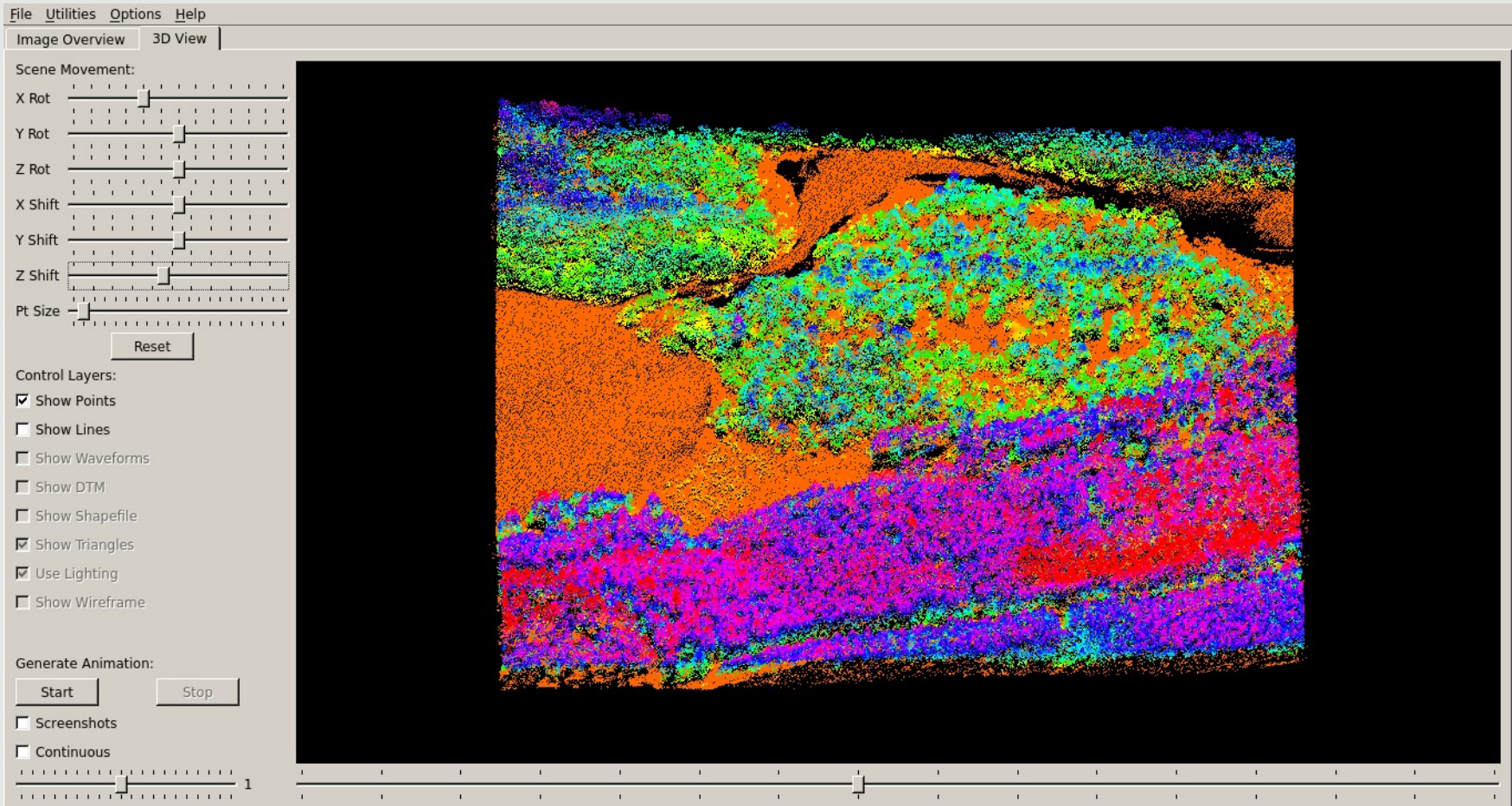
Varios impulsos:

- **FIRST**
- **LAST**

Actualmente hasta **5**

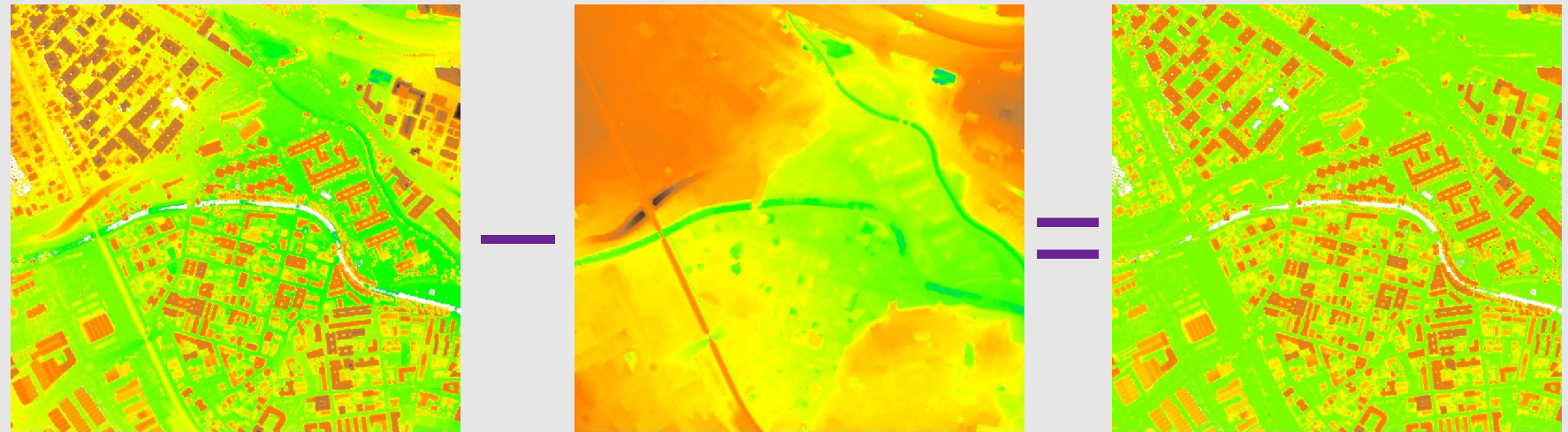
Datos LiDAR

1. Millones y millones de puntos
2. Fichero LiDAR estándar **LAS**, **LAZ** (comprimido)



Productos básicos

MDS – MDT = nMDS



Problema: Millones de puntos

1. Cada retorno (Tiempo, distancia, ángulo escaneo, intensidad, coordenadas...): Más de **40 bytes**

2. Ejemplo: $100 \text{ km}^2 \times 1 \text{ p/m}^2$

- $10000 \times 10000 \times 4 \times 26 \text{ bytes} \approx \mathbf{10.43Gb}$

3. Caso real: $20 \times 25 \text{ km}^2 \times 5 \text{ p/m}^2 \approx \mathbf{160Gb}$

4. Algoritmos especiales

- Clasificación
- Manipulación del volumen de información

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4. Algoritmos especiales

- Clasificación
- Manipulación del volumen de información

Herramientas

1. TerraScan y TerraSolid

- Microstation (CAD)
- Software privativo

2. LASTools

- Librería libre (LGPLv3) para I/O formato **LAS**
- Conjunto de herramientas: Software privativo

3. LibLAS

- Librería libre (GPLv3) para I/O formato **LAS**

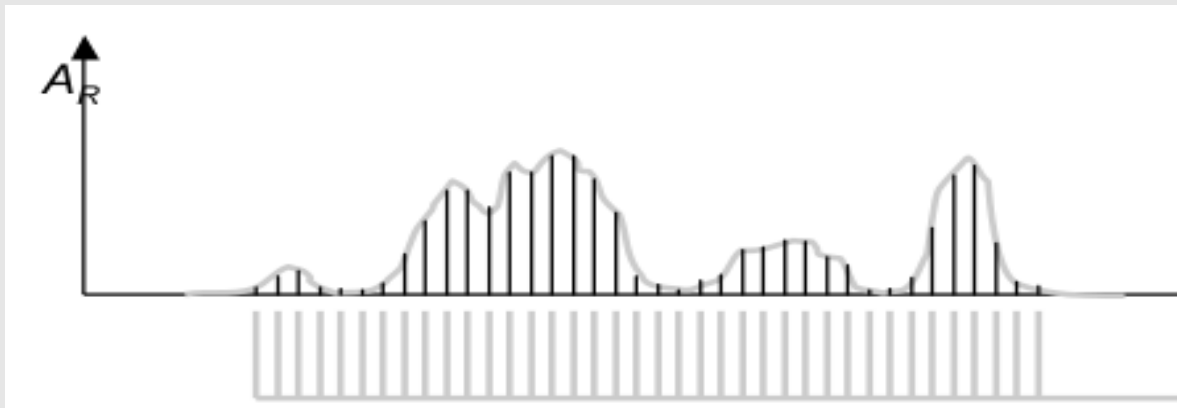
4. FUSION

- Gratuito pero cerrado

HERRAMIENTAS SPD LIB

SPDLib

1. Librerías para I/O datos LiDAR
2. Conjunto de herramientas para la **manipulación, procesamiento y análisis** LiDAR:
 - **ALS** (Aerotransportado)
 - **TLS** (Terrestre)
 - ***Full waveform***



SPDLib

1. Libres: PGLv3
2. C++
3. Bindings para Python
4. Multiplataforma
5. <http://www.spdlib.org/>

Por qué SPDlib?

Function	FUSION	LASTools	SPDlib	Terrascan
License	BSD	LGPL / Commercial	GPL3 / MIT-X	Commercial
Source Code	Closed	Mixed Open / Close	Open	Close
Import LAS/ASCII	Yes	Yes	Yes	Yes
Raster formats	ASCII / Binary	ASCII / GTIFF	GDAL	ASCII / Proprietary
Canopy Height Metrics	Yes	Yes	Yes	No
Point Cloud Z Metrics	No	No	Yes	No
Intensity Metrics	No	No	Yes	No
Metrics Calculator	No	No	Yes	No
Ground Classification	Yes	Yes	Yes	Yes
Merge Point Clouds	Yes	Yes	Yes	Yes
Interpolate Surfaces	Yes	Yes	Yes	Yes
Assign RGB Values	No	Yes	Yes	Yes
Tile Point Cloud	No	Yes	Yes	Yes
Mosaic Rasters	Yes	No	Yes	Yes
Data Indexing	No	Yes	Yes	Yes
Waveform Processing	No	No	Yes	No

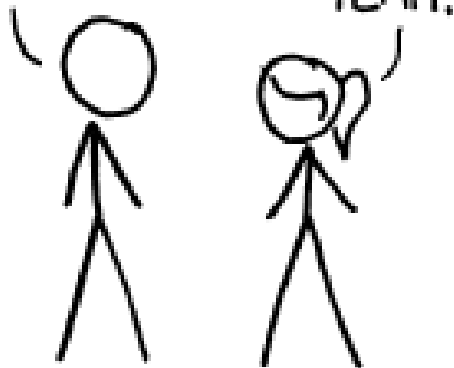
Inconvenientes

Nuevo formato **SPD** (Sorted Pulse Data)

HOW STANDARDS PROLIFERATE:
(SEE: A/C CHARGERS, CHARACTER ENCODINGS, INSTANT MESSAGING, ETC.)

SITUATION:
THERE ARE
14 COMPETING
STANDARDS.

14?! RIDICULOUS!
WE NEED TO DEVELOP
ONE UNIVERSAL STANDARD
THAT COVERS EVERYONE'S
USE CASES.



SOON:

SITUATION:
THERE ARE
15 COMPETING
STANDARDS.

SPDLib Tools

- Management tools:
 - **spdcopy**: Makes a copy of an indexed SPD file
 - **spddefiles**: Tools for defining a set of tiles ✓
 - **spdextract**: Extract returns and pulses which meet a set of criteria
 - **spdmerge**: Merge compatible files into a single non-indexed SPD file ✓
 - **spdproj**: Print and convert projection strings
 - **spdtiling**: Tools for tiling a set of SPD files using predefined tile areas ✓
 - **spdthin**: Thin a point cloud to a defined bin spacing
 - **spdtranslate**: Convert between file formats ✓
 - **spdssubset**: Subset point cloud data ✓
- Info tools:
 - **spdinfo**: Print header info for an SPD File ✓
 - **spdlastest**: Print data pulses from a LAS file - for debugging
 - **spdstats**: Provides statistics the point and pulse density of an SPD file
 - **spdversion**: Prints version information
- Interpolation methods:
 - **spdwarp**: Apply a nonlinear warp to the SPD file defined by a set of GCPs
 - **spdinterp**: Interpolate a raster elevation surface ✓

SPDLib Tools

- Terrain filters:
 - **spdmccgrd**: Classifies the ground returns using the multiscale curvature algorithm ✓
 - **spdpffgrd**: Classifies the ground returns using a parameter-free filtering algorithm
 - **spdpmfgrd**: Classifies the ground returns using the progressive morphology algorithm ✓
 - **spdplygrd**: Classify ground returns using a surface fitting algorithm
- Forest tools:
 - **spdmetrics**: Calculate metrics ✓
- Heights:
 - **spdefheight**: Alter the elevation of the pulses ✓
 - **spdprofile**: Generate vertical profiles
- Miscellaneous
 - **spdclearclas**: Clear the classification of an SPD file
 - **spdmaskgen**: Generate a binary mask for the an input SPD file
 - **spdoverlap**: Calculate the overlap between UPD and SPD files
 - **spdtiling**: Tools for mosaicing raster results following tiling

SPDLib Tools

1. Ejemplo:

Transformar de LAS a SPD

```
$ > spdtranslate -i fichero_LAS.las -o fichero_SPD.spd \  
    --if LAS --of SPD -x FIRST_RETURN
```

Transformar de LAZ a SPD

```
$ > spdtranslate -i fichero_LAZ.laz -o fichero_SPD.spd \  
    --if LAS --of SPD -x FIRST_RETURN
```

Consultar metadatos

```
$ > spdinfo fichero_SPD.spd
```

PLUGIN EN QGIS

Plugin SDPlib en QGIS

1. **Qué?** Interfaz gráfica para las herramientas SPDlib
2. **Dónde** se integra? *Processing* ToolBox
3. **Cómo?** *Python 2.7*
4. **Por qué** QGIS? Modularidad, capacidad, prestaciones, es **libre** y... es **FÁCIL**

SDPlib en QGIS: Cómo?

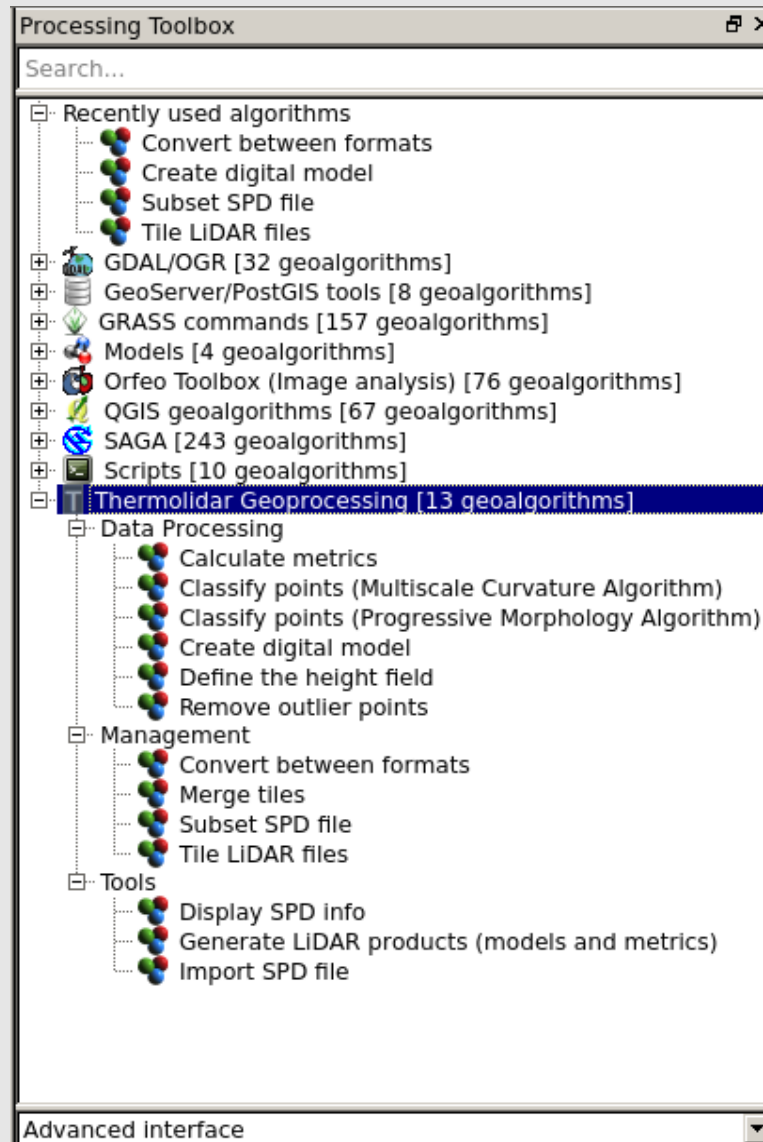
Librerías

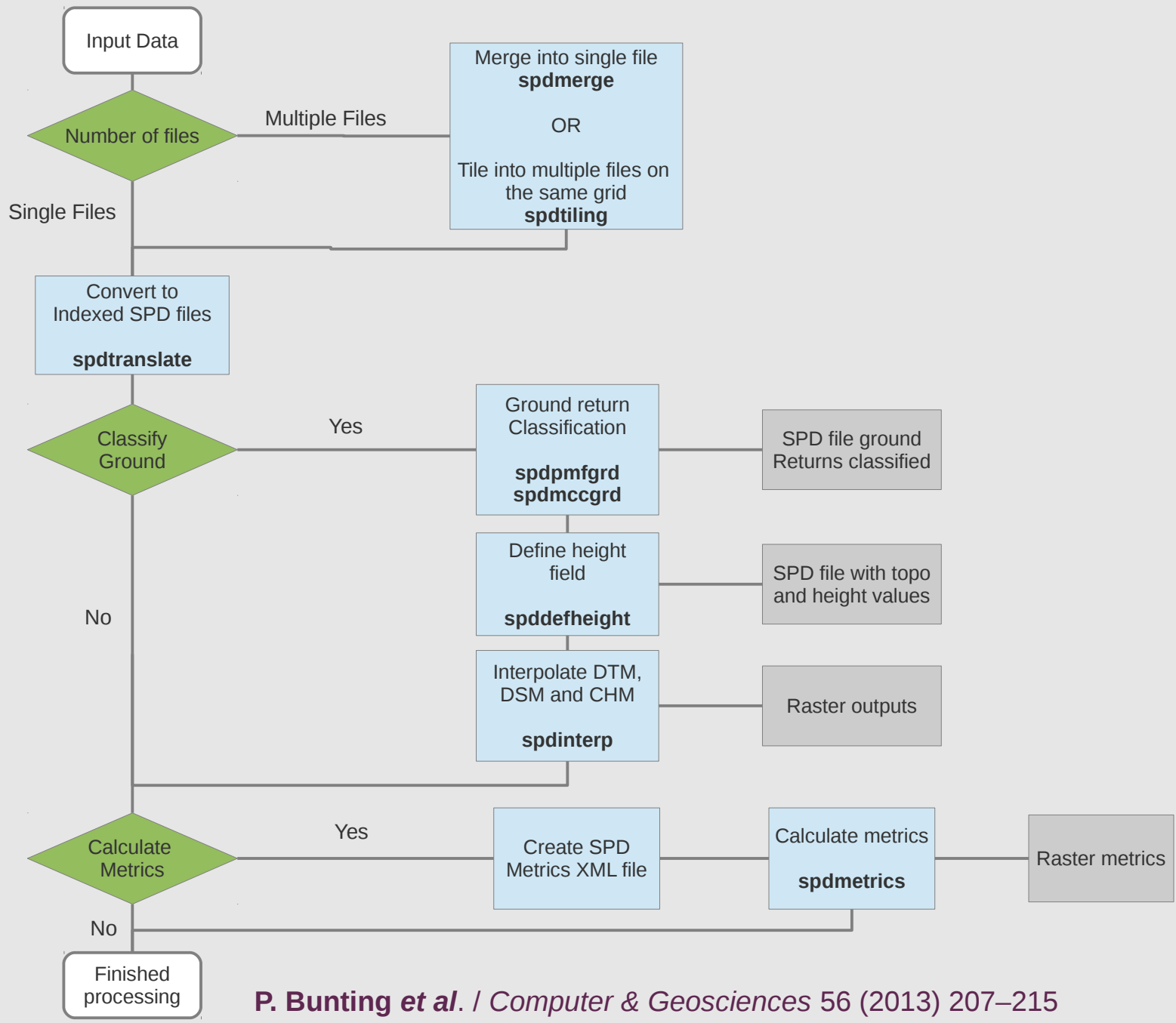
```
from processing.thermolidar.process.lidar.SPDToolsUtils import SPDToolsUtils
from processing.thermolidar.process.lidar.SPDToolsAlgorithm import SPDToolsAlgorithm
from processing.parameters.ParameterRaster import ParameterRaster
from processing.outputs.OutputHTML import OutputHTML
```

Parámetros

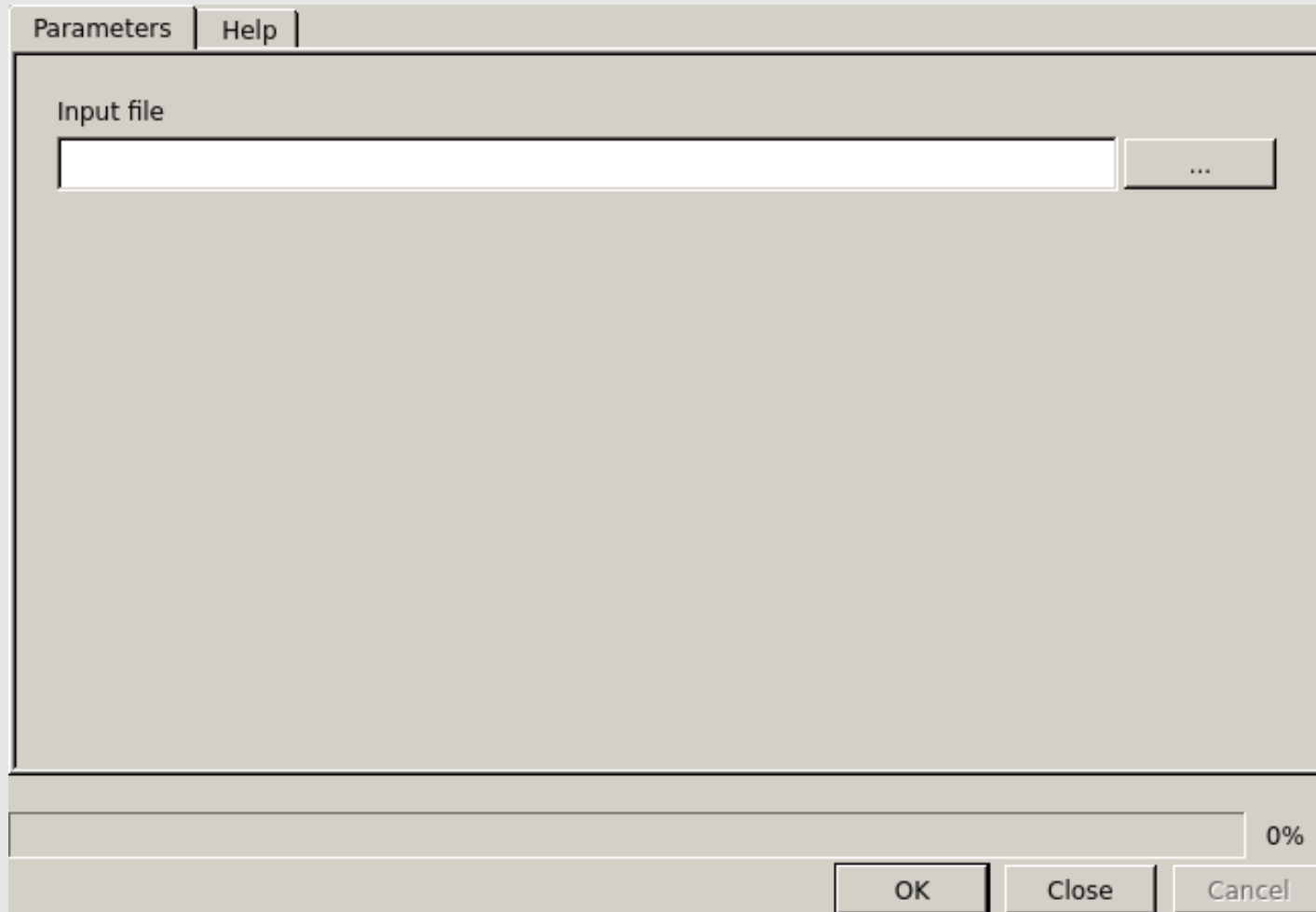
```
self.addParameter(ParameterFile(spinfo.INPUT, "Input layer"))
self.addOutput(OutputHTML(spinfo.OUTPUT, "Output file"))
```

Processing Toolbox

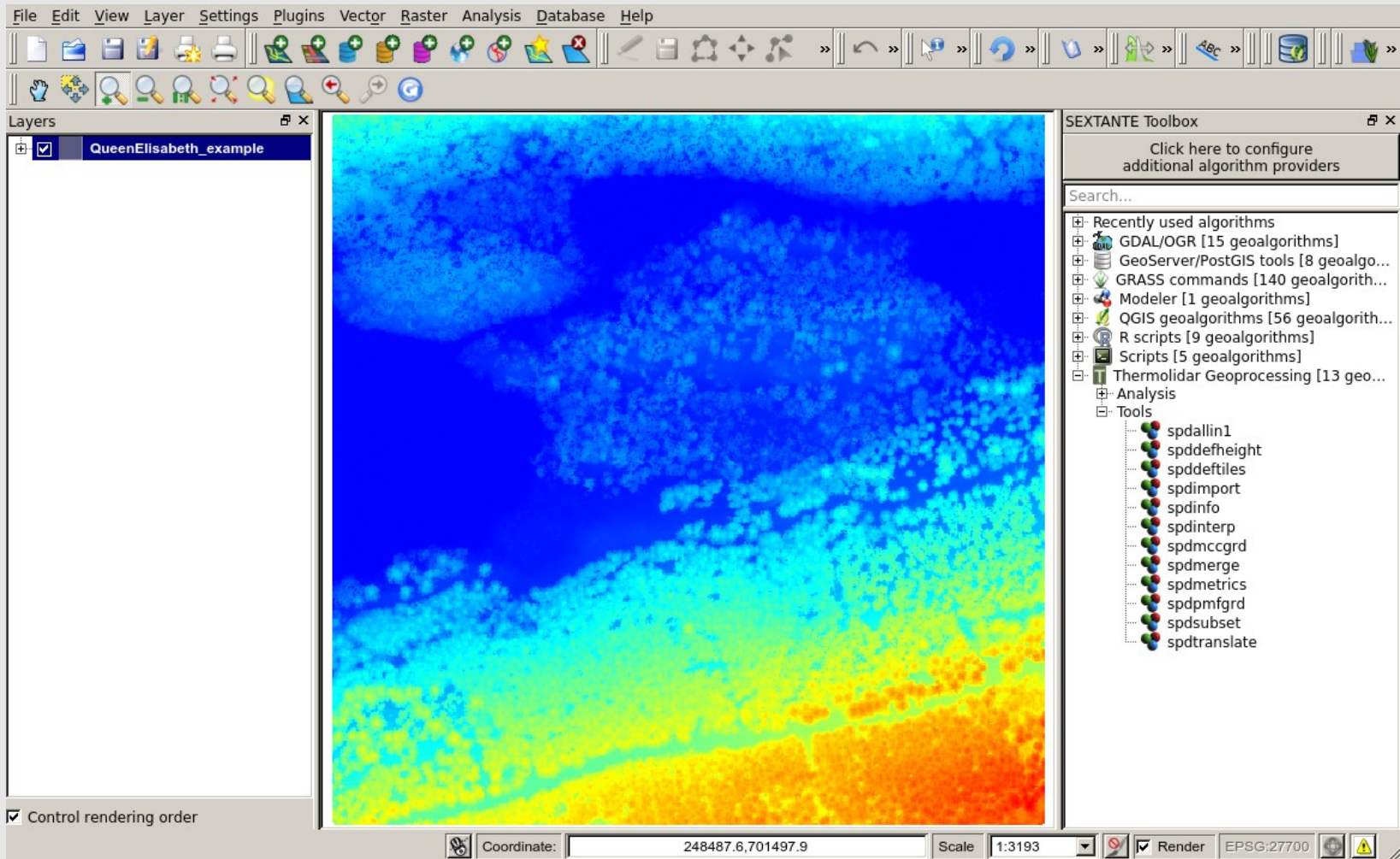




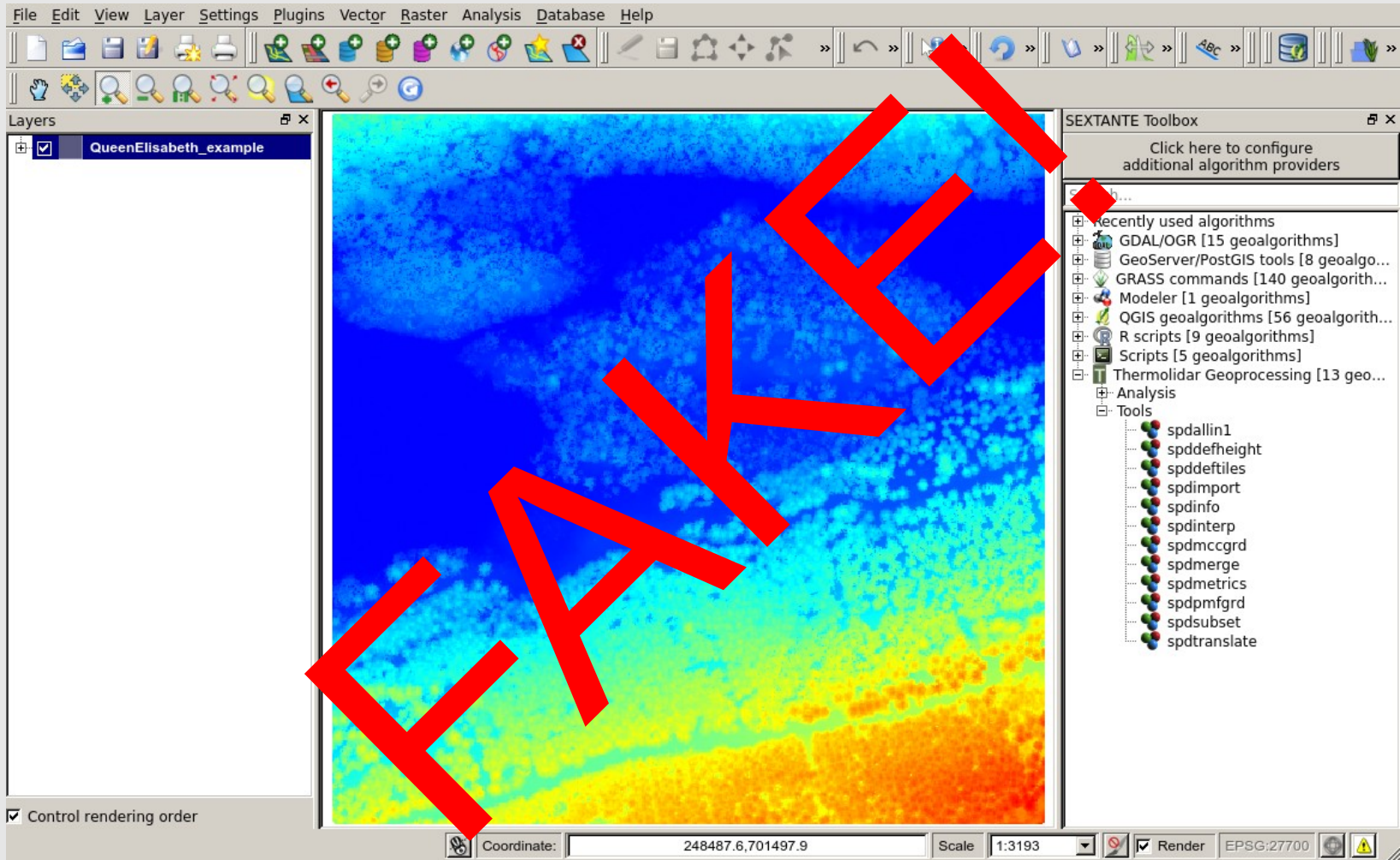
Importar datos



Importar datos



Importar datos



Clasificar puntos: Algoritmo morfológico progresivo (PMF)

1. Input

2. Output

3. Bin size:

- Indexado de puntos

4. Class:

- Clases particulares

The image shows a screenshot of the 'Parameters' dialog box for the PMF (Progressive Morphological Filter) algorithm. The dialog box has a title bar with 'Parameters', 'Log', and 'Help' menus. It contains various input fields and controls for configuring the algorithm's behavior. The parameters are as follows:

- Input file:** A text field with a browse button (...).
- Only use points of particular class:** A numeric input field set to 0.
- Generated an image rather than classifying points (useful for parameter selection):** A dropdown menu set to '[Not selected]'.
- Bin size for SPD file index:** A numeric input field set to 0.
- Size (in bins) of the overlap between processing blocks:** A numeric input field set to 10.
- Number of columns within a tile (Generates a non-sequential SPD file):** A numeric input field set to 0.
- Number of rows within a tile:** A numeric input field set to 100.
- Size of the median filter (half size i.e., 3x3 is; 5x5 is 2...):** A numeric input field set to 2.
- Do not run a median filter on generated surface (before classifying ground point or export):** A dropdown menu set to 'No'.
- Threshold for deviation from identified ground surface for classifying ground returns:** A numeric input field set to 0.300000.
- Maximum elevation difference threshold:** A numeric input field set to 5.
- Initial elevation difference threshold:** A numeric input field set to 0.300000.
- Slope parameter related to terrain:** A numeric input field set to 0.300000.
- Maximum size of the filter:** A numeric input field set to 7.
- Initial size of the filter (half size i.e., 3x3 is; 5x5 is 2...):** A numeric input field set to 1.
- Output file:** A text field containing '[Save to temporary file]' and a browse button (...).

At the bottom of the dialog box, there is a progress indicator showing '0%' and three buttons: 'Run', 'Close', and 'Cancel'.

Clasificar puntos: Algoritmo curvatura multiescala (MCC)

1. Input

2. Output

3. Bin size:

- Indexado de puntos

4. Class:

- Clases particulares

The image shows a screenshot of a software parameter dialog box titled "Parameters | Log | Help". The dialog contains various input fields and controls for configuring the MCC algorithm. The parameters are as follows:

Parameter	Value
Input file	[...]
Only use points of particular class	0
Bin size for SPD file index	0
Size (in bins) of the overlap between processing blocks	10
Number of columns within a tile (Generates a non-sequential SPD file)	0
Number of rows within a tile	100
Use only multiple return pulses to calculate the amount of change between iterations	No
Median filter to smooth the generated raster instead of an average filter	No
The threshold for the	0.100000
The size of the smoothing filter (half size i.e., 3x3 is 1)	1
The number of points used for the TPS interpolation	16
Maximum search radius for the TPS interpolation	20
Iteration step curvature tolerance parameter	0.500000
Minimum curvature tolerance parameter	0.100000
Initial curvature tolerance parameter	1
Gap between increments in scale	0.500000
The number of scales below the init scale to be used	1
The number of scales above the init scale to be used	1
Initial processing scale (Usually the native resolution of the data)	0
Output file	[Save to temporary file]

At the bottom of the dialog, there is a progress indicator showing "0%" and three buttons: "Run", "Close", and "Cancel".

Definir alturas (respecto al terreno)

Parameters | Log | Help

Input file
 ...

Define the reference for the height
Interpolation

The input elevation image
[Not selected] ...

Interpolator to be used
NATURAL_NEIGHBOR

Bin size for SPD file index
0

Size (in bins) of the overlap between processing blocks
10

Number of columns within a tile, using this option generates a non-sequential SPD files
0

Number of rows within a tile (Default 25)
100

Resolution of the grid index used for some interpolates
0

Resolution of the grid used to thin the point cloud
0

The number of point allowed within a grid cell following thinning
0

Thin the point cloud when interpolating
No

Output file
[Save to temporary file] ...

0%

Run Close Cancel

Definir alturas (respecto al terreno)

1. Input

2. Output

3. Superficie de referencia:

- Interpolación
- Imagen

4. Bin size: Indexado

Crear modelos digitales

Parameters | Log | Help

Input file
[Empty text box] ...

Type of output model
CHM

The interpolator to be used
NATURAL_NEIGHBOR

Bin size for processing and output image - Note 0 will use the native SPD file bin size
0

Size (in bins) of the overlap between processing blocks
10

Number of columns within a tile, using this option generates a non-sequential SPD files
0

Number of rows within a tile (Default 25)
100

Resolution of the grid used to thin the point cloud
0

The number of point allowed within a grid cell following thinning
0

Thin the point cloud when interpolating
No

Output raster
[Save to temporary file] ...

Open output file after running algorithm

0%

Run Close Cancel

Crear modelos digitales

1. Input

2. Output

3. *Bin size*: Resolución

4. Tipo de **modelo**

- MDT
- MDS
- CHM (Modelo de copas = **C**anopy **H**eight **M**odel)

5. Interpolador

- NATURAL_NEIGHBOR: Vecino natural
- NEAREST_NEIGHBOR: Vecino más próximo
- TIN_PLATE: Linear

Visualizar MDS

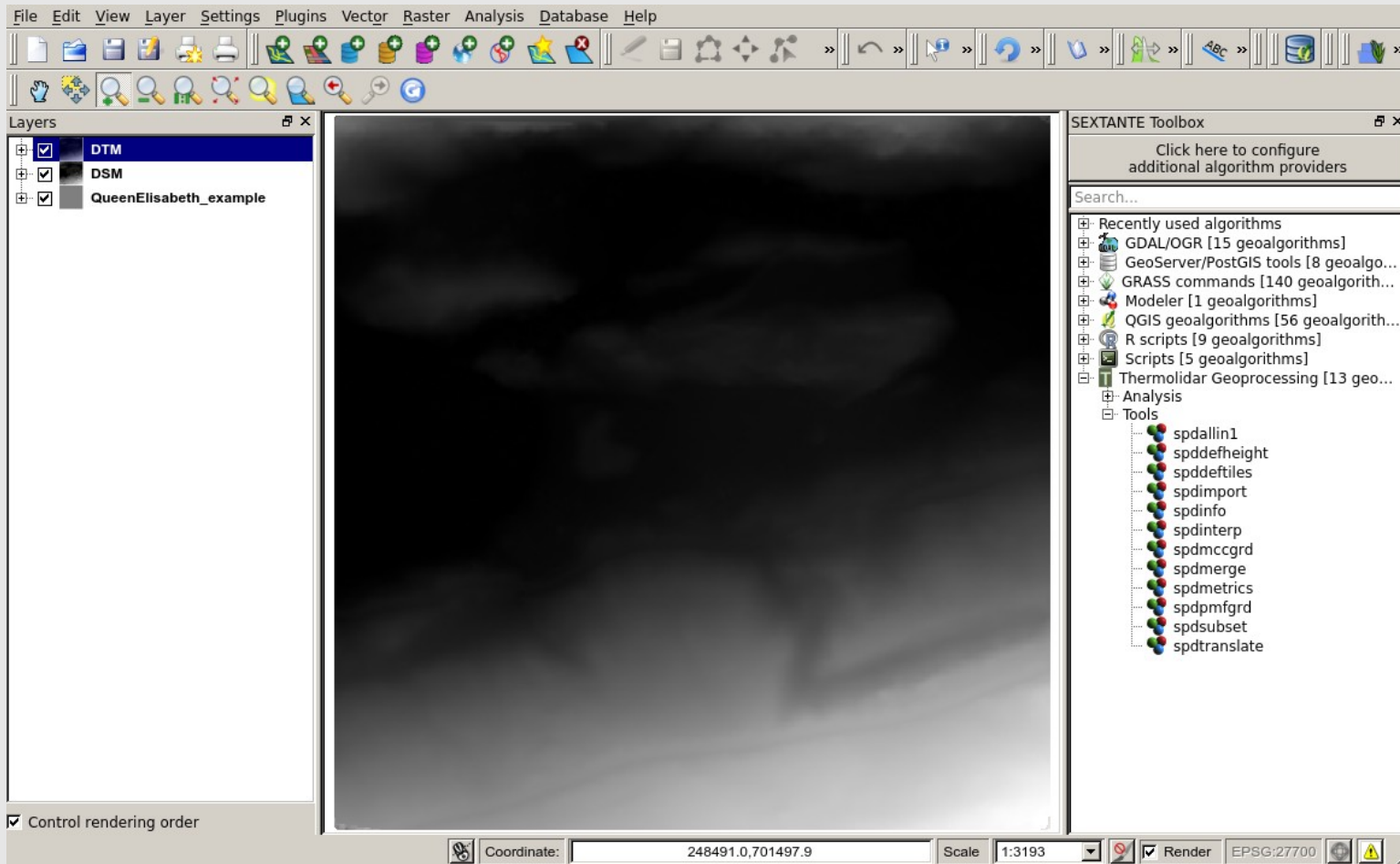
The image shows a screenshot of the QGIS software interface. At the top, there is a menu bar with options: File, Edit, View, Layer, Settings, Plugins, Vector, Raster, Analysis, Database, and Help. Below the menu bar is a toolbar with various icons for file operations, navigation, and analysis. The main window is divided into several panels:

- Layers Panel:** Located on the left, it shows two layers: "DSM" (checked) and "QueenElisabeth_example" (checked).
- Main Canvas:** The central area displays a grayscale image of a terrain, likely a Digital Surface Model (DSM), showing a road and surrounding terrain.
- SEXTANTE Toolbox:** Located on the right, it contains a search bar and a list of algorithms. The "Tools" category is expanded, showing a list of algorithms: spdallin1, spddefheight, spddeftiles, spdimport, spdinfo, spdinterp, spdmccgrd, spdmerge, spdmetrics, spdpmfgrd, spdssubset, and spdtranslate.

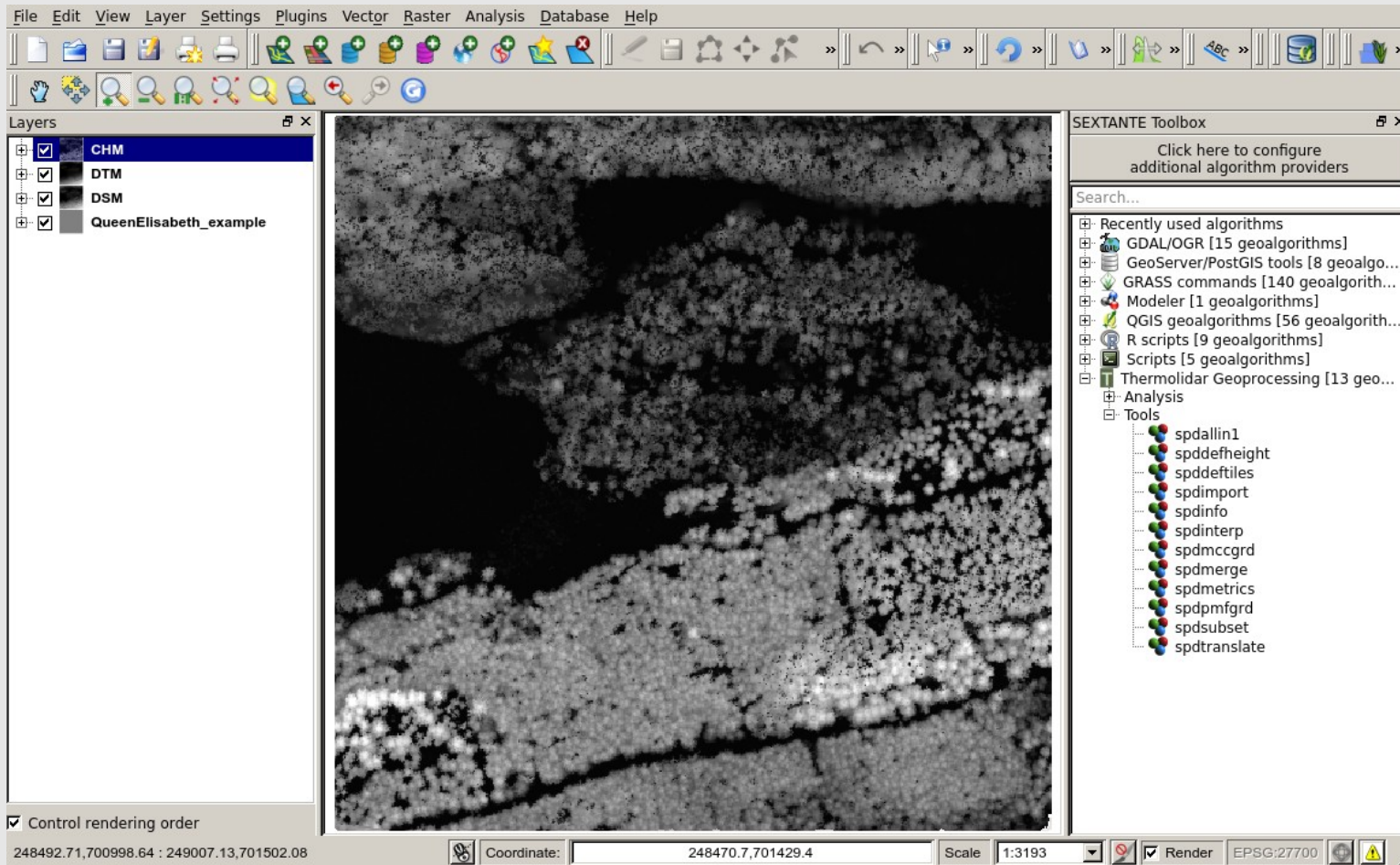
At the bottom of the interface, there is a status bar with the following information:

- Coordinate: 248460.6, 701369.5
- Scale: 1:3193
- Render: Render
- EPSG:27700

Visualizar MDT



Visualizar CHM



Calcular métricas

Parameters | Log | Help

Input SPD file
[Empty text box] ...

XML input file
[Empty text box] ...

Shapefile vector input file
[Not selected] ... [Refresh icon]

Output format
Image

Bin size for SPD file index
0 ...

Number of columns within a tile (Generates a non-sequential SPD file)
0 ...

Number of rows within a tile
100 ...

Output file
[Save to temporary file] ...

Open output file after running algorithm

0%

Run Close Cancel

Calcular métricas

1. Utiliza XML:

- **Metrics:** Nombre de la métrica
- **Field:** El nombre asignado al atributo shp
- **Options:** Opciones relacionadas con la métrica
 - *return*
 - *class*
 - *threshold*

Calcular métricas

```
1 <?xml version="1.0" encoding="UTF-8" ?>
2 <!--
3   Description:
4     XML File for execution within SPDLib
5     This file contains a template for the
6     metrics XML interface.
7
8   Created by Roberto Antolin on Thu Jan 30 16:33:36 2014.
9   Copyright (c) 2014 Roberto Antolin.
10 -->
11
12 <spdlib:metrics xmlns:spdlib="http://www.spdlib.org/xml/">
13   ...<spdlib:metric metric="percentileheight" field="95thPerH" percentile="95" return="All" class="NotGrd" lowthreshold="0.1" />
14   <spdlib:metric metric="meanheight" field="MeanH" return="All" class="NotGrd" lowthreshold="2" />
15   <spdlib:metric metric="numpulses" field="numPulses" minNumReturns="0" />
16   <spdlib:metric metric="divide" field="groundCover" >
17     <spdlib:metric metric="numreturnsheight" field="Out_Name" return="All" class="Grd" upthreshold="40" />
18     <spdlib:metric metric="numreturnsheight" field="Out_Name" return="All" class="All" upthreshold="40" />
19   </spdlib:metric>
20   <spdlib:metric metric="divide" field="CanopyCover" >
21     <spdlib:metric metric="numreturnsheight" field="Out_Name" return="All" class="NotGrd" upthreshold="40" />
22     <spdlib:metric metric="numreturnsheight" field="Out_Name" return="All" class="All" upthreshold="40" />
23   </spdlib:metric>
24 </spdlib:metrics>
```

1. metrics: *percentilheight*

2. field: *95thPerH*

3. options:

- Percentile: *95%*
- return: *All*
- class *NotGrd*
- lowthreshold: *0.1*

Calcular métricas: Percentil 95%

The screenshot displays the QGIS interface with a heatmap visualization of metrics. The main window shows a grid of colored cells representing different values. The 'Layers' panel on the left lists several layers: 'metrics' (checked), 'CHM', 'DTM', 'DSM', and 'QueenElisabet...'. The 'metrics' layer is expanded to show a legend with five color-coded categories: 1 (dark blue), 26.3333 (light blue), 51.6667 (yellow), 77 (orange), and 1 (red). The 'SEXTANTE Toolbox' on the right lists various algorithms, with 'spdmetrics' highlighted under the 'Analysis' > 'Tools' category. The status bar at the bottom indicates the coordinate (248489.8, 701072.9), scale (1:3508), and projection (EPSG:27700).

File Edit View Layer Settings Plugins Vector Raster Analysis Database Help

Layers

- metrics
 - 1
 - 26.3333
 - 51.6667
 - 77
- CHM
- DTM
- DSM
- QueenElisabet...

SEXTANTE Toolbox

Click here to configure additional algorithm providers

Search...

Recently used algorithms

- spdinfor
- spdpmfgrd
- spdmccgrd
- spddefheight
- spdinterp
- spdimport

GDAL/OGR [15 geoalg...]

GeoServer/PostGIS too...

GRASS commands [14...]

Modeler [1 geoalgorith...]

QGIS geoalgorithms [5...]

R scripts [9 geoalgorit...]

Scripts [5 geoalgorith...]

Thermolidar Geoproc...

Analysis

Tools

- spdallin1
- spddefheight
- spddeftiles
- spdimport
- spdinfor
- spdinterp
- spdmccgrd
- spdmmerge
- spdmetrics**
- spdpmfgrd
- spdssubset
- spdtranslate

Coordinate: 248489.8,701072.9 Scale 1:3508 Render EPSG:27700

CONCLUSIONES

Conclusiones

1. **LiDAR** requiere de mucha capacidad y algoritmos especiales por su volumen de datos
2. **No** existen herramientas totalmente libres
3. **SPDlib** es una herramientas libre para la manipulación de datos LiDAR, con capacidad para
 - **Procesar**: teselar, clasificar y determinar alturas
 - **Generar modelos**: MDT, MDS, NmDs
 - **Generar métricas**
4. SPDlib se ha integrado en **QGIS** como puglin basado en módulos

Procesado de datos LiDAR en QGIS con SPDlib

GRACIAS!

E-mail: Roberto.antolin@forestry.gsi.gov.uk

Twitter: @Tolanss

