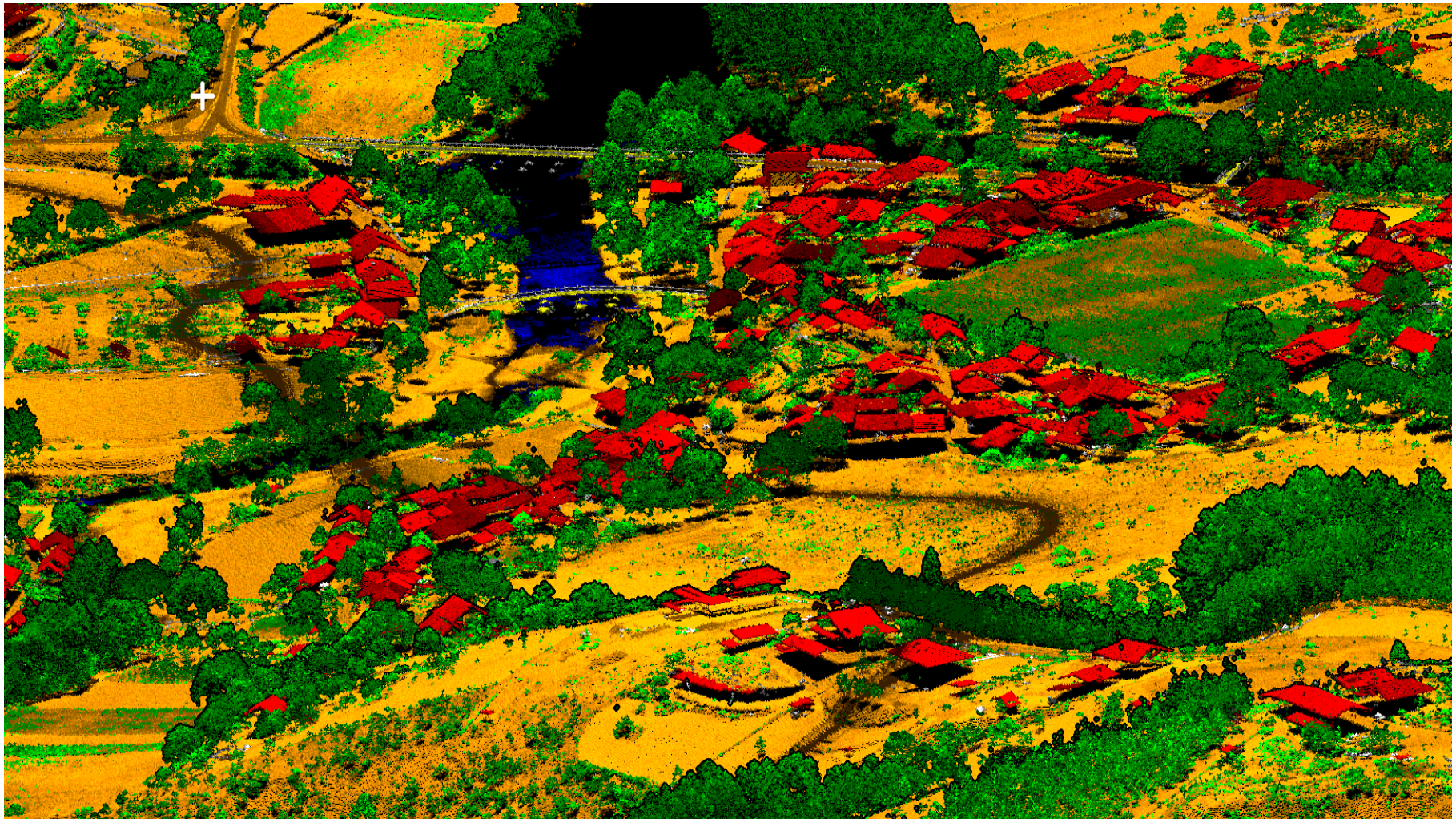
LiDAR survey for Portugal mainland



Marisa Silva – Direção-Geral do Território

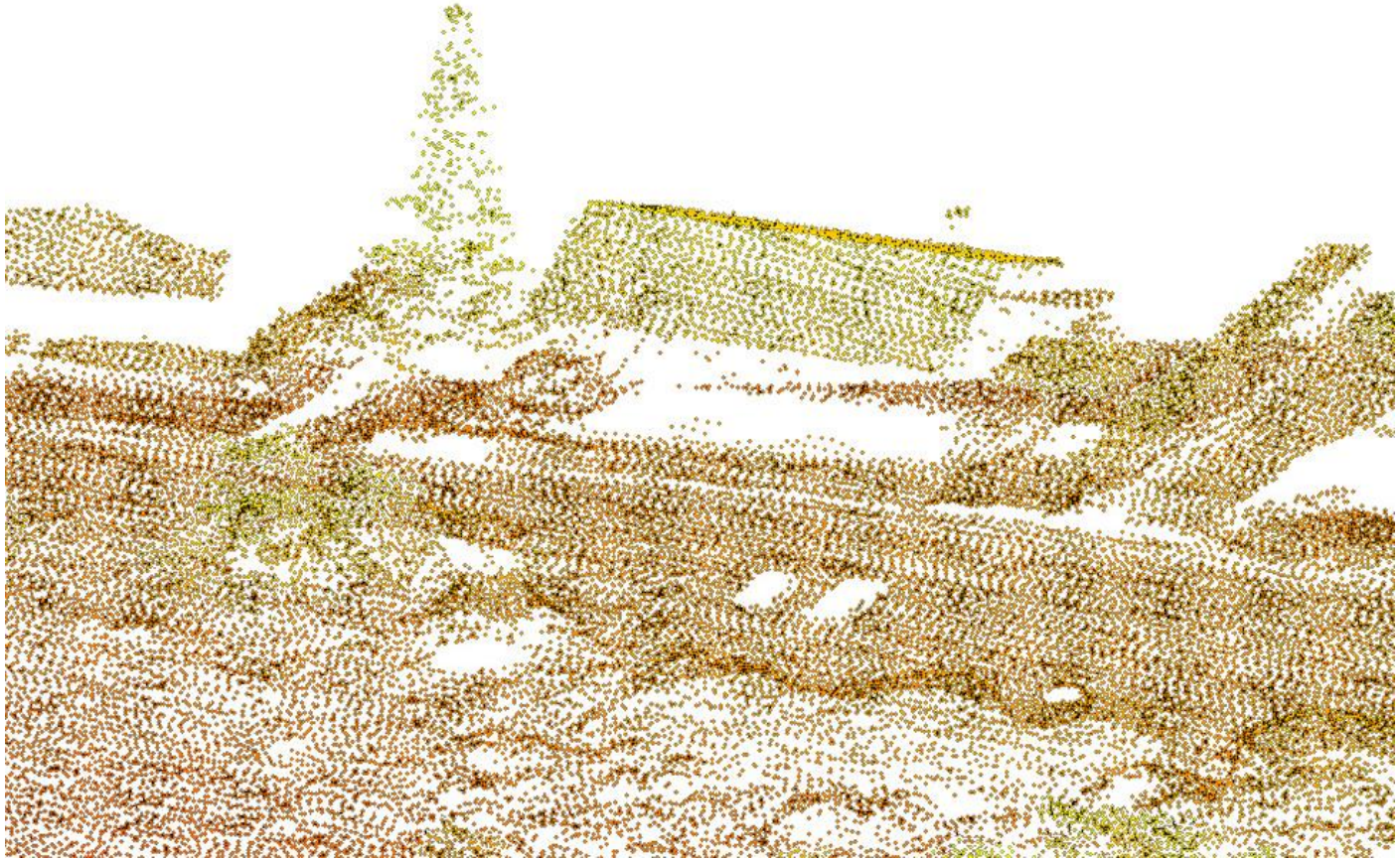
PRR Plano de Recuperação e Resiliência
REPÚBLICA PORTUGUESA
Financiado pela União Europeia NextGenerationEU
SMOS Sistema de Monitorização da Ocupação do Solo
d.gTerritório

Motivation

- LiDAR technology enables terrain elevation mapping within a short timeframe while ensuring high altimetric positional accuracy
- This technology offers significantly higher efficiency compared to alternative data acquisition methodologies used to generate Terrain and Surface Models (DTM and DSM)
- Mainland Portugal lacks a homogeneous, up-to-date, and high-precision DTM
- Accurate territorial altimetry data is critical across multiple activity sectors

Applications

Widespread utility across diverse sectors of activity



- Agriculture
- Environment Infrastructure
- Archaeology
- Public Works
- Energy
- Spatial Planning
- Forestry
- Nature Conservation
- Civil Protection
- Telecommunications
- Urban Planning
- Municipal Management
- Insurance....

Financing

Recovery and Resilience Plan

Component 08 – Forest

Investment RE-C08-i2

Rural Property Cadastre and Land Cover Monitoring System:

Land Cover Monitoring System (LCMS) (or Land Use and Land Cover Monitoring System)

Cadastre preservation system and accreditation system for property cadastre technicians under the National Cadastre System (SNCP)

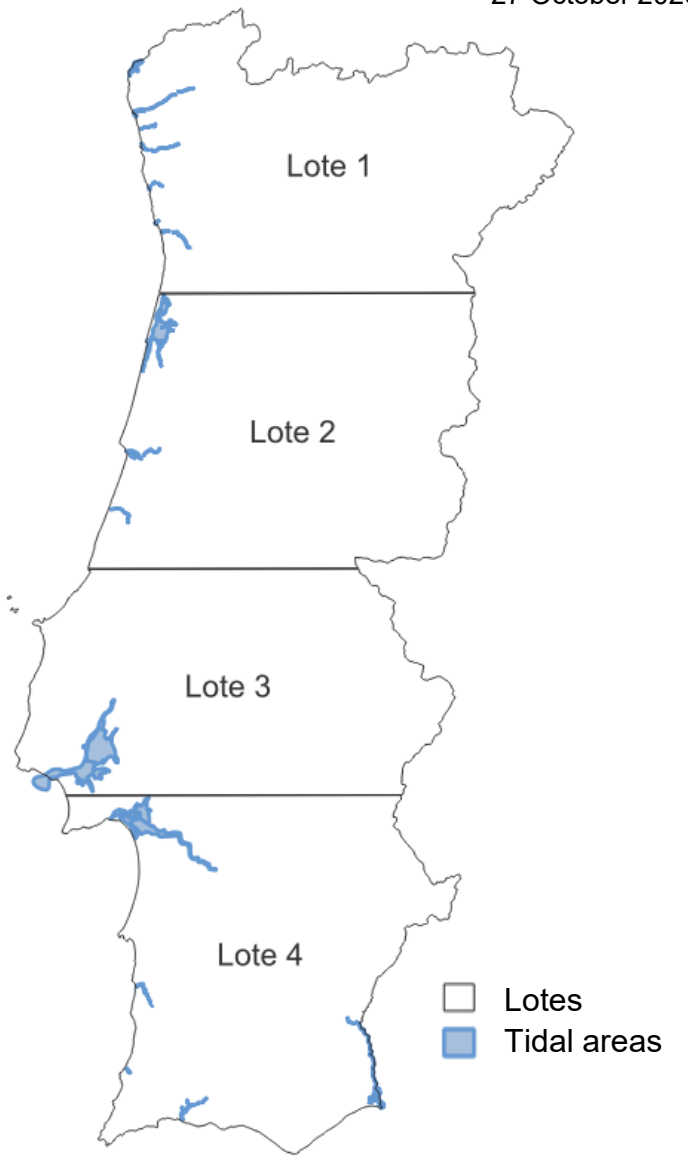
Work Packages

Lote 1 – Group Viamapa / S.T.I.

Lote 2, 3 e 4 – SOCARTO

Quality control - Firemap

Technical advisory - Fullwave



Sensors

- **LiDAR Sensor:**
  - Linear-mode sensor
  - Pulse wavelength in the infrared spectrum
  - Pulse repetition frequency (PRF) of 400 kHz or higher
  - Capability to record at least 4 returns per pulse

- **Digital Aerial Photogrammetric Camera:**
  - Spatial resolution of 0,25 m or higher
  - Radiometric resolution of 8 bits or higher
  - 4-band spectral composition: Red, Green, Blue and Near-Infrared (NIR)

Equipment

Aircrafts



Piper PA-31T2 Cheyenne II XL



Partenavia P-68



PA31T Cheyenne

Equipment

LiDAR sensors



Galaxy T2000

Teledyne Optech



RIEGL VQ-780 II-S

RIEGL

Equipment

Aerial cameras and others



PhaseOne iXU-RS1000



PhaseOne iXM-RS 150F – RGB

PhaseOne iXM-RS 100 – NIR

Support systems

- GNSS system
- Inertial Navigation System (IMU/INS)

Point cloud

Point cloud – LAS format

LAS Specification v.1.4 - R15

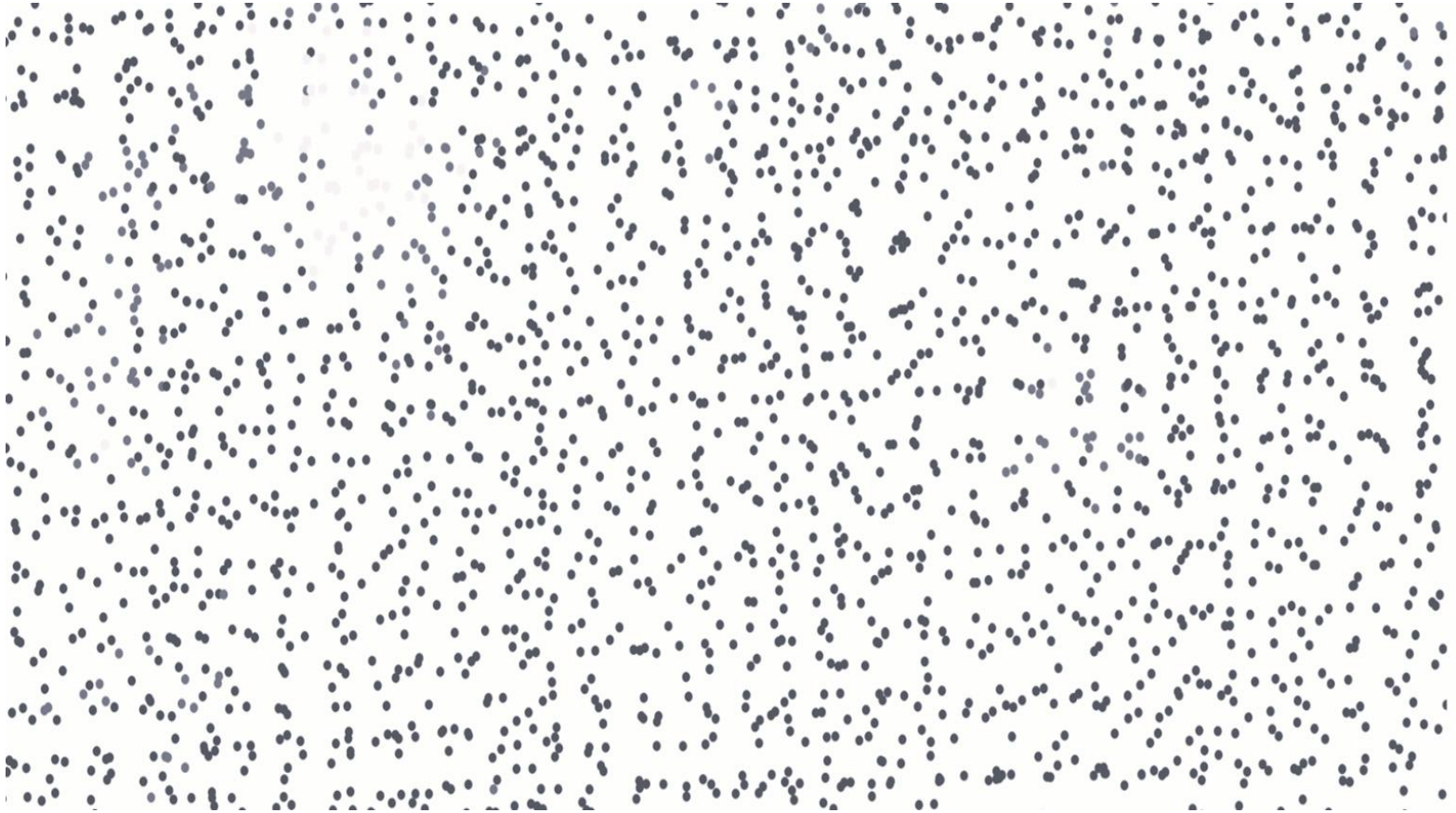
ASPRS -American Society for Photogrammetry & Remote Sensing

Point Data Record Format 8

Also supplied as compressed LAZ file

Item	Format
X	long
Y	long
Z	long
Intensity	unsigned short
Return Number	4 bits (bits 0-3)
Number of Returns (Given Pulse)	4 bits (bits 4-7)
Classification Flags	4 bits (bits 0-3)
Scanner Channel	2 bits (bits 4-5)
Scan Direction Flag	1 bit (bit 6)
Edge of Flight Line	1 bit (bit 7)
Classification	unsigned char
User Data	unsigned char
Scan Angle	short
Point Source ID	unsigned short
GPS Time	double
Red	unsigned short
Green	unsigned short
Blue	unsigned short
NIR	unsigned short

Point cloud



Average density:

10 points/m^2

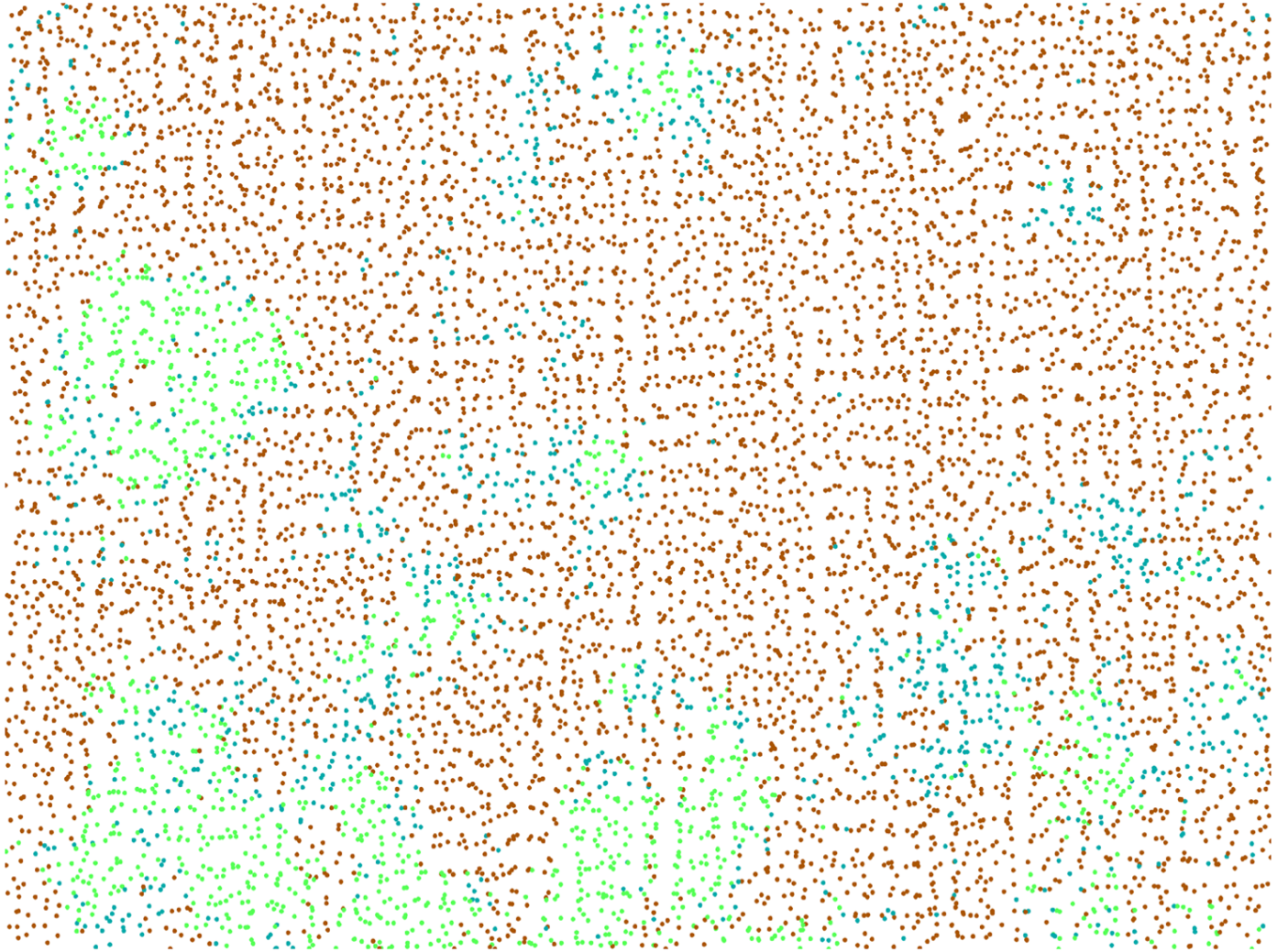
Altimetric accuracy:

10 cm

Planimetric accuracy:

30 cm

Point cloud



Classification

1 – Unclassified

2 – Ground

3 – Low Vegetation (0 m – 0,5 m)

4 – Medium Vegetation (0,5 m – 2 m)

5 – High Vegetation (above de 2 m)

6 – Building

7 – Low Pont (Noise)

9 – Water

26 – Bridge

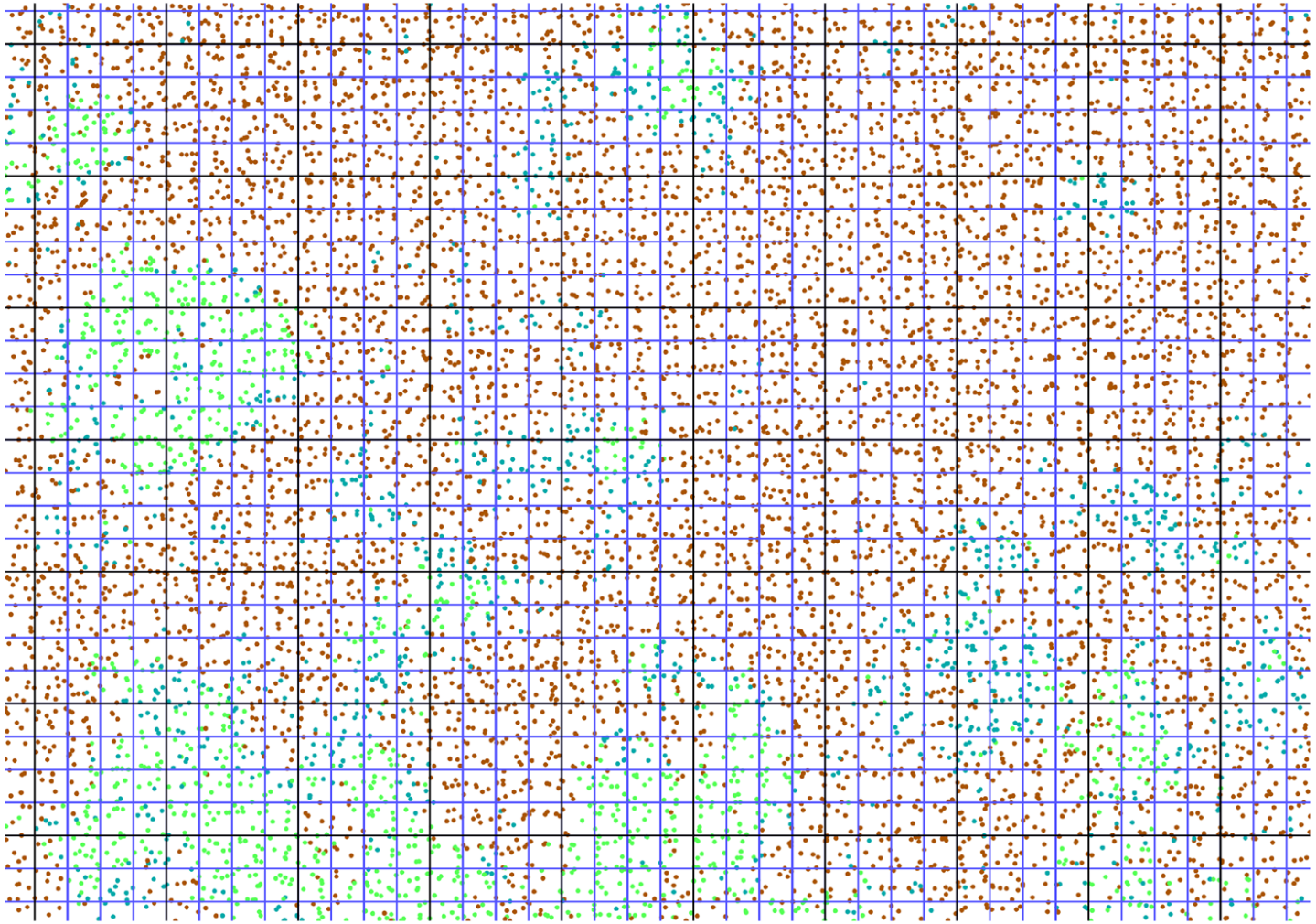
Classification error:

Ground: 1%

Other Classes: 10%

DTM and DSM

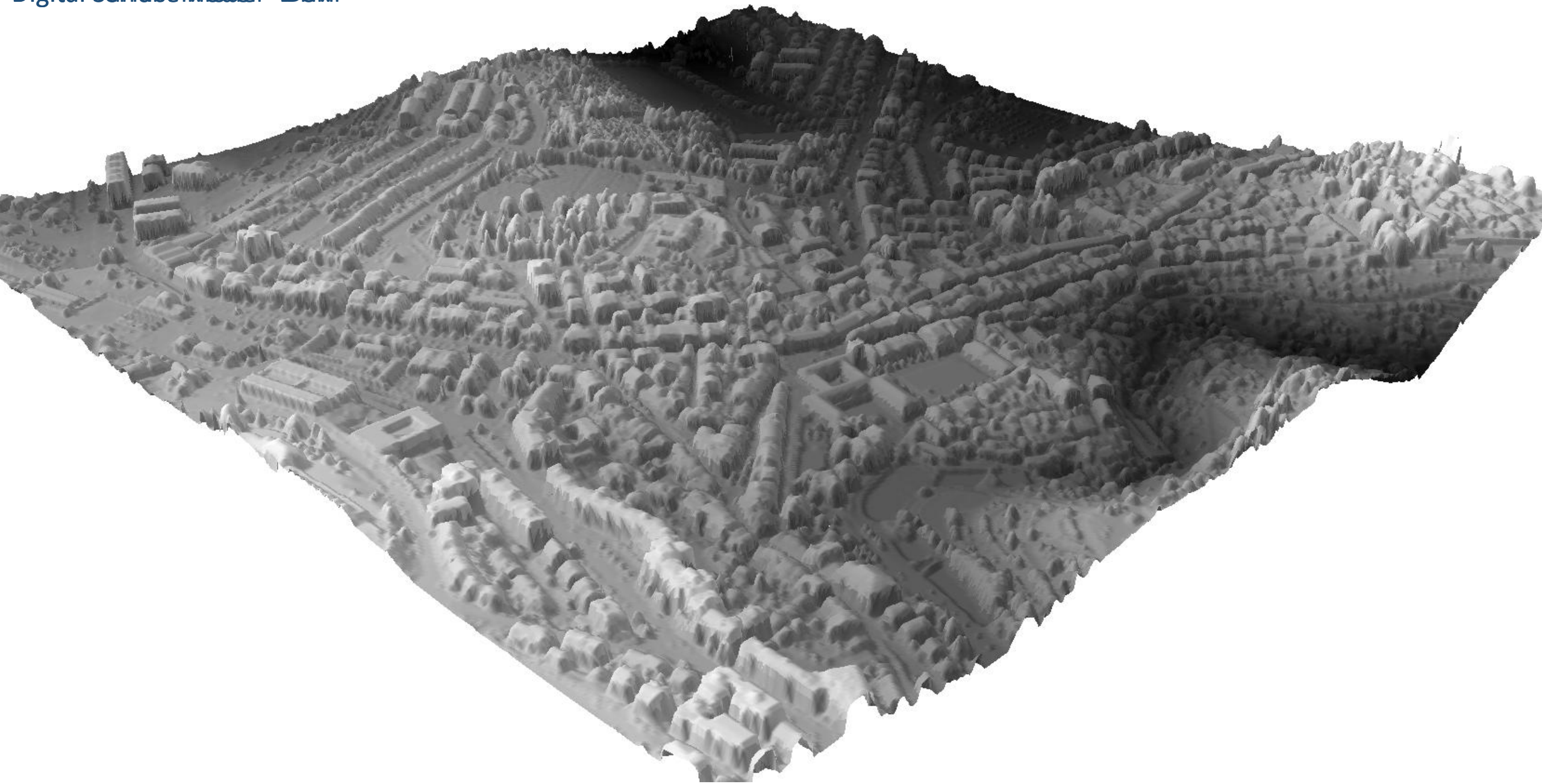
Resolution: 2 m **Resolution: 50 cm**



DTM
2 – Ground

DSM
1 – Unclassified
2 – Ground
3 – Low Vegetation
4 – Medium Vegetation
5 – High Vegetation
6 – Building
26 – Bridge

Digital Surface Model – DSM



Data volume



Data volume

Altimetry – final products

LAZ files: ~ 15,5 TB

MDT and MDS: ~ 2,3 TB

Other deliverables

~ 100 TB

Data distribution

DGT in collaboration with:

CNCA - Centro Nacional de Computação Avançada



- Hosting the CDD (Download Data Centre) platform
- Processing and visualization services

https://www.acnca.pt

LABORATÓRIO DE INSTRUMENTAÇÃO
E FÍSICA EXPERIMENTAL DE PARTÍCULAS

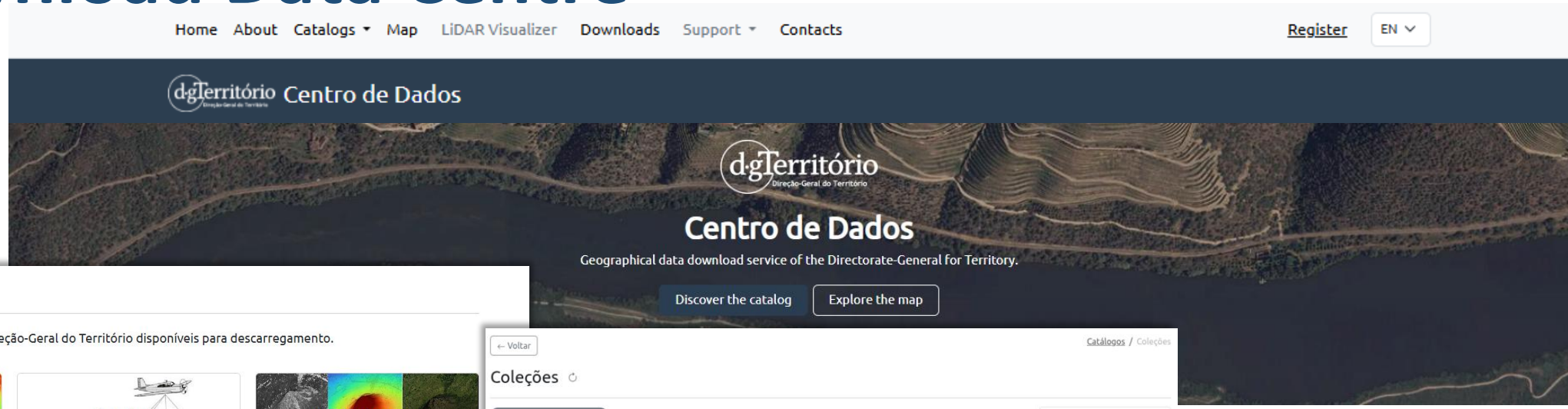
The leading institution for experimental particle physics and associated technologies in Portugal.
Particle Physics, Instrumentation and Methods, Computing.

- Developing the CDD platform
- Developing processing and visualization services

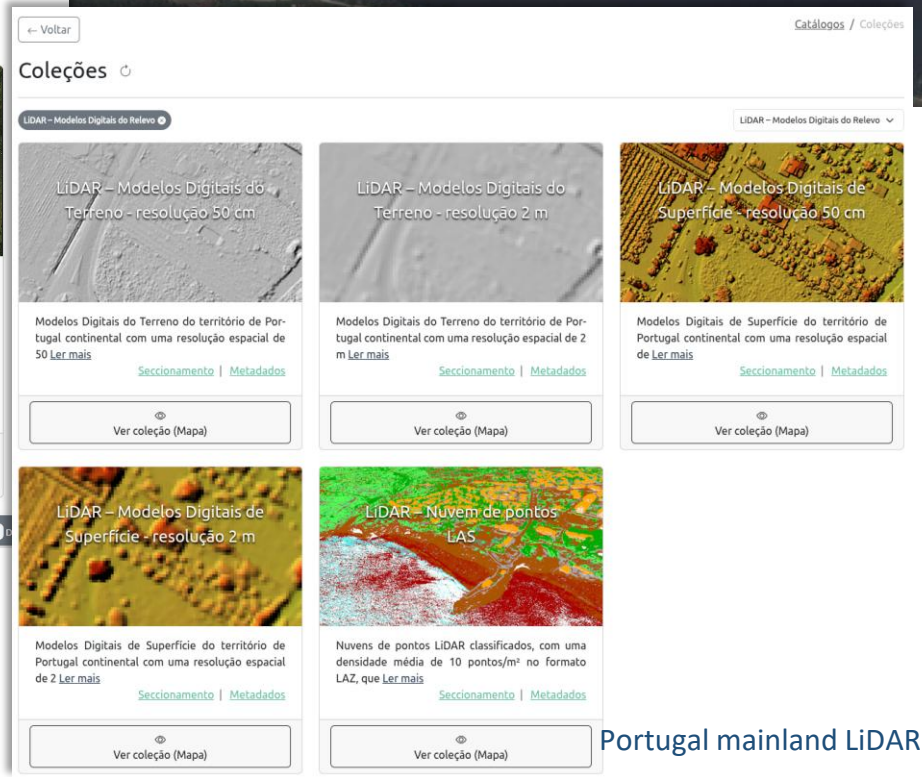
https://www.lip.pt/

DGT Download Data Centre

https://cdd.dgterritorio.gov.pt/







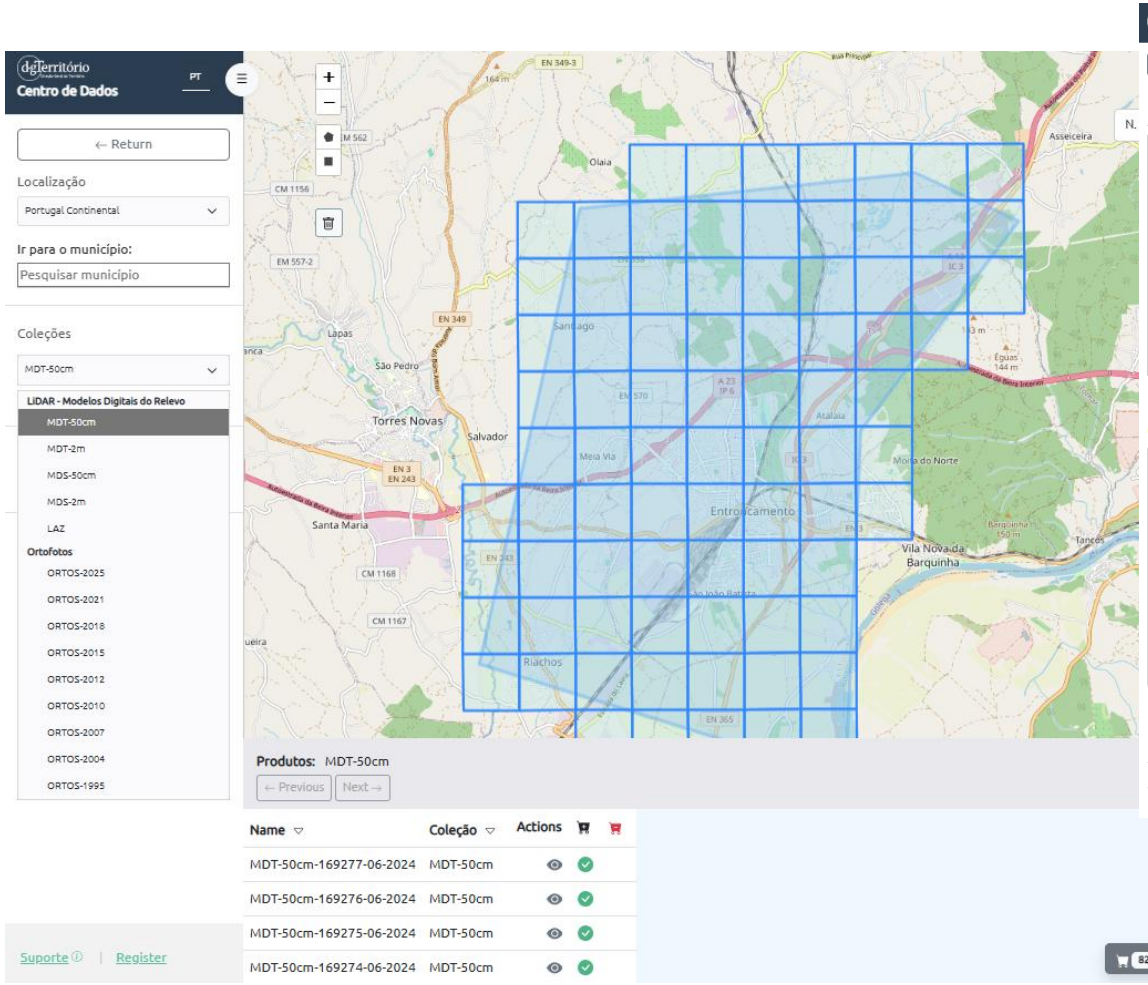
LiDAR catalogue ⇒ Collections

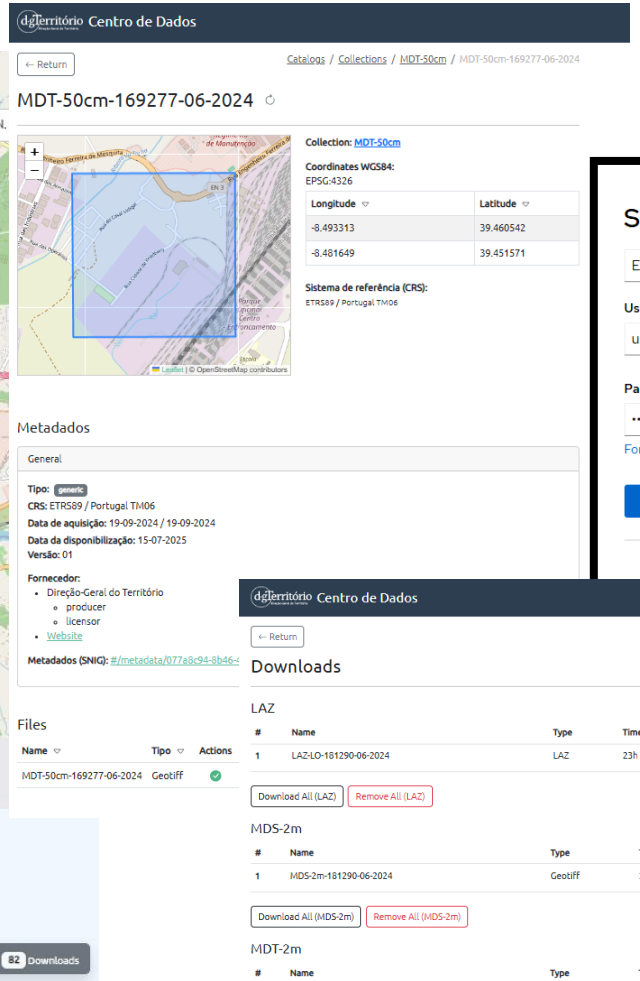
1. DTM 50 cm
2. DTM 2m
3. DSM 50 cm
4. DSM 2 m
5. LAZ

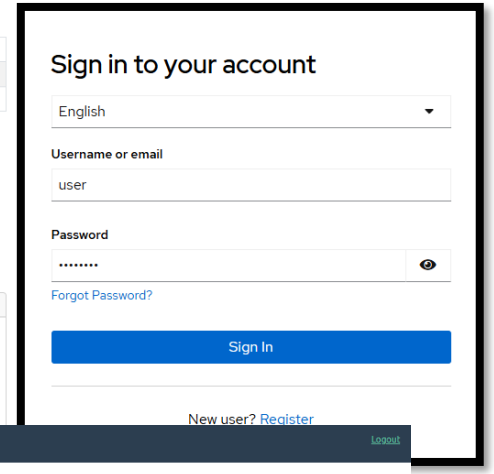
Portugal mainland LiDAR 2024-2025

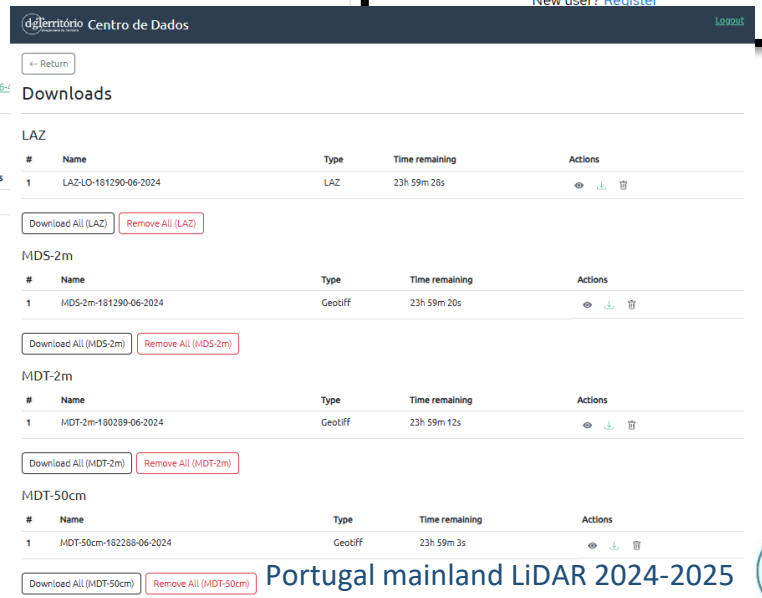
DGT Download Data Centre

https://cdd.dgterritorio.gov.pt/





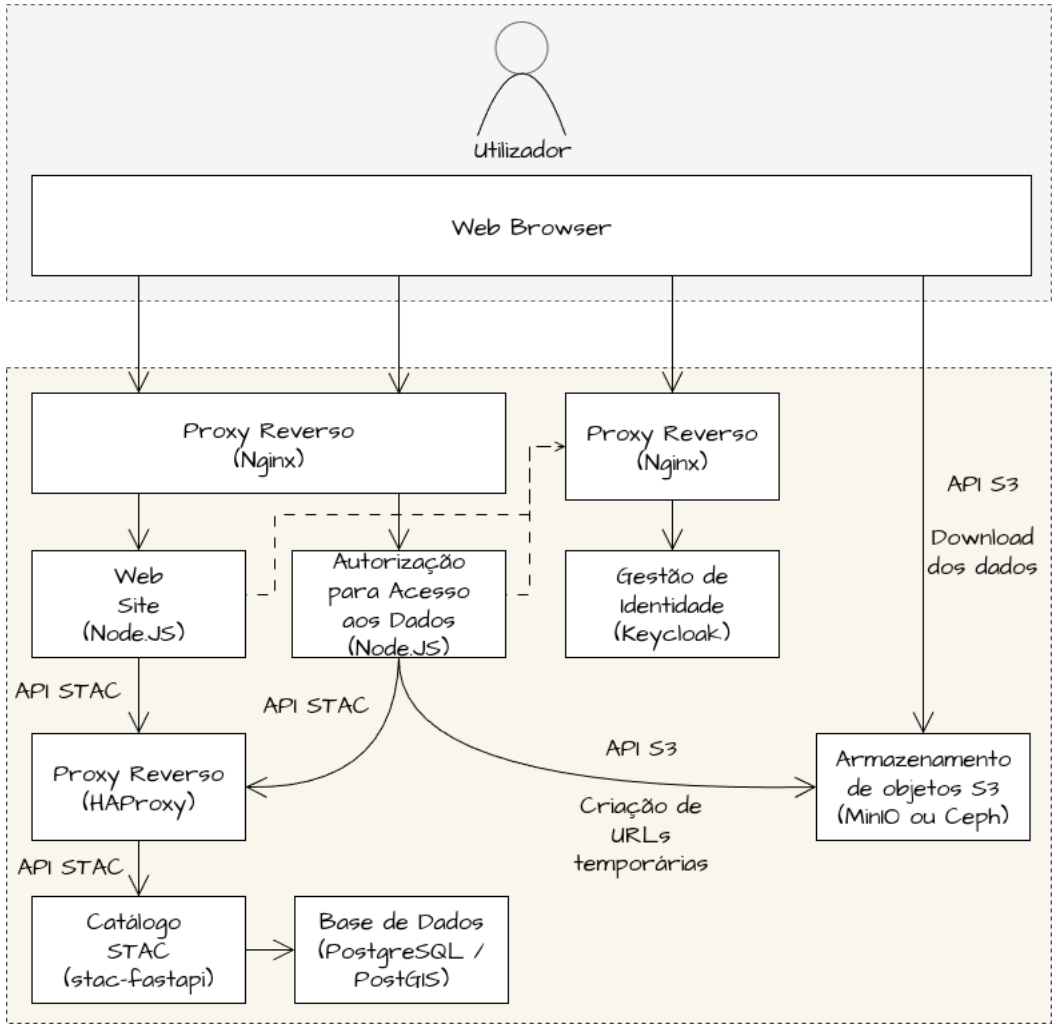




Portugal mainland LiDAR 2024-2025

DGT Download Data Centre

https://cdd.dgterritorio.gov.pt/



STAC Catalogue:

- Collections Metadata
- Based on eoAPI (stac-fastapi, PgSTAC, PostGIS)

Data storage:

- S3 object storage

Web interface:

- JavaScript + Node.JS + Express e EJS
- Leaflet + Openstreetmaps
- Keycloak
- HAProxy
- Nginx

Ingestion:

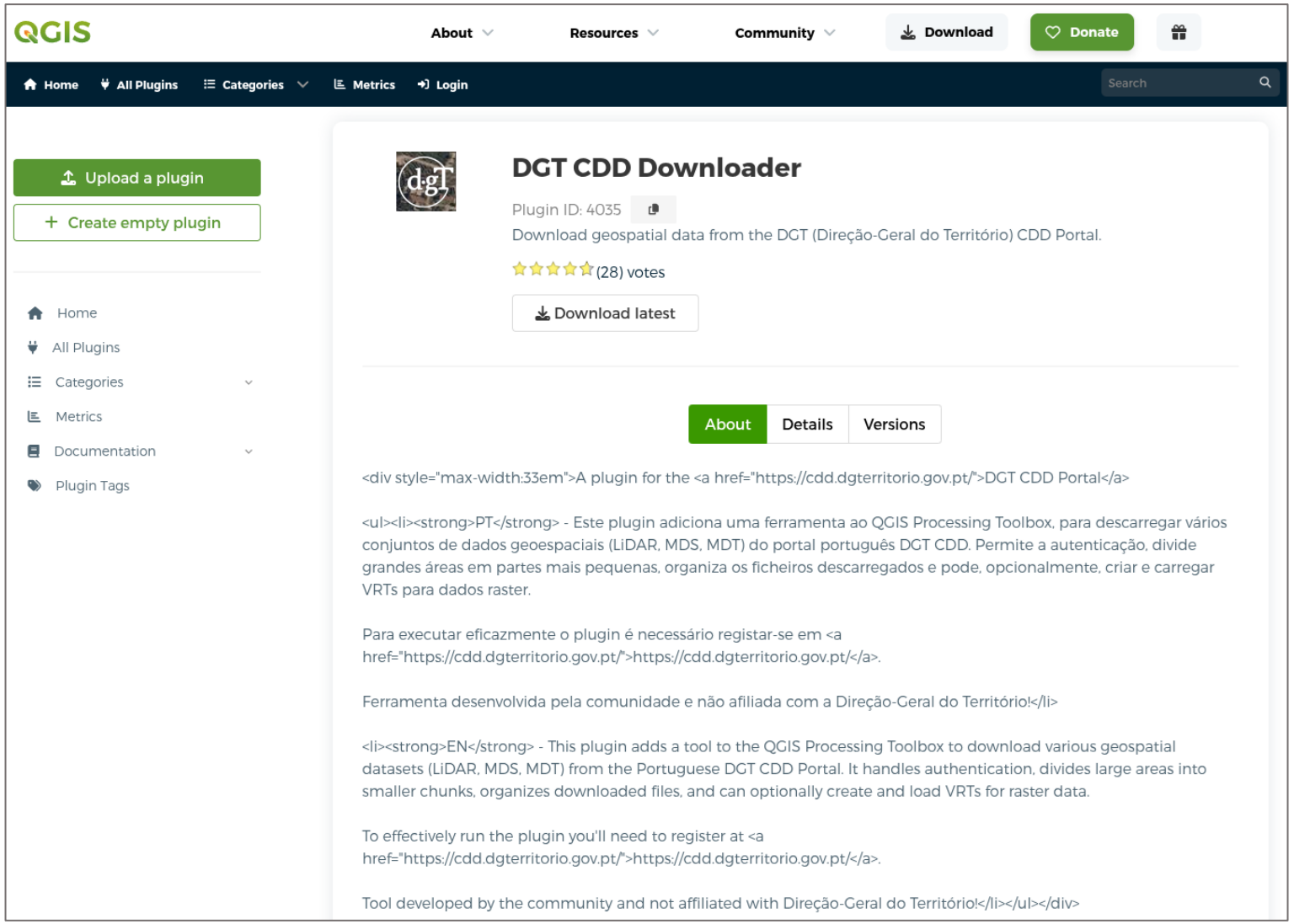
- Python scripts
- PDAL

Code management and deployment:

- GitLAB + Containers

LiDAR

QGIS DGT CDD Downloader Plugin



QGIS Plugin facilitates data downloading

It is a community-driven development and is independent of DGT

A collaboration has been established to align the maintenance of both the plugin and the CDD

LiDAR Processing

Aiming at making the processing of DGT LiDAR data easier

CNCA provides a JupyterHub platform:

- enable processing of the DGT LiDAR data close to the data storage servers
- uses CNCA computing resources in the same datacenter where the data is stored

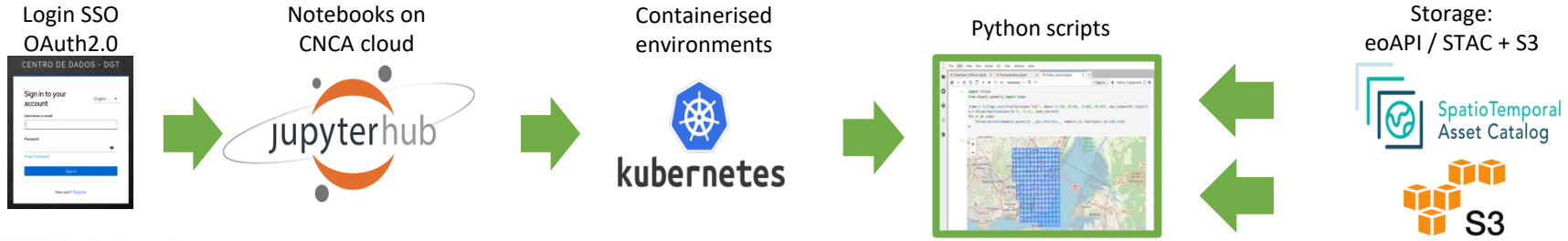
The JupyterHub platform allows fast direct access to:

- metadata through the STAC catalogue API
- data from the collections LAZ, DTM e DSM through the object storage system
- avoid having to download data to the user device
- avoid having to use the download web interface to access the data

Independent of the Jupyter platform, users with computing projects at the CNCA will have direct access to the data.

Through the JupyterHub platform the users:

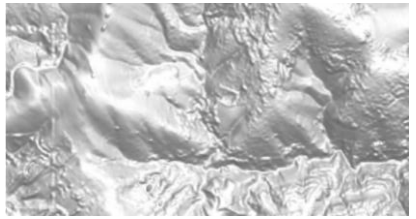
- have access to pre-configured programming environments with relevant tools for LiDAR data processing;
- be able to create their own codes for LiDAR data processing;
- be able to process and explore the DGT LiDAR data with higher performance



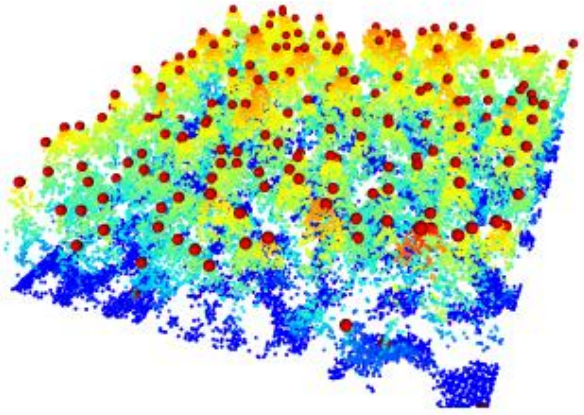
LiDAR derived products

Taking advantage of LiDAR data:

- DTM with 10 m resolution, facilitating broad-scale analyses across the mainland;
- Slope map, presenting a continuous and homogeneous slope coverage of the mainland;
- Hillshade and Solar Aspect Map: spatial distribution of illuminated and shaded areas, resulting from the interaction between the sun's position and surface geometry (Surface);
- Canopy height model – raster representing the height of any object to the ground.
- Tree tops, points representing the height of tree tops
- Tree Crowns (polygons)
- Alerts for the production of COS (Land Cover and Land Use Map)
- Point classification raster – 0,5 m (raster)
- Buildings (polygons)
- …



Slope map



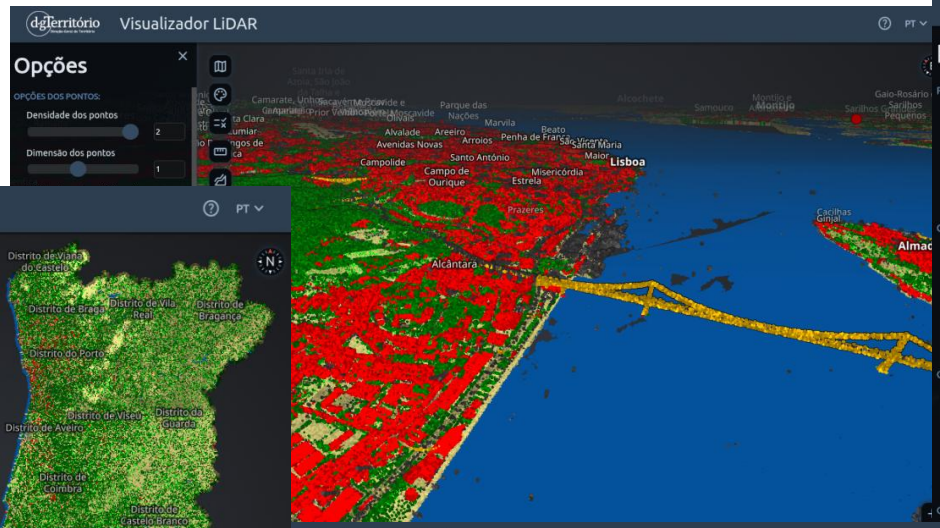
Tree tops

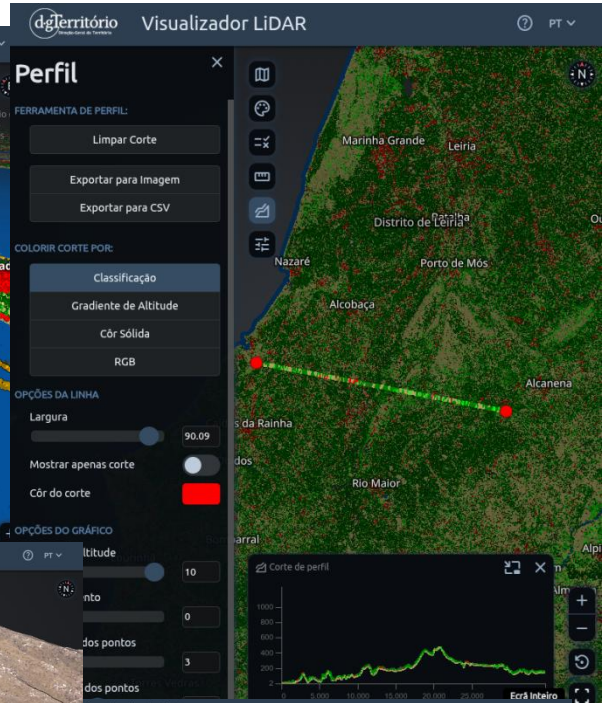
LiDAR Viewer

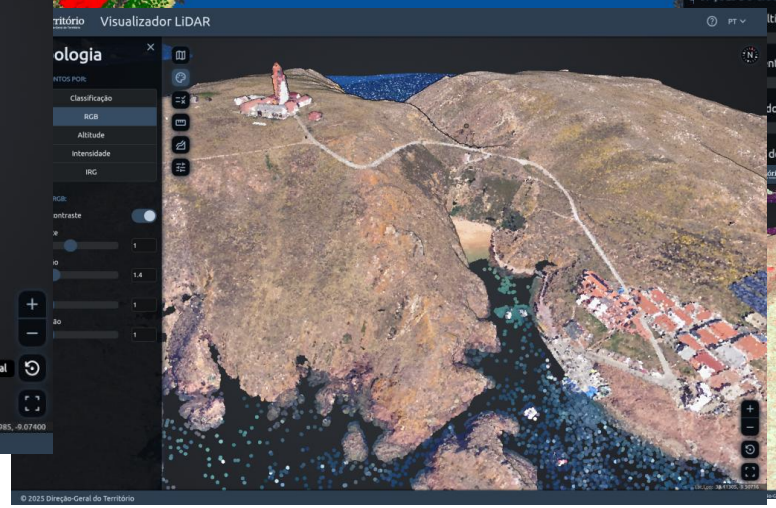
https://portugal3d.dgterritorio.gov.pt/

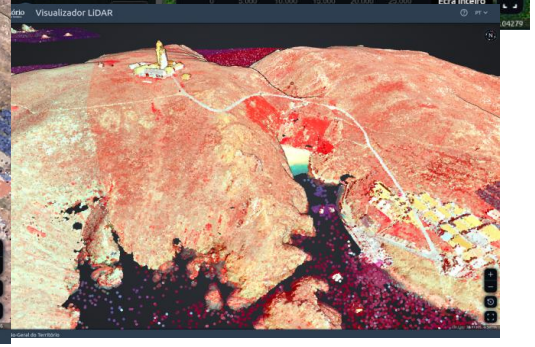
The viewer allows users to interactively explore and navigate via a web browser

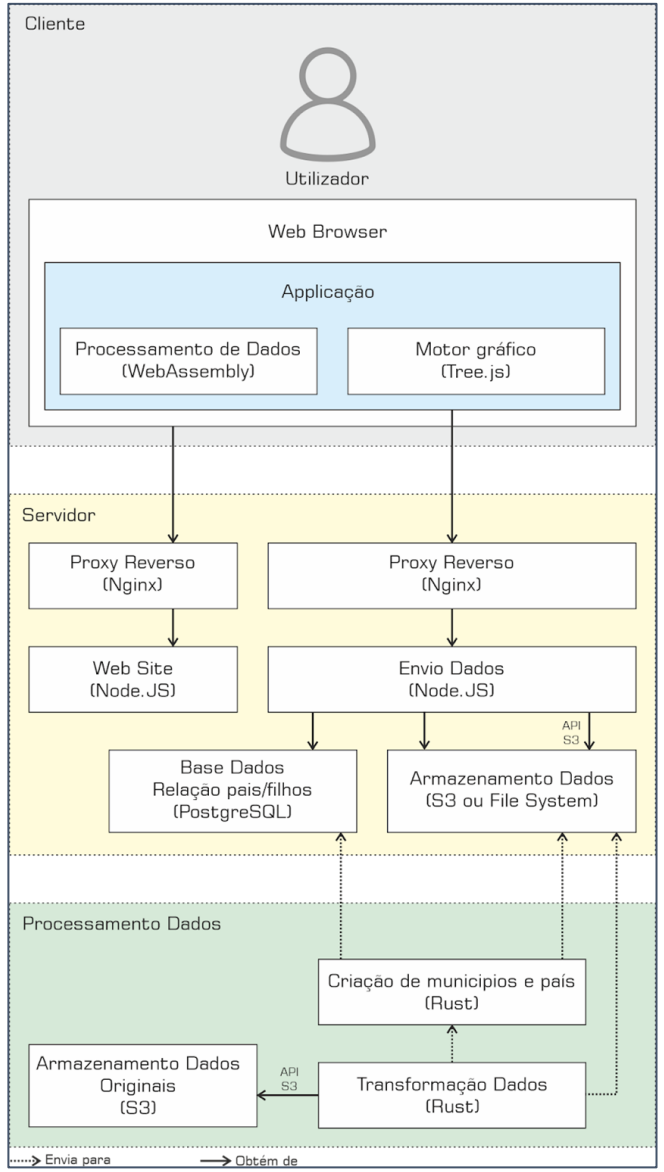












LiDAR

<– click to see the video

Thank you for your attention!

marisas@dgterritorio.pt

cartografia@dgterritorio.pt

d·gTerritório
Direção-Geral do Território