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LIDAR HIGH DENSITY PROJECT
FOCUS ON QUALITY CHECK STEPS

Hélène Buissart, Lidar HD project coordinator

Eurogeographics - Quality Knowledge Exchange Network 20.04.2023

Agenda

1. What is the Lidar HD Program ?
2. Data control
3. Geometric accuracy control
4. Evaluation of the point cloud classification
5. Conclusion

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The Lidar HD program

Lidar HD program

First national program in France aiming at covering homogeneously the whole territory in Lidar data

Coherence of the whole cover

Entirely coordinated by IGN

Open data

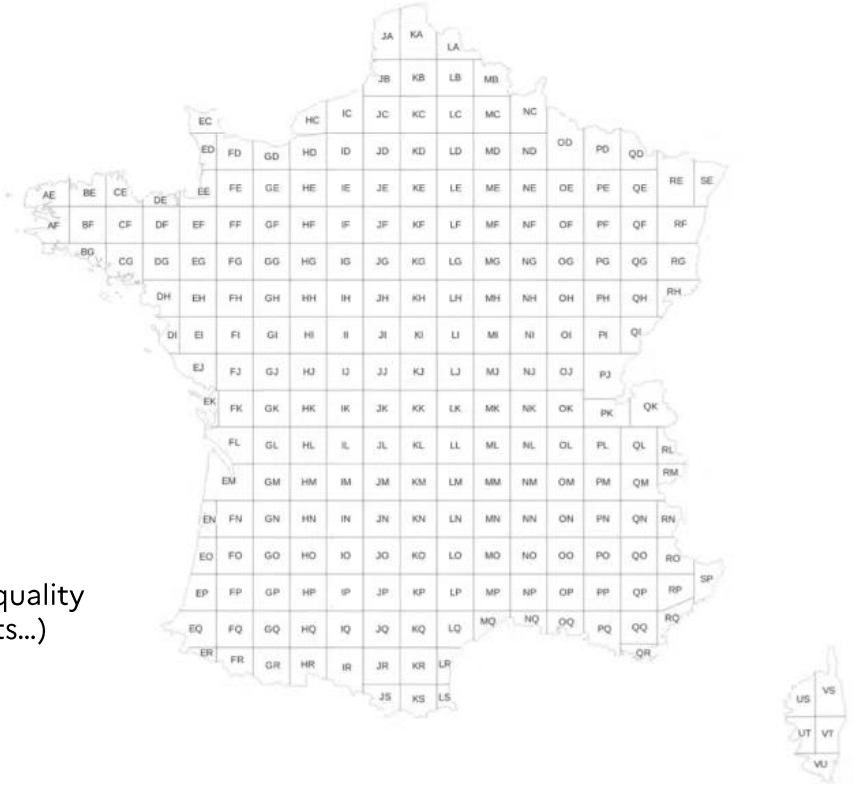
Period : 2020-2025

Main needs and uses

- Risk prevention
- Forestry
- Agriculture
- Territory development
- Ecology
- Security
- Archeology

And for IGN :

- Improving our databases quality (topo, forest, property limits…)



Lidar HD program main goals

ACQUIRE

airborne LiDAR data

10 pulses/m² density

whole Metropolitan territory

+ overseas territories

5 years (started in '21)

7000 flight hours

PROCESS LiDAR point clouds

to meet the various needs of public policies :

- Georeferencing
- Points clouds classification
- Digital Models Computation :

DTM, DSM, DHM

- Metadata

HOST AND PUBLISH

open data

Classified point clouds

DTM, DSM, DHM

~3PB

SUPPORT users

in using these new products

Characteristics

Point density : 10 pulses/m^2

Absolute accuracy :

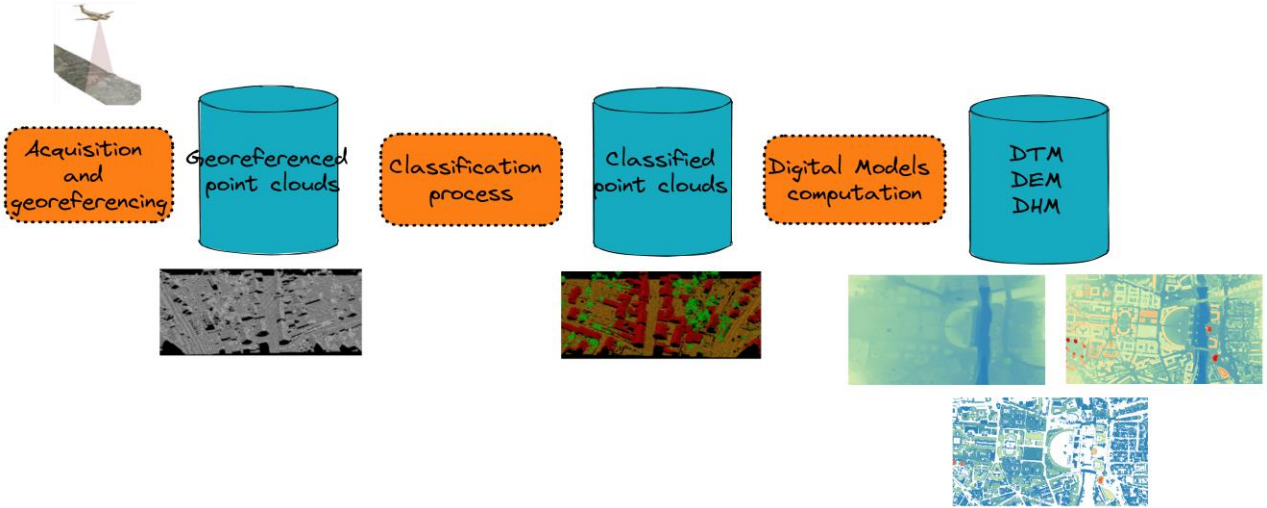
- planimetry 50 cm (1σ),
- elevation 10cm (1σ)

Relative accuracy :

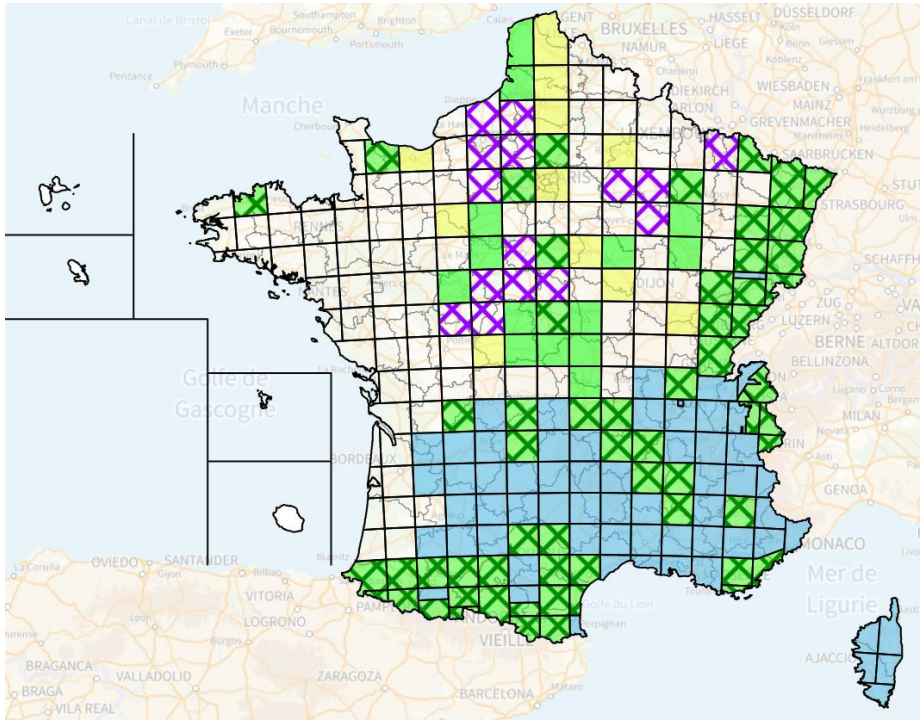
- planimetry ≤25 cm,
- elevation ≤ 5 cm

Classes :

1	Non classes	
2	Sol	
3	Vegetation basse	
4	Vegetation intermediaire	
5	Vegetation haute	
6	Batiment	
9	Eau	
17	Tablier de Pont	
64	Sursol perenne	
65	Artefact	
66	Point virtuel	
67	Divers Batis	



Acquisitions



Metropolitan territory divided in ~250 blocks

50kmx50km blocks

55% acquired *(blue & green)*

37% already passed *(blue)*

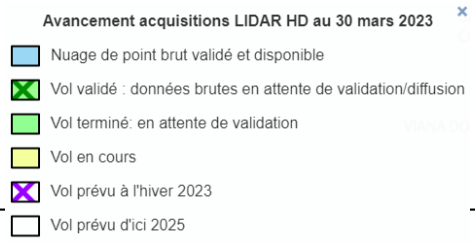
+ overseas : Guadeloupe, Martinique, Reunion, Mayotte *(excepted French Guyana)*

Acquisitions made by :

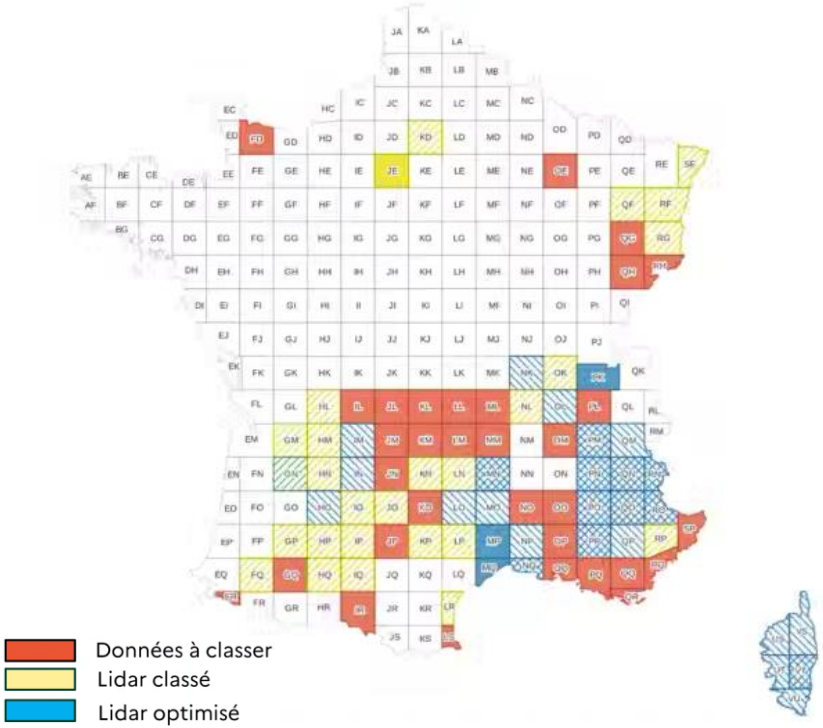
IGN

4 subcontractors

Summer/winter



Processing point cloud classification



+100 blocks will be classified by the end of '23

- **Interactive classification**

29 blocks (started in '22) by subcontractors

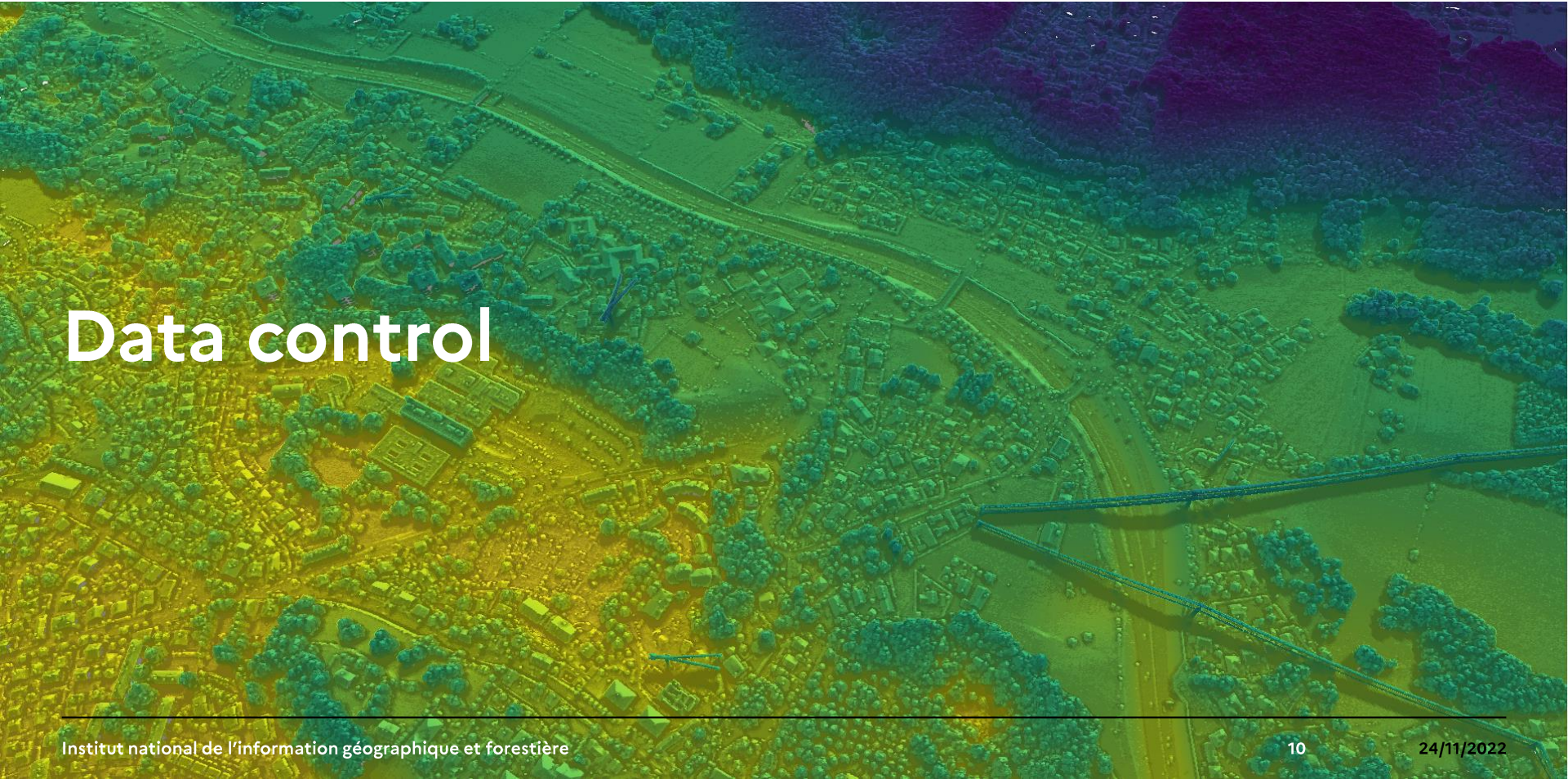
automatic + manual improvement and corrections

- **Full-automated IGN classification process**

IGN put the effort in'22 on it to :

- reduce production delays
- offer a Minimum Viable Product classification : a philosophy which benefits from continuous improvement

Our process is based both on « classical » methods (using TerraSolid), with AI steps to improve classes like buildings, ground…



Data control

Data control

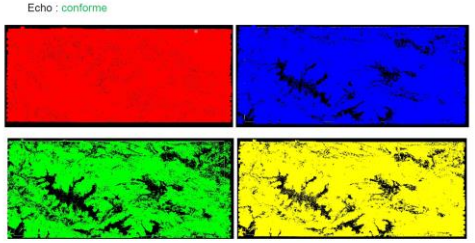
Automatic basic controls :

Files format integrity

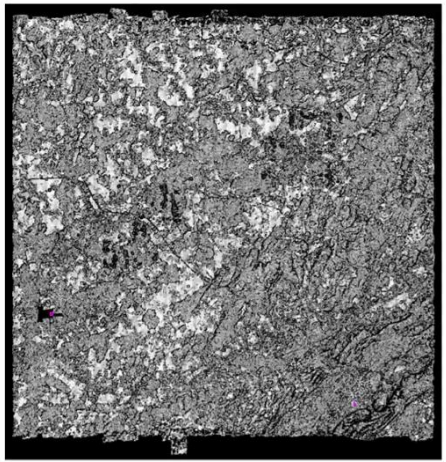
Naming

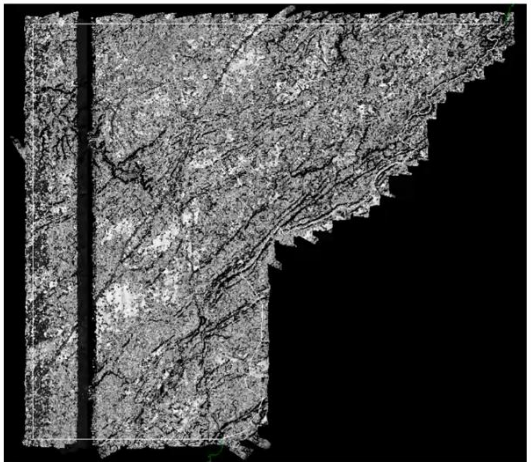
Points attributes :

- Echos (first, intermediate, last, only)
- Scan angles
- Flightlines coherence with trajectories
- Intensity coherence (not normalized)



Nuage de points symbolisé par type d'écho (exemple sur une dalle)





Data control

Coverage completion

Density

control on a specific density map @ 4m res

The density is controlled twice :

1) at the end of the acquisition

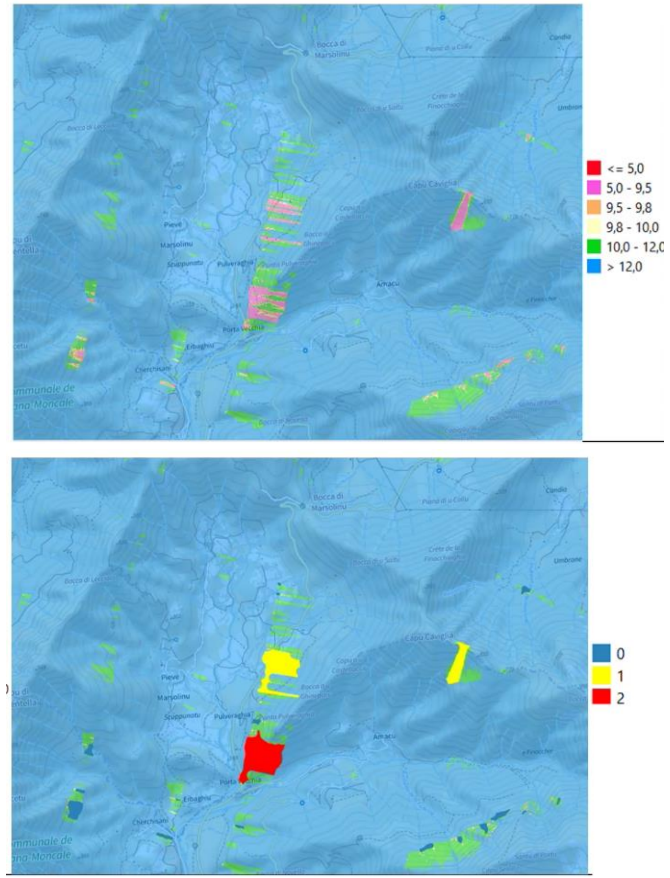
2) in the final data

Identification of nonconformity areas :

0 = OK

1 = warning

2 = program a new flight



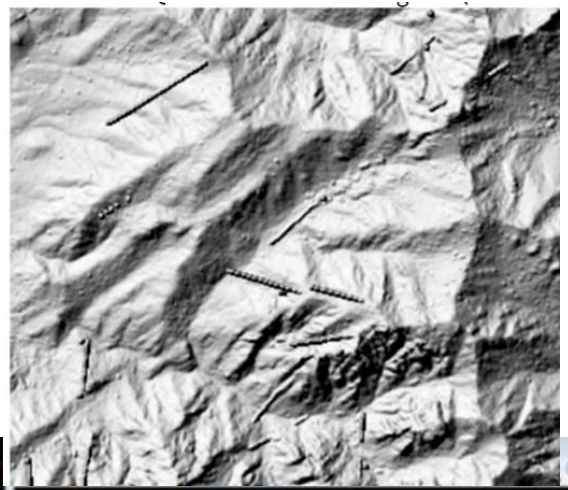
Data control

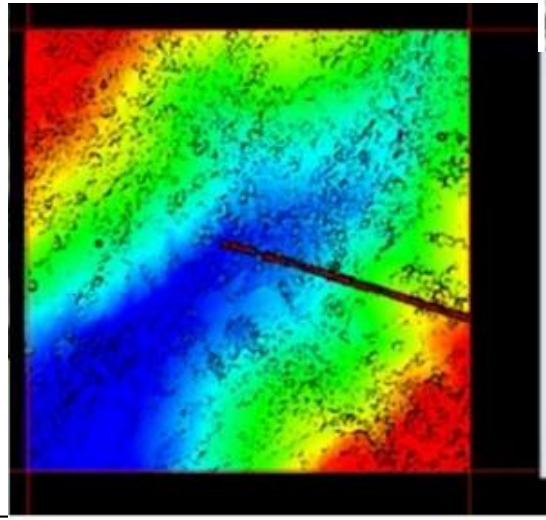
Geometric artefacts

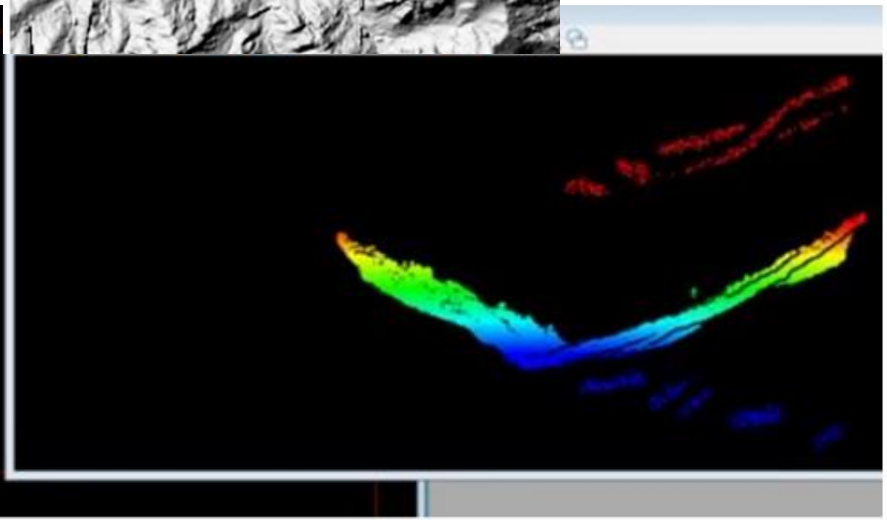
Detection on an DTM lowest/highest @25m res

Noise

Control on roads





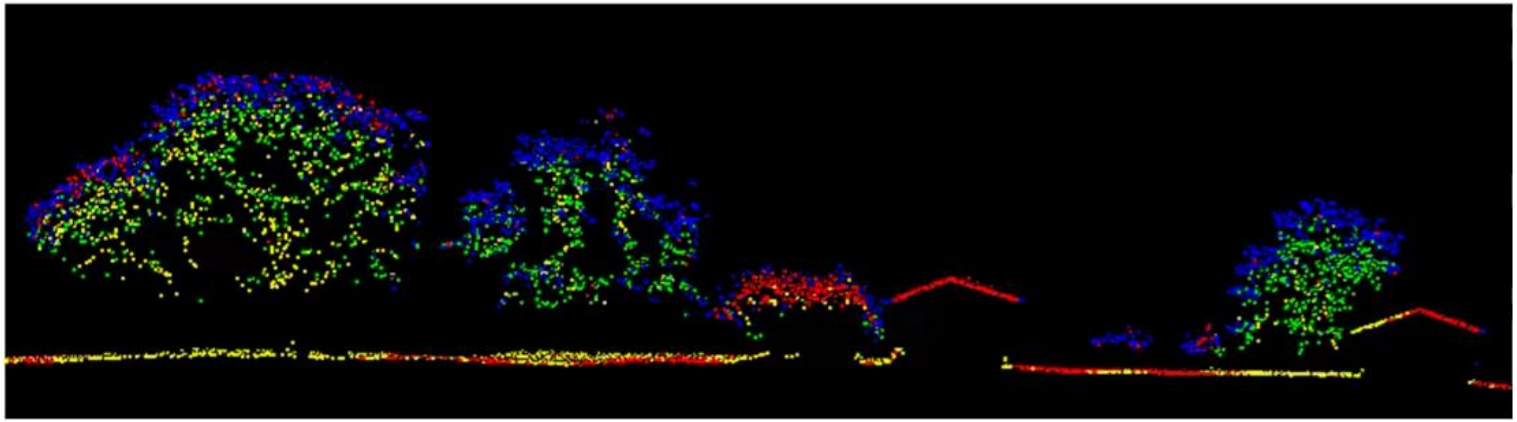


Other data control

Trajectories

GCP (points or surfaces) used in the geometric process

Production report including QC results and describing processing

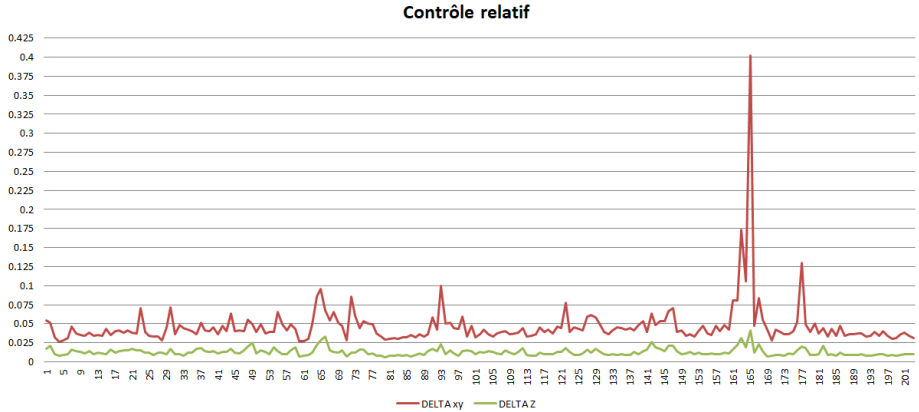


Geometric accuracy control

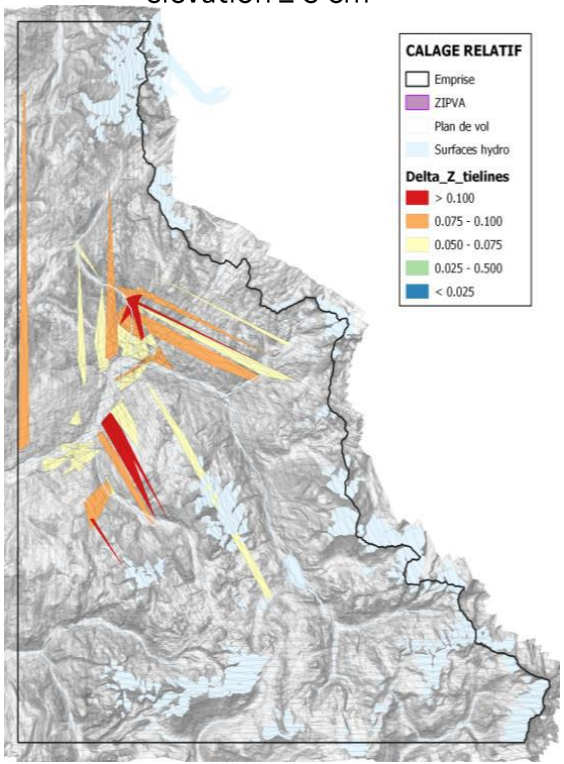
Controlling the relative accuracy First method by flightline

Controlled in line overlaps

1) XY and Z difference **Means by flightline**
2) Tielines Z difference view



Relative accuracy :
- planimetry ≤25 cm,
- elevation ≤ 5 cm



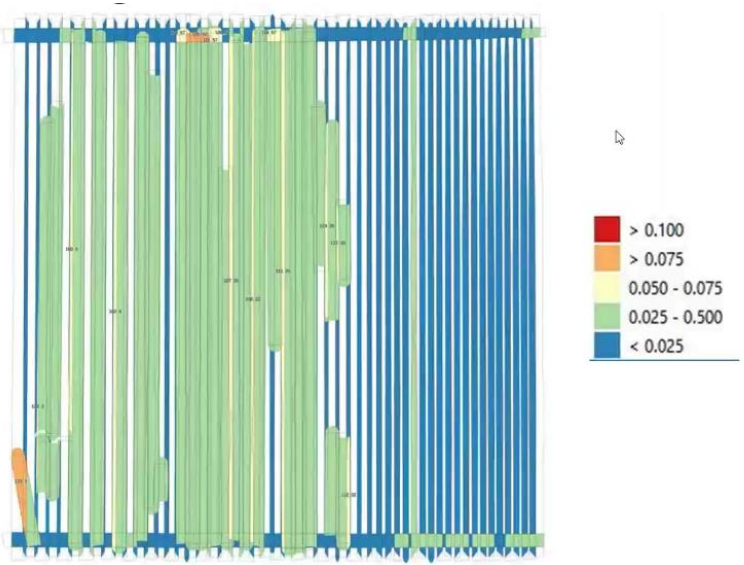
Controlling the relative accuracy : Second method for elevation

Based on tielines

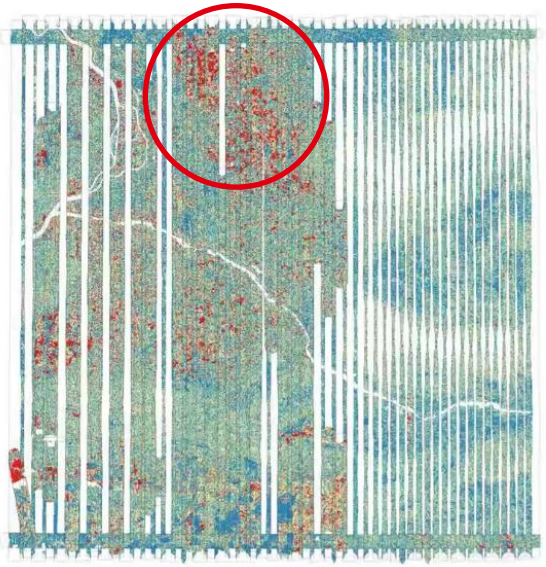
It appears that defects could be hidden in the control by line in overlaps : this reveals local defects

Problem encountered especially in mountainous areas (sometimes + 100 lines)

Control outside snow areas, fields…



Moyenne par inter-bande



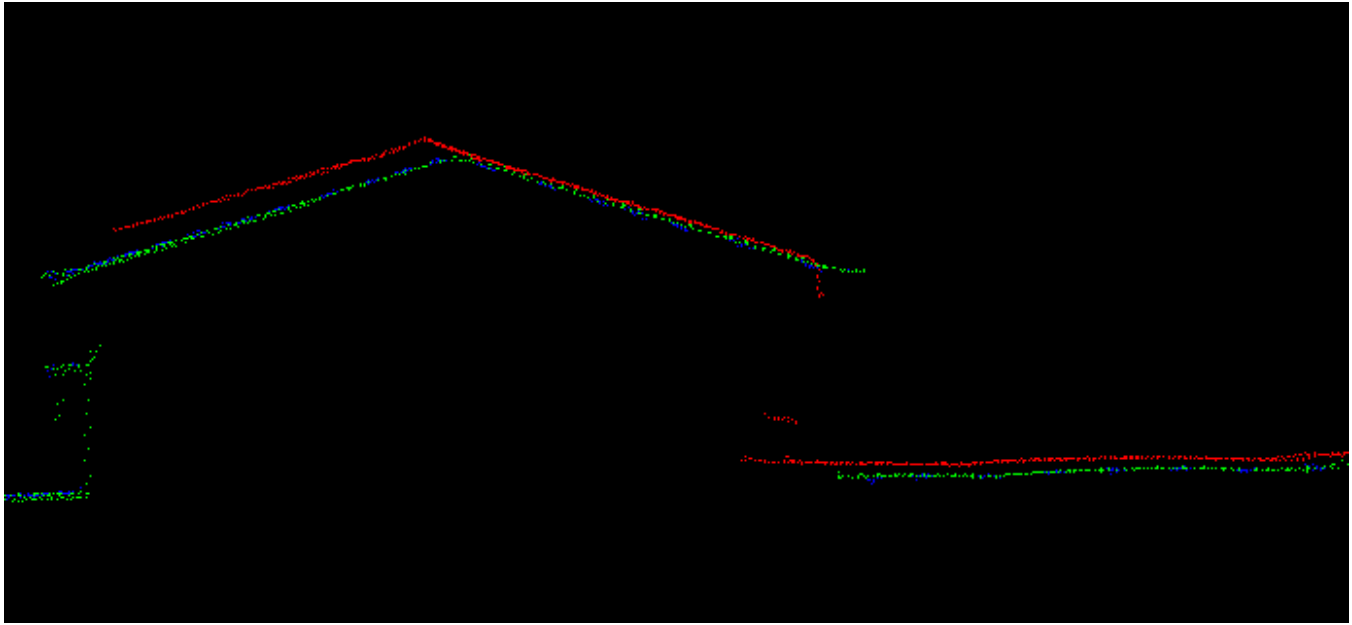
Valeur par tie-line

Controlling the relative accuracy

Example of relative XY accuracy problem

Correction required

Remaining defaults will have consequences on the classification process (building detection)



Controlling the expected absolute accuracy

Field work

ALTIMETRY control

1) Ground classification
2) Import of GCPs
3) Automatic measure in the point cloud
4) Measure verification

Controlling the expected absolute accuracy

PLANIMETRY

1) Computation of an intensity raster @ 25 cm res
2) Measure of GCPs on this intensity view

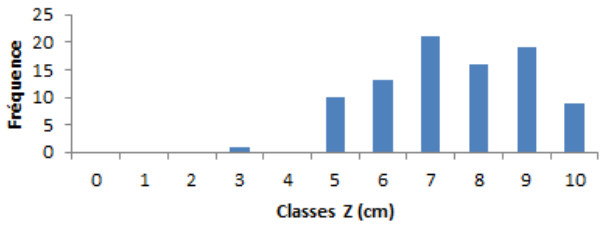
1 GCP / 10kmx10km area

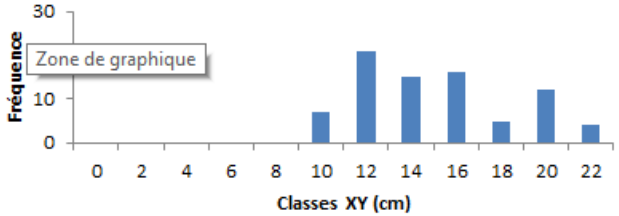
Controlling the expected absolute accuracy

Distribution of standard deviation, computed on 165 blocks

Planimetric absolute accuracy : always better than 50cm required

Altimetric absolute accuracy : up to 10cm





Evalulation of the point cloud classification

Classification control

Strategies are different to control :

- Interactive classification
- Automatic classification

Automatic classification

Quick basic control

- Authorized classes only
- Comparison to the original point cloud checking only the class attribute has been modified

⇒ no geometric change

⇒ Attributes integrity

- Computation of a classification map : raster used to control the global coherence of the block

⇒ Detection of a computation problem or file corruption…

Classification control

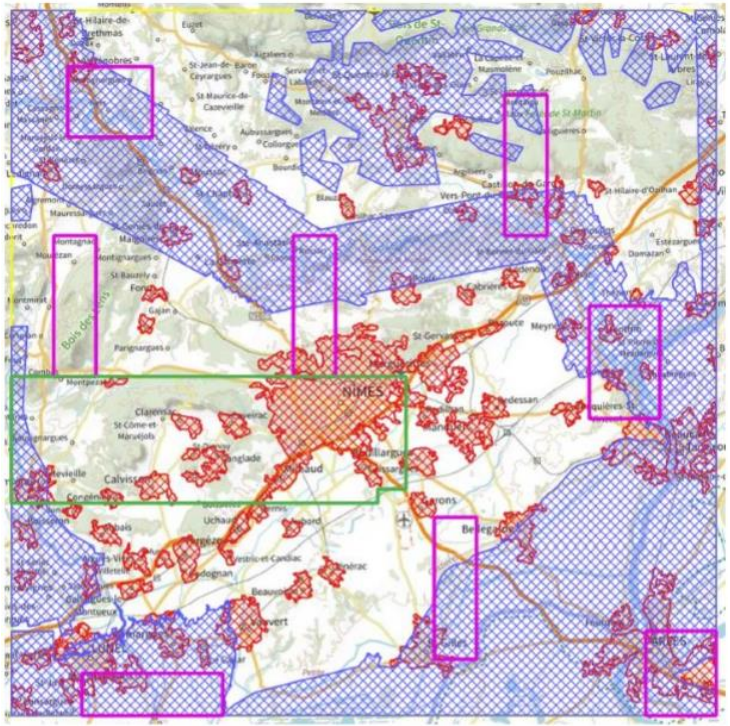
Interactive classification

3 steps :

- 10 km² « pilot » delivery
- 10% delivery : exhaustive control *(green area)*
- 100% delivery : only 10% controlled *(pink area)*

In case of nonconformity, new delivery, new 10% control

Areas are selected by an experienced operator considering areas of interest : issue areas, urban areas ; variety of landscapes



Interactive classification control

Pre-acceptance check : automatic controls on these 5 items

- *Authorized classes only*
- *Comparison to the original point cloud checking only the class attribute has been modified*
- *Computation of a classification map : raster used to control the global coherence of the block*
- Vegetation separation (low, medium, high) : statistical analysis
- Coherence between model key points and constraint vectors delivered

Operational qualification : interactive control

- Conformity to our technical requirements on different products
- **Manual control** with guidelines to define defects to be noticed
- **Supervised to ensure homogeneity and equity of the controls**

Scoring the classification

Defect importance	Meaning
*	Minor defect
**	Defect
***	Serious defect

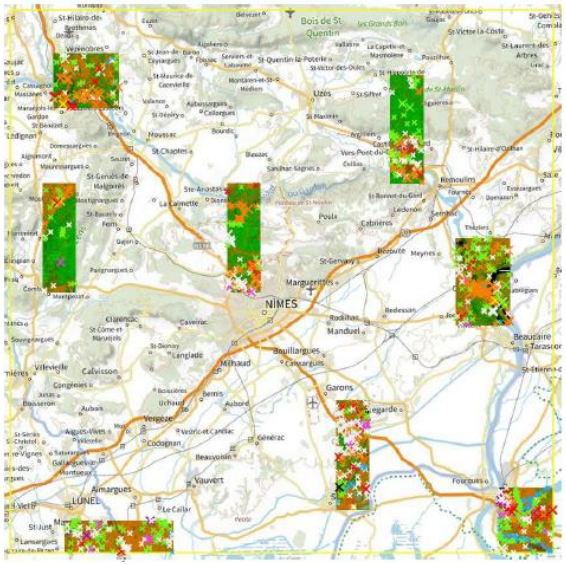
Definition of an empirical formula to get a classification score

composed of 3 sub-scores on :

- Ground and bridges description (witch will influence the DTM quality)
- Buildings
- Other class confusions et 1* warnings

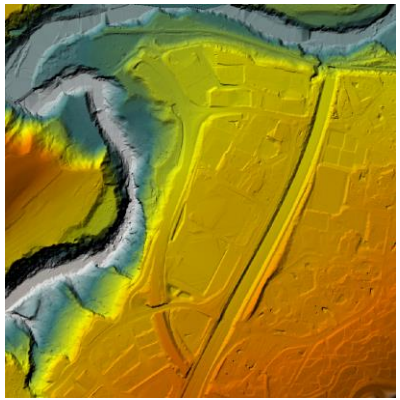
Defects have weighting coefficients depending on :

- Importance
- Situation (in/outside issue areas)

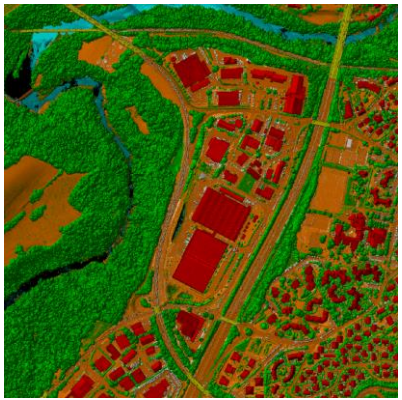


Control on 4 products
computed from the point cloud

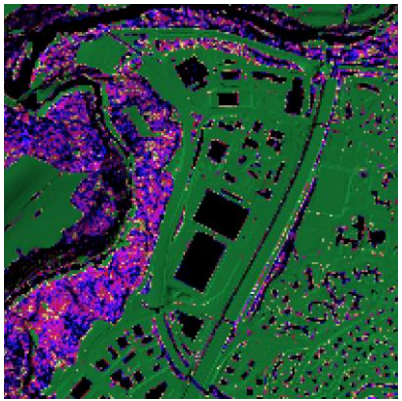
DTM



« Classification map »



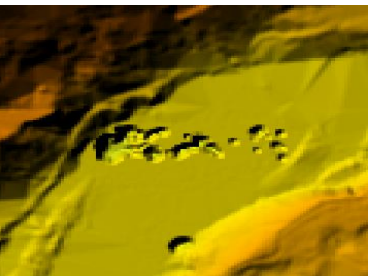
Density map



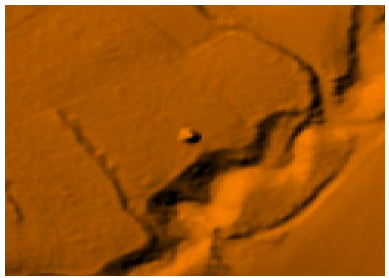
Vector data

Checking the DTM

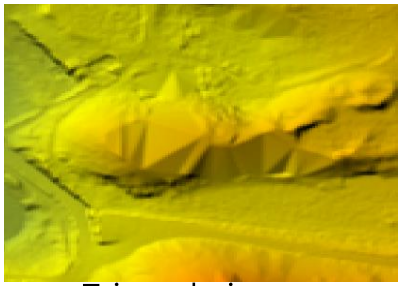
- Zoom @ 1:2500
- Only the defects > 60 cm are registered



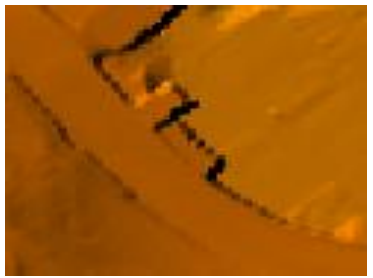
Artefacts



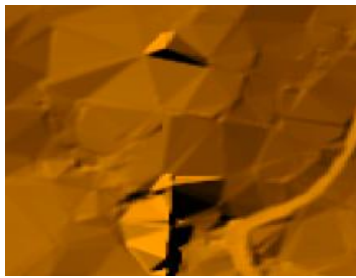
Ground peaks

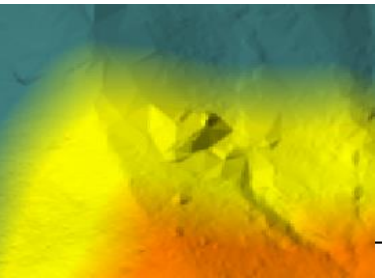


Triangulation

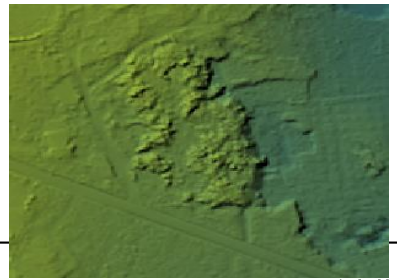


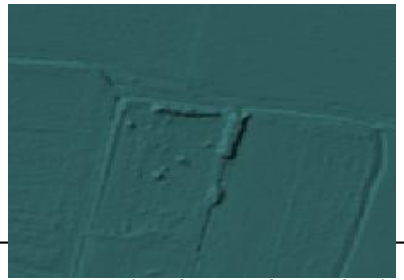
Building-ground confusionl



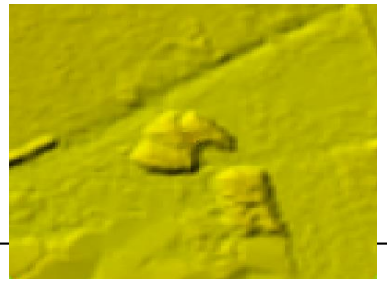


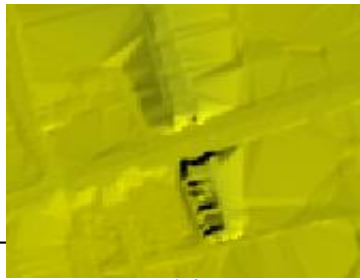
Vegetation/ground confusion





Middle vegetation/gound confusion

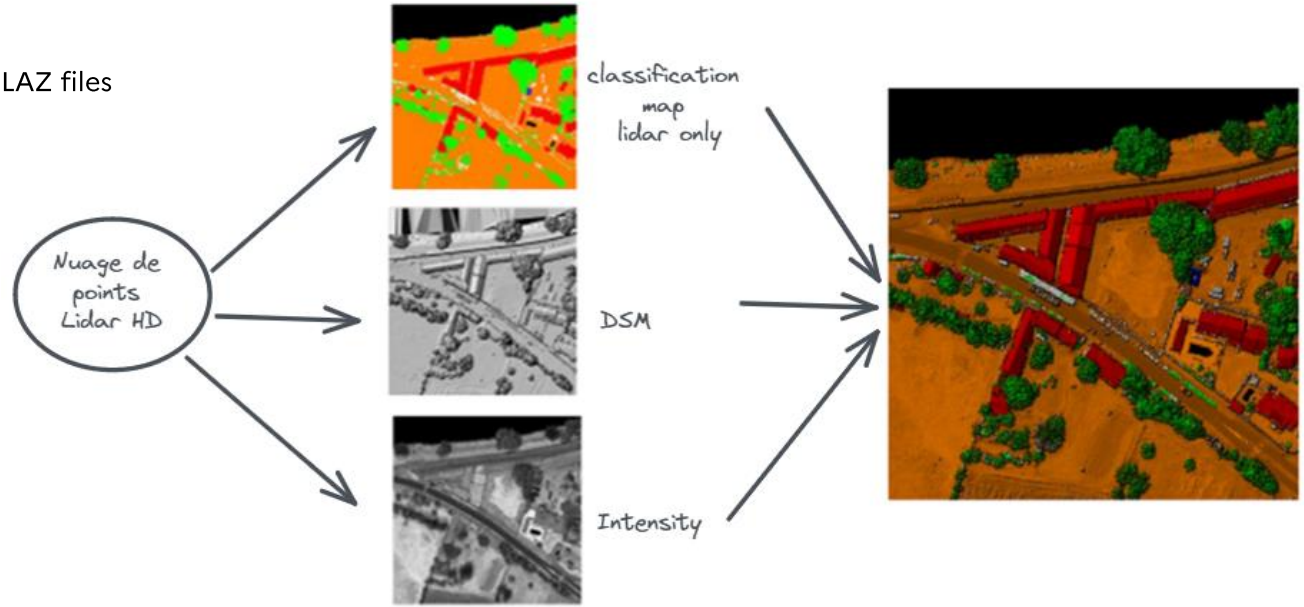




Bridge

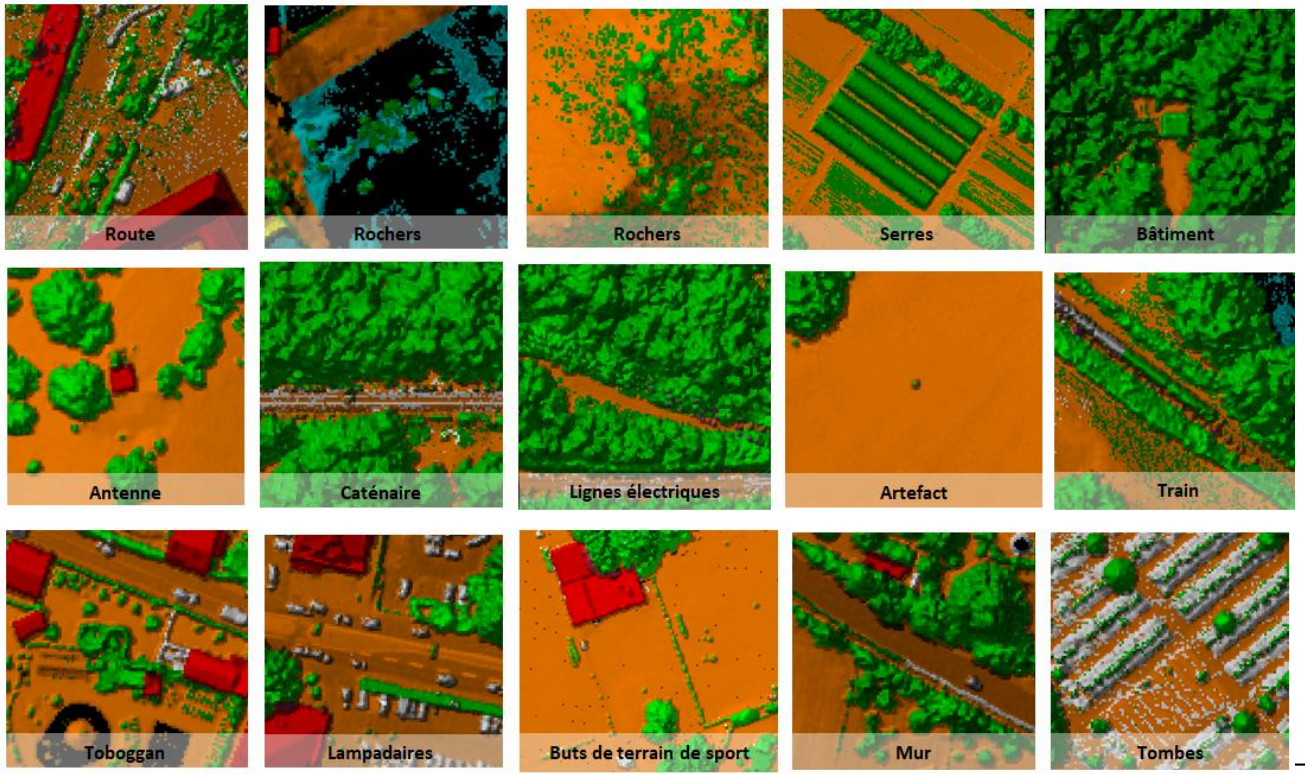
Checking class confusion with a « classification map »

- Zoom @ 1:1250
- If question, directy in LAZ files

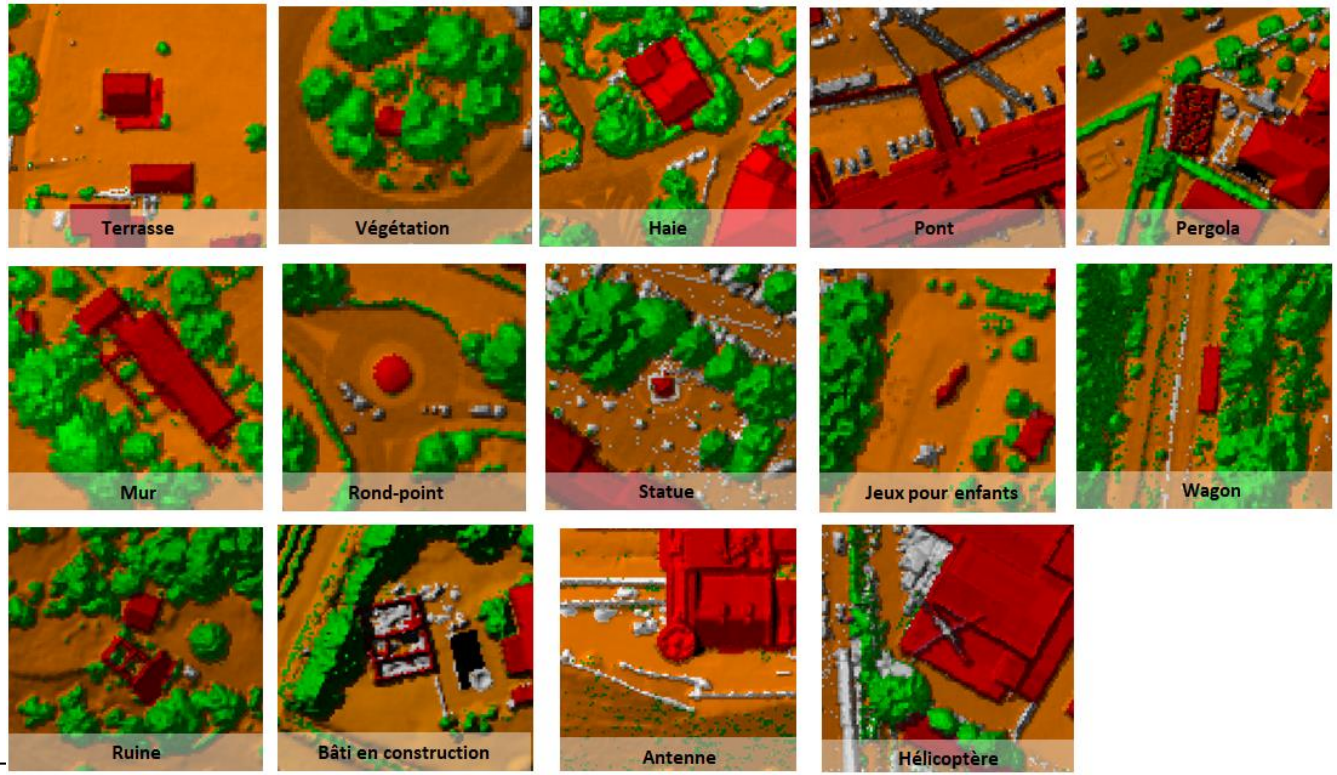


Guidelines : Examples of confusion on unclassified class

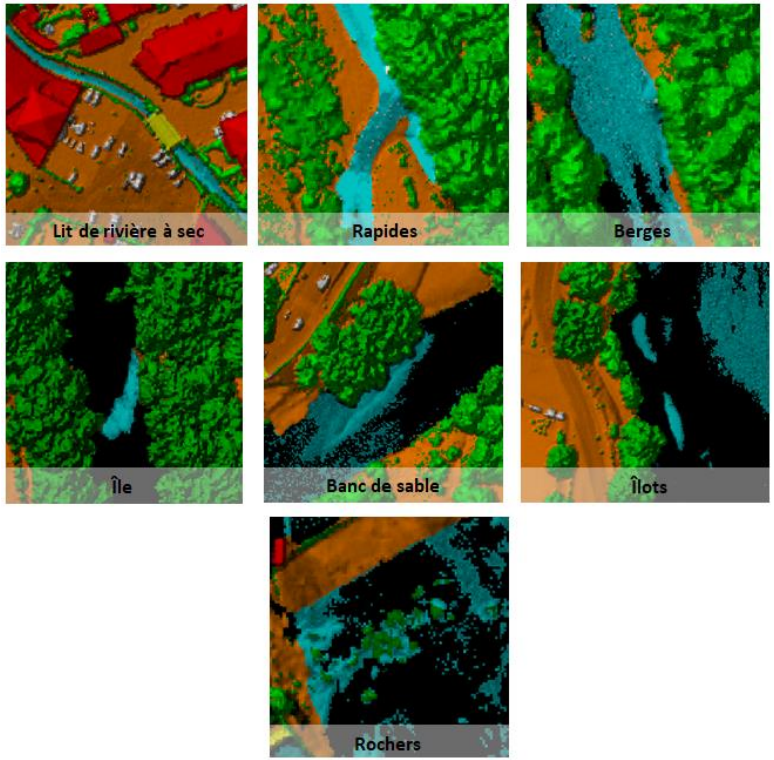
Examples of confusion : vegetation class



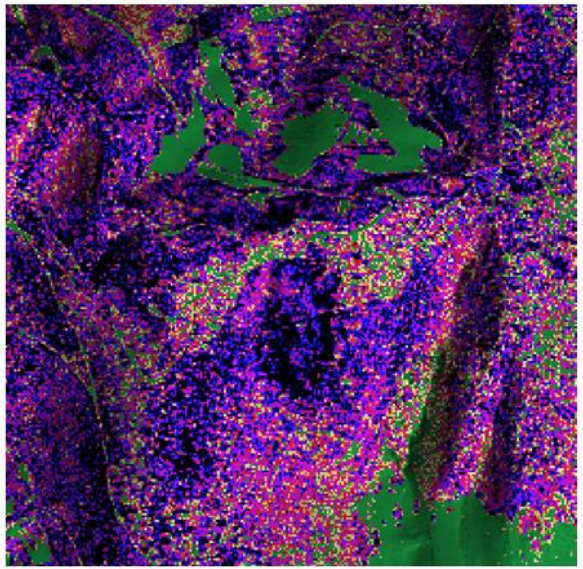
Examples of confusion : building class



Examples of confusion : water class

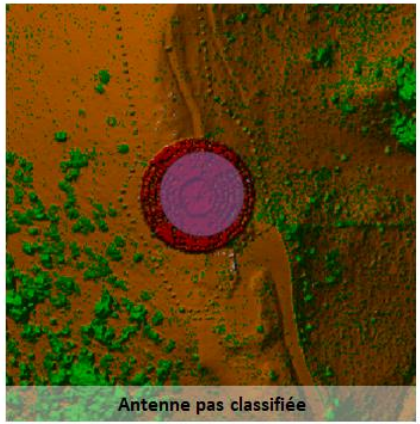


Verifying density gaps on ground points



0	pts sol / m²	
1	pts sol / m²	
2	pts sol / m²	
5	pts sol / m²	
6	pts sol / m²	
8	pts sol / m²	
9	pts sol / m²	
10 et +	pts sol / m²	

Using vector data from French topographic database to check completion on wires, antennas…



Antenne pas classifiée

Caténaires de voie ferrée pas classifiés

A challenging project in progress

A selection of opened questions

1. How to get the best part of subcontractors work ?

We've improved our control methods over time : the production process have to follow this trajectory.

Get the data validated at first control and avoid back and forth which are time consuming : adding delay is very problematic

Are our geometric relative accuracy requirements too demanding on difficult landscapes ?

2. How to have a good terrain model with data acquired in summer?

Define a confidence index to help the user : ground points density map…

3. How to measure classification absolute quality from field work ?

4. Working on measuring the quality improvement on our automatic classification between two versions of the process.

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THANK YOU FOR YOUR ATTENTION

MORE DETAILS AND DATA ON LIDAR HD | GÉOSERVICES (IGN.FR)