Limits and potentialities of gridded LiDAR data in the forest context: the case of the Piemonte Region dataset

Enrico Borgogno Mondino*, Vanina Fissore*, Renzo Motta*

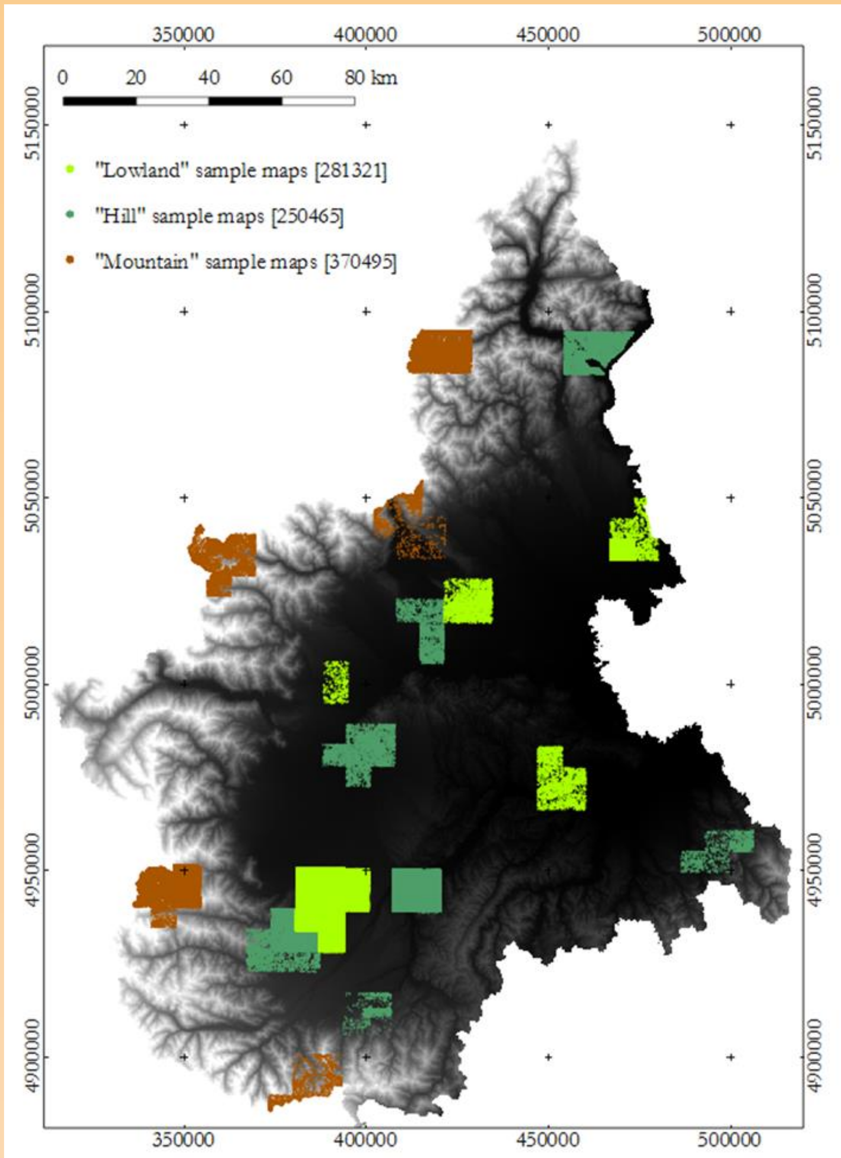
*DISAFA, Università di Torino, L. go Paolo braccini 2, 10095, Grugliasco (TO), Italy

GOAL

INDIRECT Quality Assessment of the «new» Piemonte Region **LiDAR gridded dataset (DTM+DSM)** and **digital orthoimages**: error quantification and relationship with terrain morphometry.

METHODS

TEST SET: 17 sample areas, 3 different terrain conditions: **Lowland, Hill, Mountain.**



AVAILABLE DATASETS

ICE 2009/2011 DTM and DSM

Format: grid (interpolated) with GSD = 5m

Quality: DTM level 4th ; Height accuracy = ±0.3 m

Horiz. accuracy= ± 0.3 m

RGB /VNIR digital orthos: GSD = 0.4 m

SENSORS TECHNICAL DETAILS

LIDAR sensor: LEICA LS50-II.

Digital camera: ZI-DMC

HOW CAN DATA BE VALIDATED WITHOUT GROUND TRUTH?

ERRORS QUANTIFICATION

A traditional validation, based on the comparison between ground and data measurement is too expensive. But, specifically for DSMs, some indications can come from:

A) investigating the occurrences of CHM (*Canopy Height Model*) negative values;

B) comparing height values at the same position, if overlapping areas between adjacent tiles are present.

C) Investigating co-registration level between orthoimages and DSM.

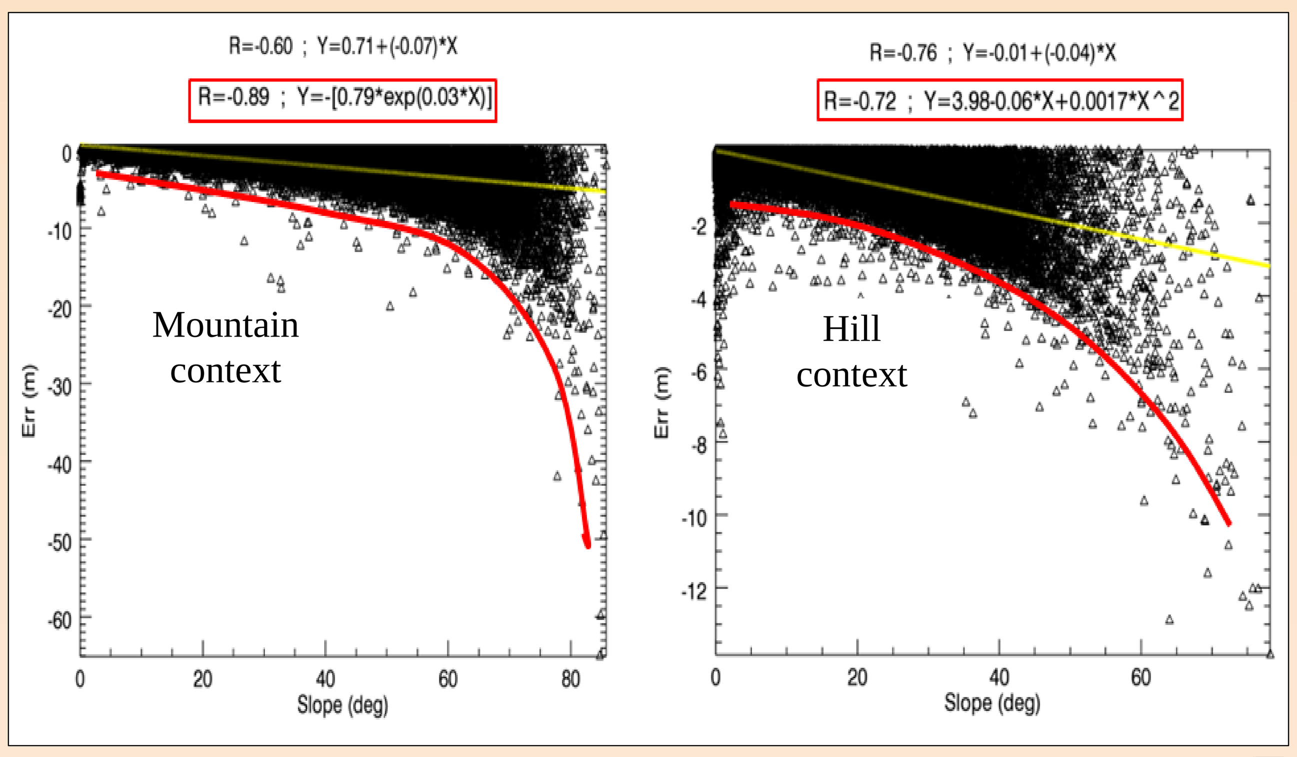
ERRORS QUALIFICATION

For **A)** and **B)** a correlation analysis was done to investigate if any relationship between errors and terrain morphometry (slope) is present.

A **geostatistical analysis** was performed by analyzing **variograms** to measure and qualify the spatial autocorrelation of errors.

RESULTS

A1 - CHM ERRORS ANALYSIS (results are referred to 5% of points with CHM<0)

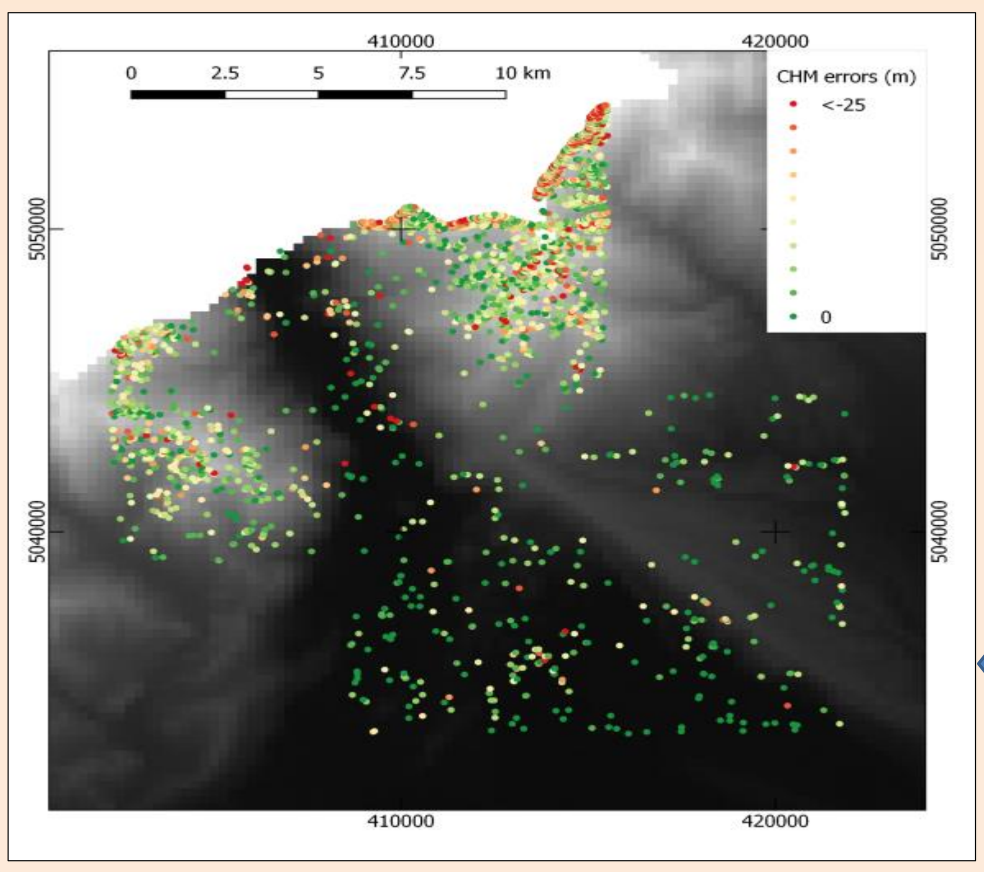


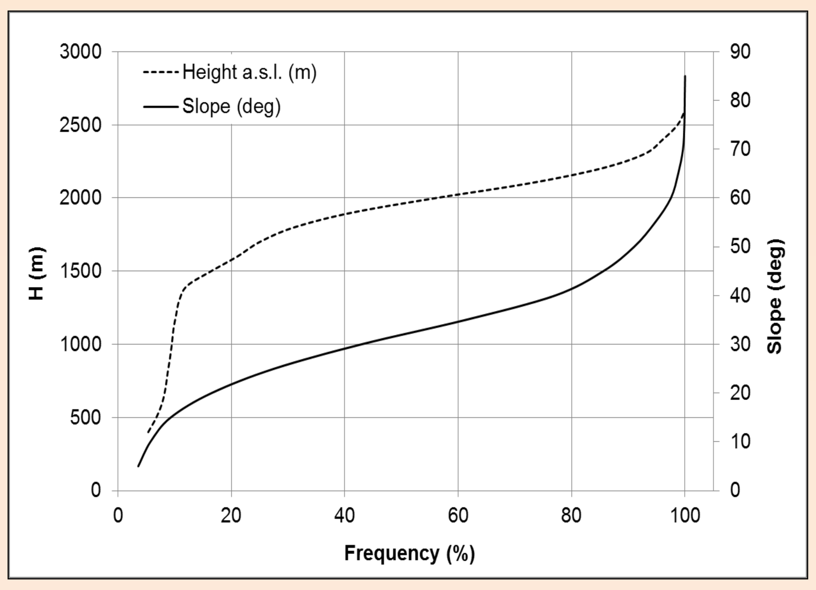
Scatterplots relating CHM errors and slope steepness.

Exponential and **parabolic** regression models well fit the maximum committable error (MCE) in mountain and hill context.

CHM errors (negative) > declared tolerance ($\sqrt{2}$ *x0.60 m*)

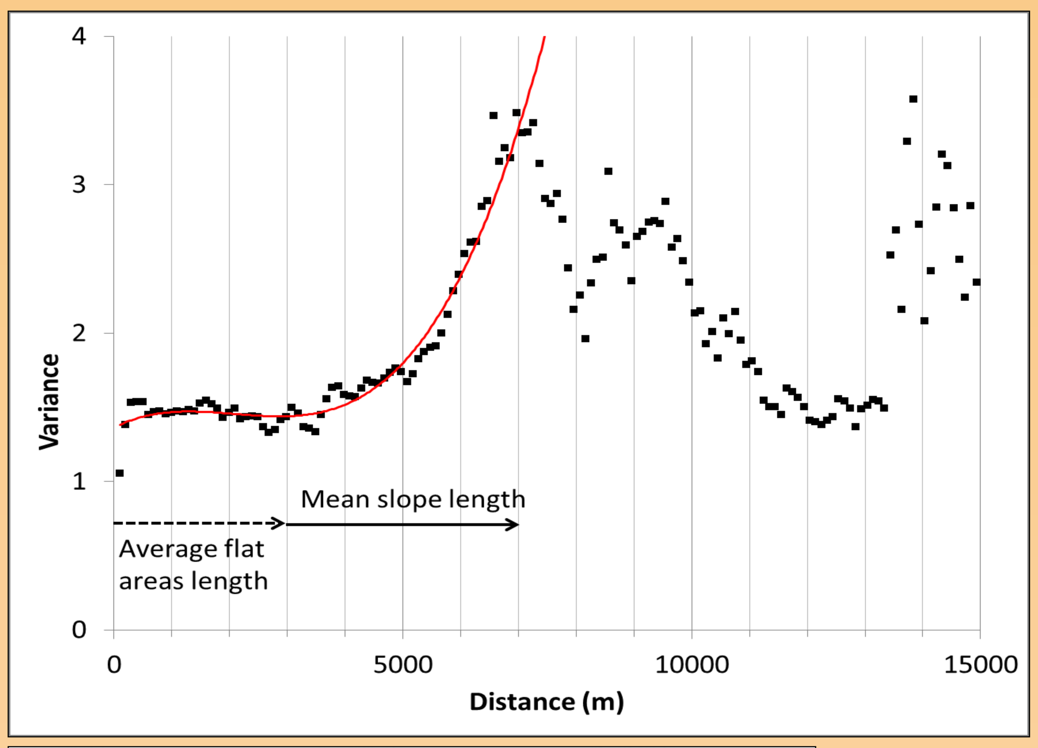
Lowland = 0.34 % , **Hill** = 1.28 % , **Mountain=** 12.24 %

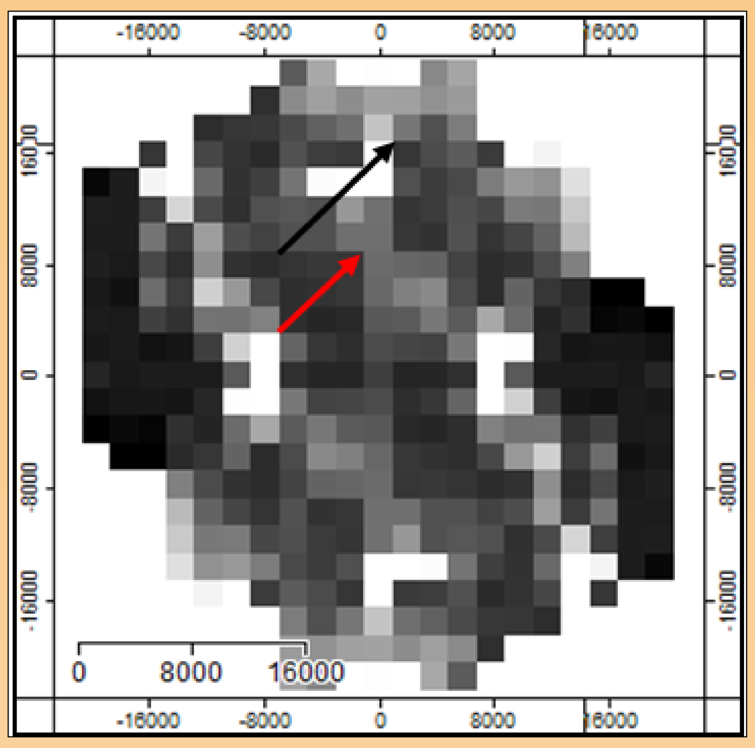


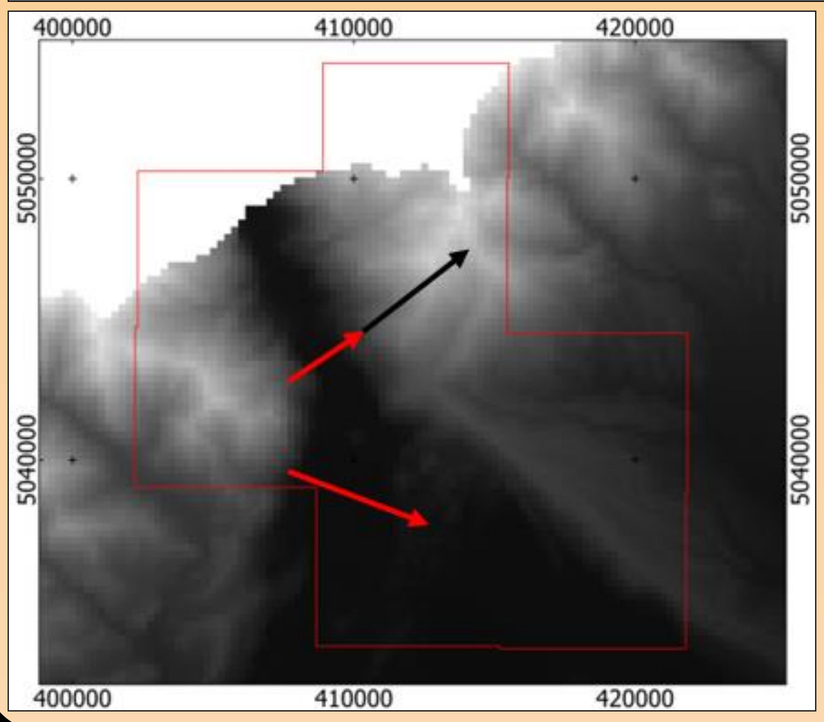


Example area (mountain) and correspondent cumulative frequency distribution for elevations and slopes.

A2 - CHM ERROR VARIOGRAMS







VARIOGRAM and **SURFACE VARIOGRAM**

CHM errors strongly depend on topography

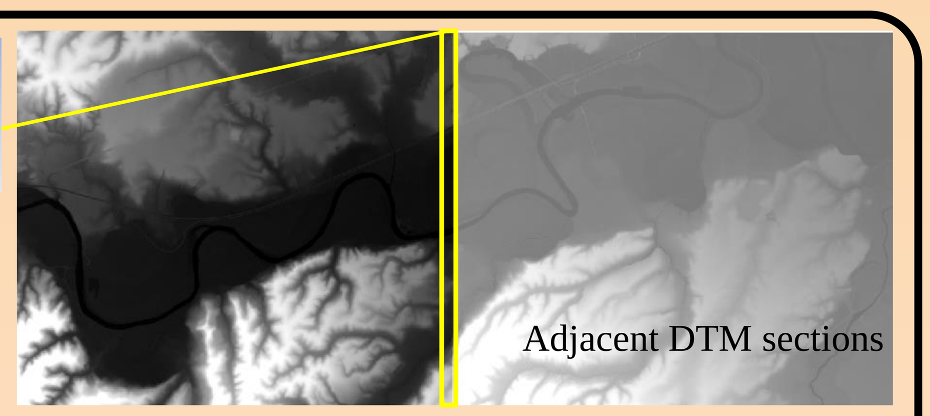
Variogram and surface variogram can be easily related to the actual morphometry of the area.

- Variance is low for flat areas, i.e. spatial autocorrelation of error is missing
- Variance increases while slopes tend to be steepest

B - DTM/DSM ERRORS ANALYSIS

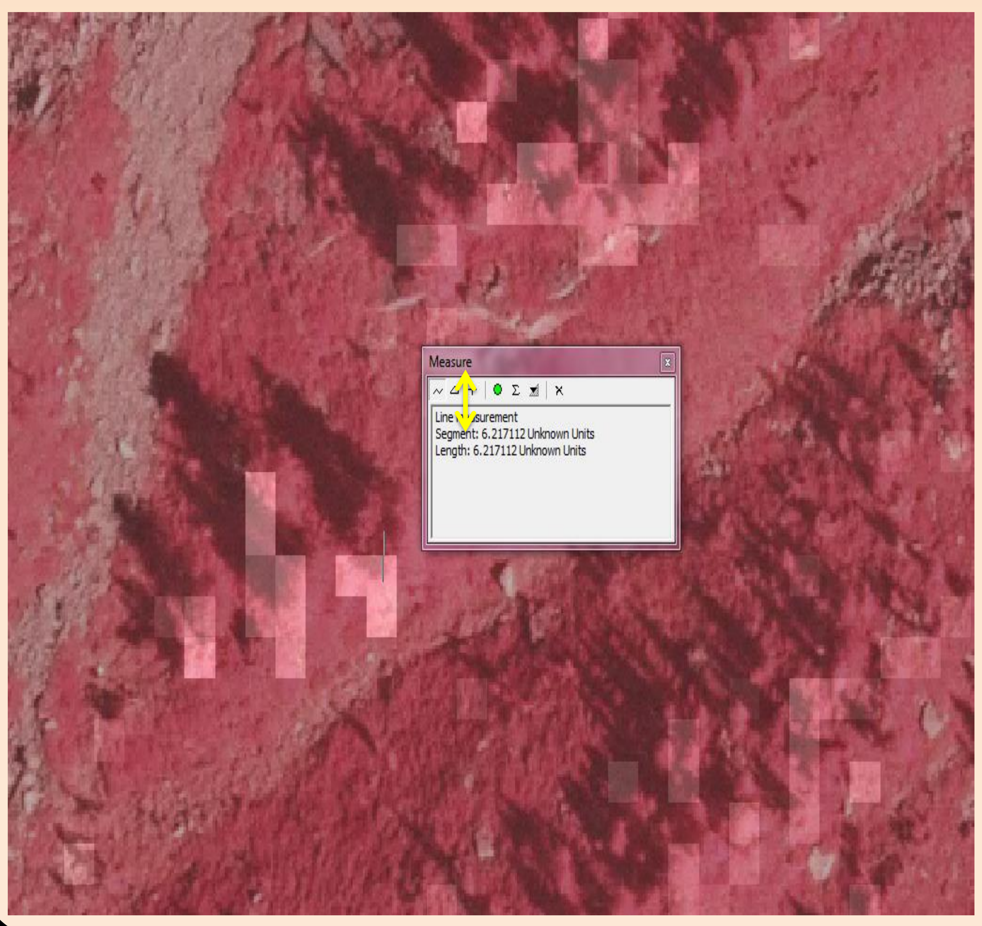
(referred to 20% of points)

No correlation of errors with terrain morphometry was found for this type of error



Context	Data	*Err >Tolerance ($\sqrt{2}$ x0.60 m)*
Lowland	DTM	0.30%
Hill	DTM	1.80%
Mountain	**DTM**	**17.50%**
Lowland	DSM	1.70%
Hill	**DSM**	**8.80%**
Mountain	**DSM**	**22.00%**

C - DSM AND ORTHOIMAGES CO-REGISTRATION ANALYSIS



Displacements between canopies mapped from DSM and canopies mapped from orthoimages → orthoimages are not TRUE orthoimages → as many forest applications dealing with tree-line mapping often base their measurements onto aerial or satellite ortho-images this is an important issue. In fact canopy position derived from orthos, depending on the image acquisition geometry, can be shifted determining, especially in steep areas a not negligible error in the determination of the tree-line height.

CONCLUSIONS AND FURTHER DEVELOPMENTS

CHM from LiDAR acquisition proves once more to be a valuable support for forestry applications **…BUT…**

1) it suffers from precision limitations especially where slopes are steep. This can determine some errors in vegetation mapping. Therefore a question is necessary**: "How and where these anomalies are more restrictive?"** → A conscious use of the data is required.

2) LiDAR data and correspondent orthoimages are not perfectly co-registered. Preliminary tests shows that displacements depends on joint effects of LiDAR and image acquisition geometry. Results (i.e. tree-line mapping) obtained from these data can be not coherent → TRUE ORTHOS are required?