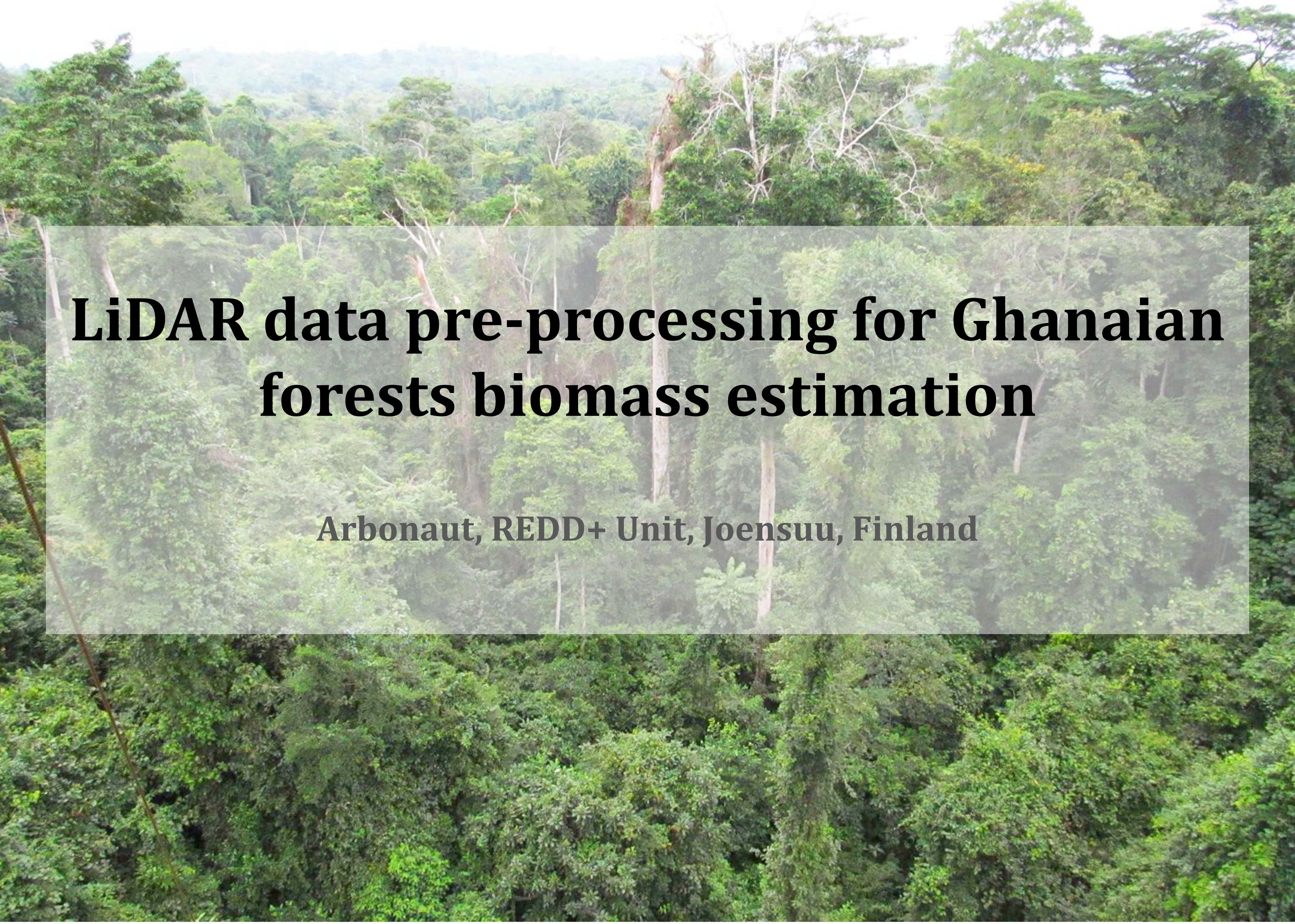


LiDAR data pre-processing for Ghanaian forests biomass estimation

Arbonaut, REDD+ Unit, Joensuu, Finland

Airborne Laser Scanning principle

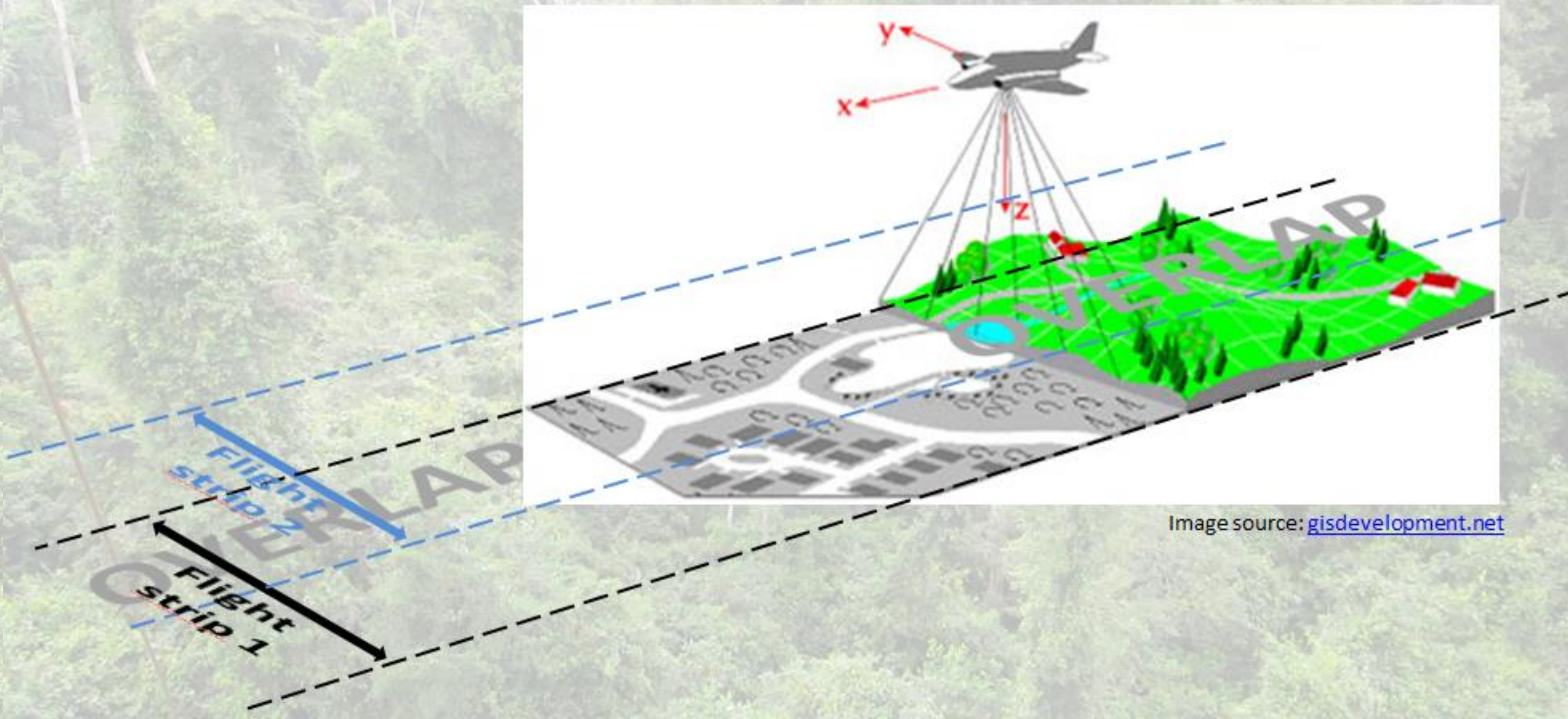


Image source: gisdevelopment.net

Objectives of the research

- Prepare the laser scanning data for further analysis:
  - Division of laser scanned data by flightlines
  - Classify or reclassify the data
  - Overlapping Digital Terrain Model analysis (!)
  - Crown Height Model creation
  - LiDAR_30 features analysis on overlapping areas (!)
- Analyze the laser scanning data – quality assessment

Challenges:

- Fixed-wing aircraft used for mountainous area scanning
- Missing flightline ID - corrupted files received from the vendor
- Large set of laser scanning data (few hundreds of gigabytes)
- New software to be learnt

Acquired laser data descritption

- Airborne LiDAR survey undertaken by Fugro Geoid under the supervision of Asia Air Survey Co., Ltd in December 2011 and January 2012 for the Ghana Forest Preservation Program.
- The data includes 19 LiDAR blocks named from B1 to B19, further divided into a total of 879 individual tiles

Total Coverage	770 km^2
Aerial Platform	Fixed wing
Flying altitude	1300 m AGL +/-100 m
Flying speed	120 knots ~ 222.24 km/h
Sensor pulse rate	81,100 khz
Sensor Scan speed	47.6 Hz
Pulse density - ground level	2 returns /m^2
Scan FOV half-angle	13.5 degrees
Swath width at ground level	644 m
Sensor	LEICA ALS50-II
Point spacing	1.2 m across, 1.3 m down
Laser beam setting (Optech)	N/A Leica
Beam footprint at ground level	31 cm /e^2
Projection	UTM30N
Datum	WGS84

LEICA ALS50-II

Applied software

Bentley V8i MicroStation

Terrasolid – Software for laser and images

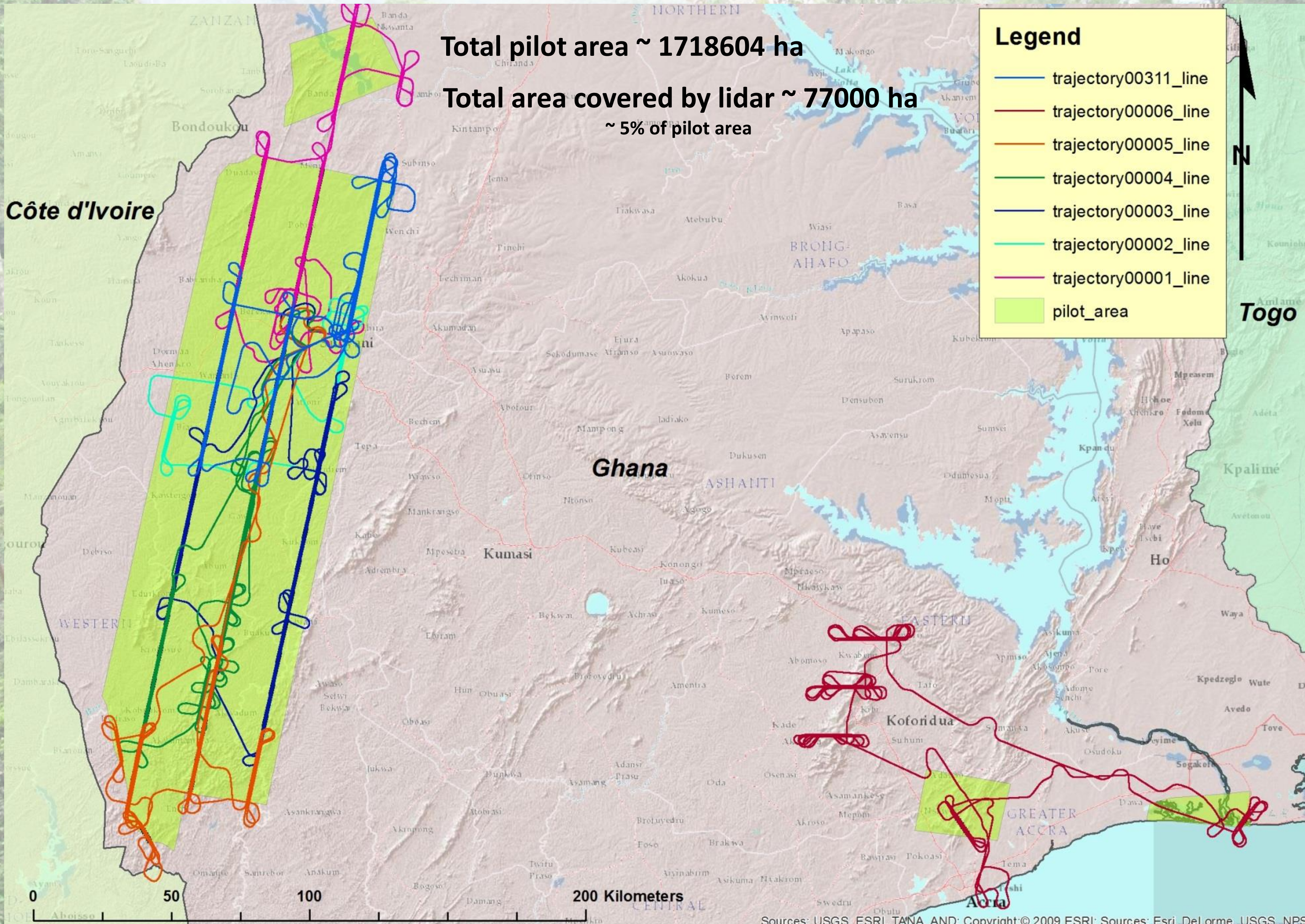
arbolidar

ESRI ArcGIS

LasTools

R

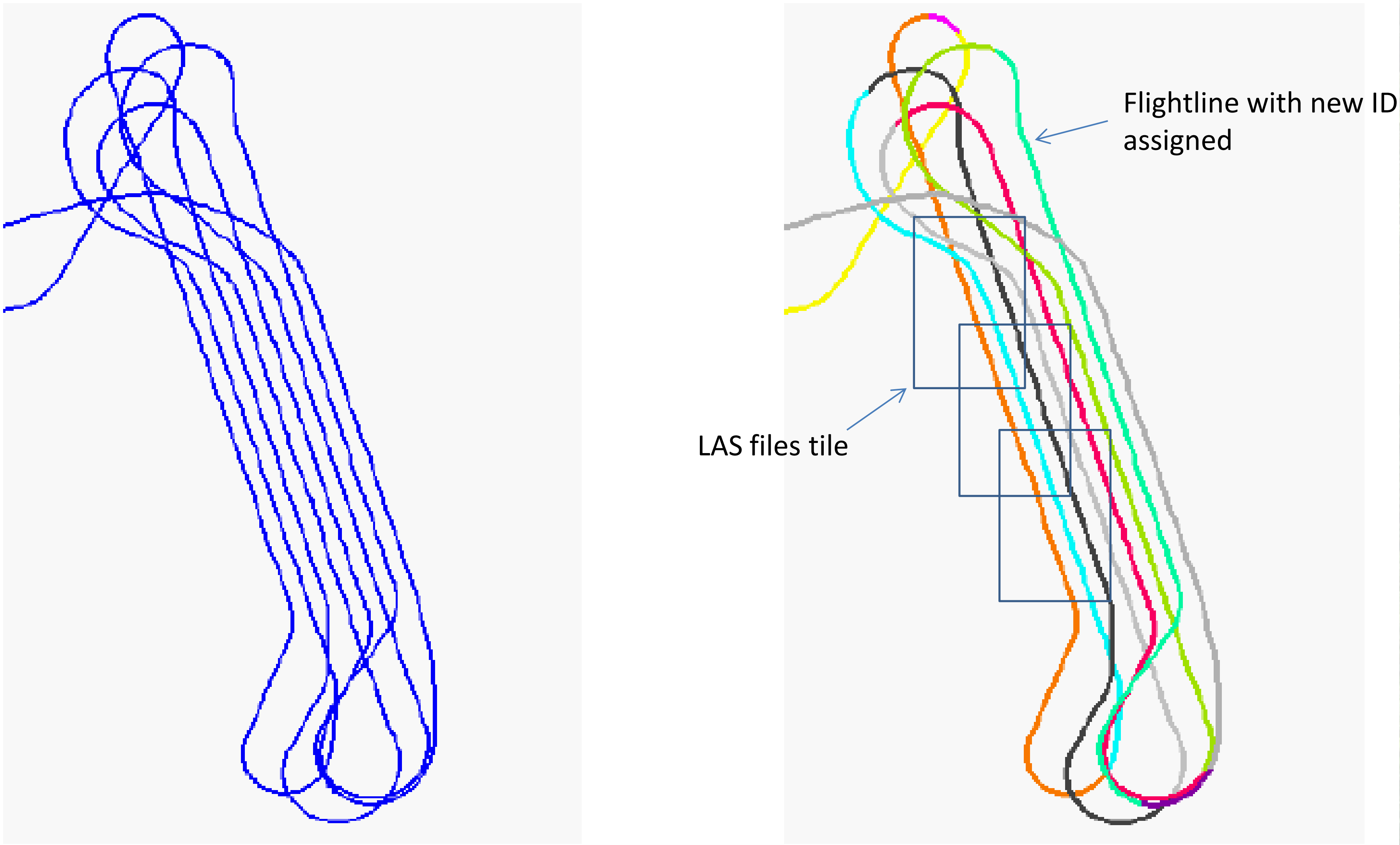
Area of investigation



Distribution of trajectories

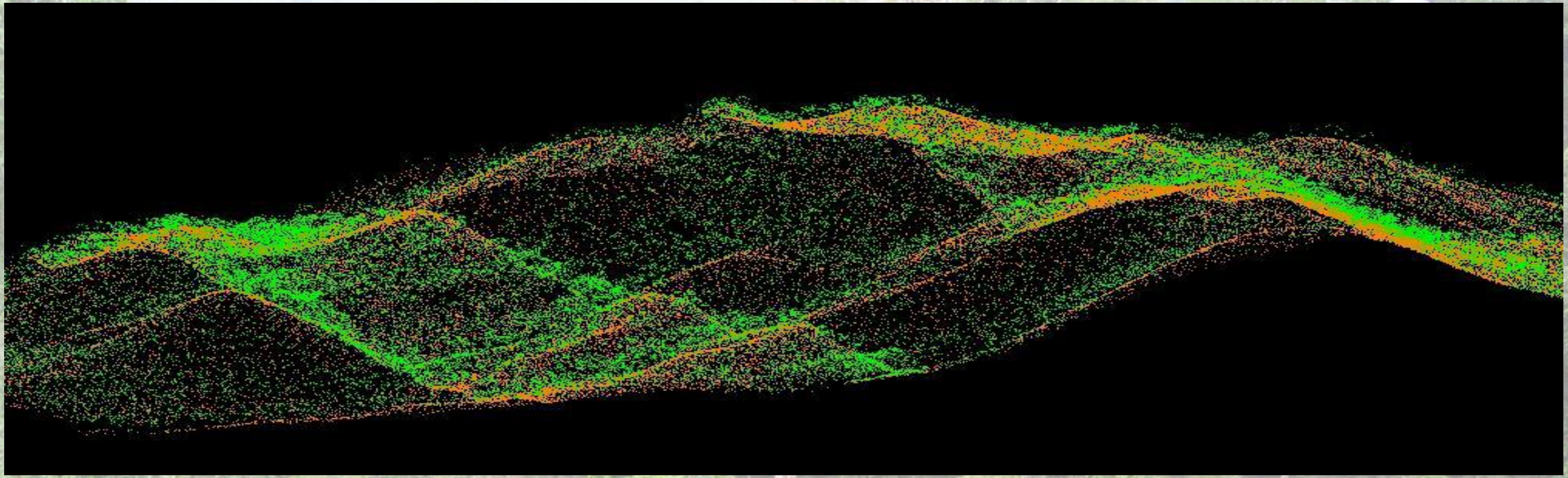
Distribution of trajectories

Assigning the ID to flightlines

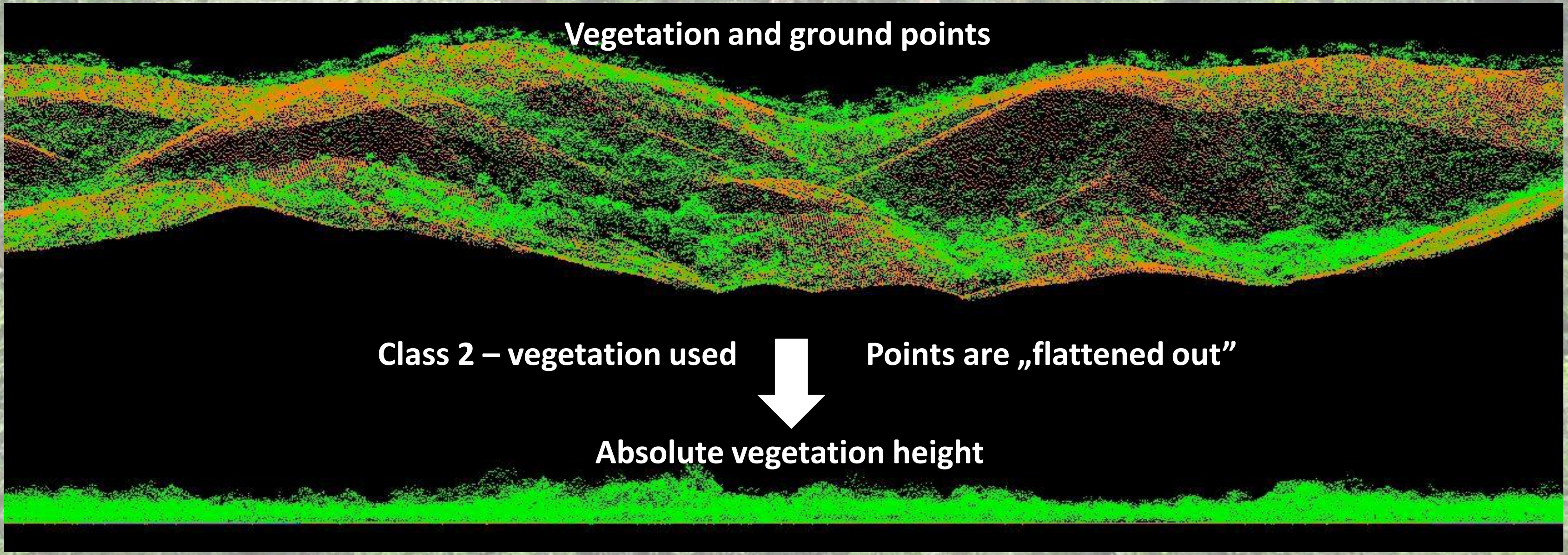


Source: TerraScan manual

Flightlines overlapping areas

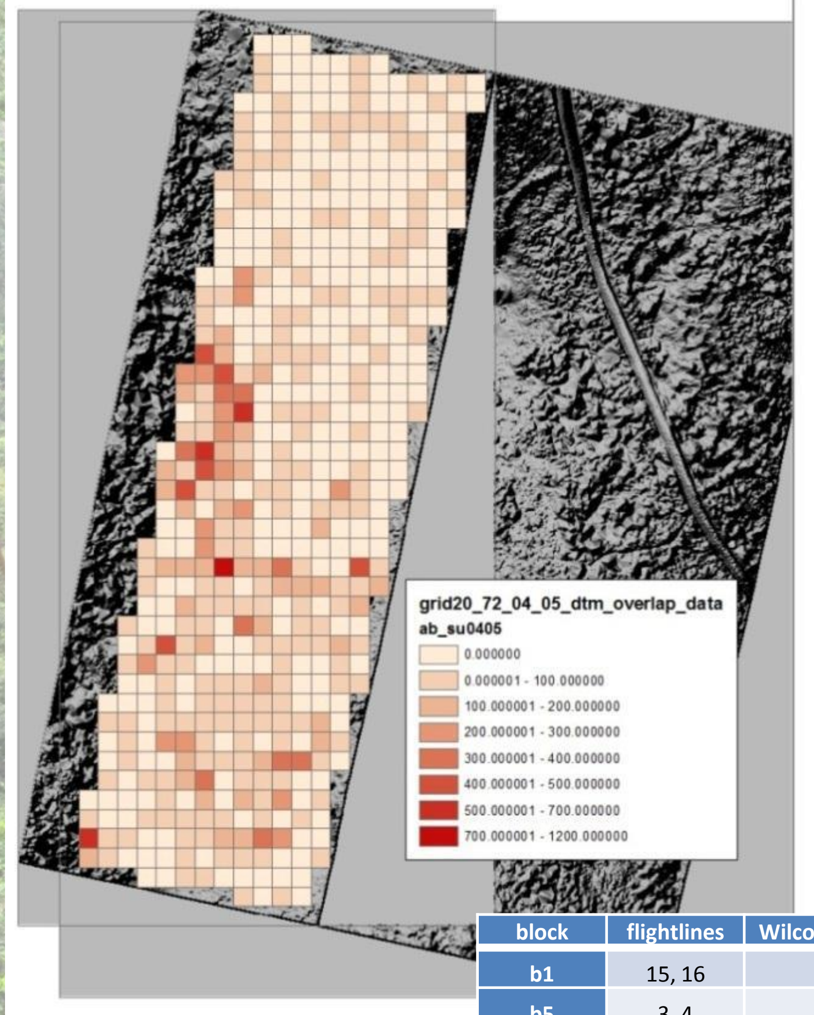


DZ transformation

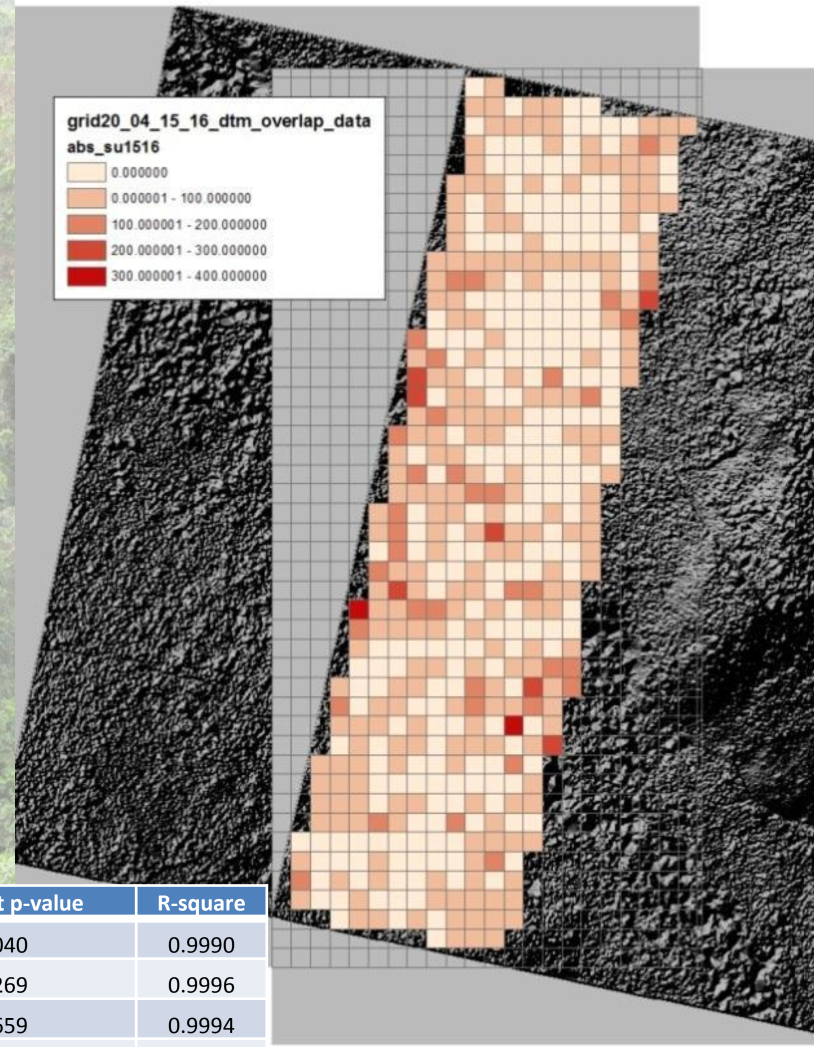


Flightlines overlapping Digital Terrain Models comparison

Error rates (mm) between overlapping flightlines 04 and 05



Error rates (mm) between overlapping flightlines 15 and 16



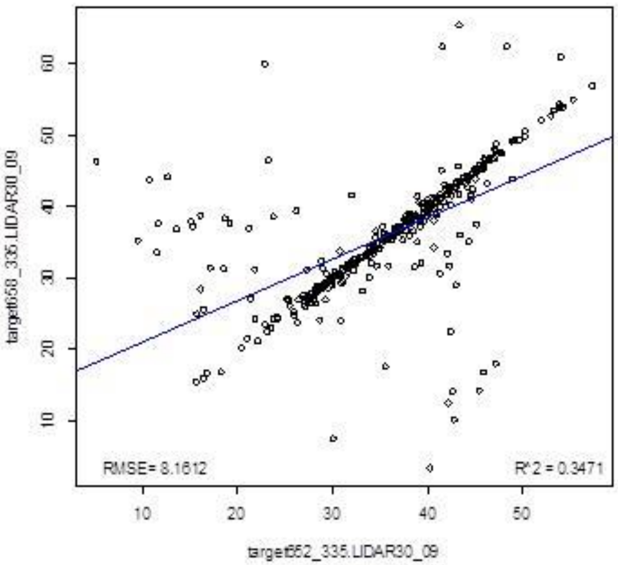
block	flightlines	Wilcoxon test p-value	R-square
b1	15, 16	0.9040	0.9990
b5	3, 4	0.9269	0.9996
b5	4, 5	0.9659	0.9994
b7	8, 9	0.9052	0.9999
b6	18, 19	0.9590	0.9987

LiDAR_30 features analysis

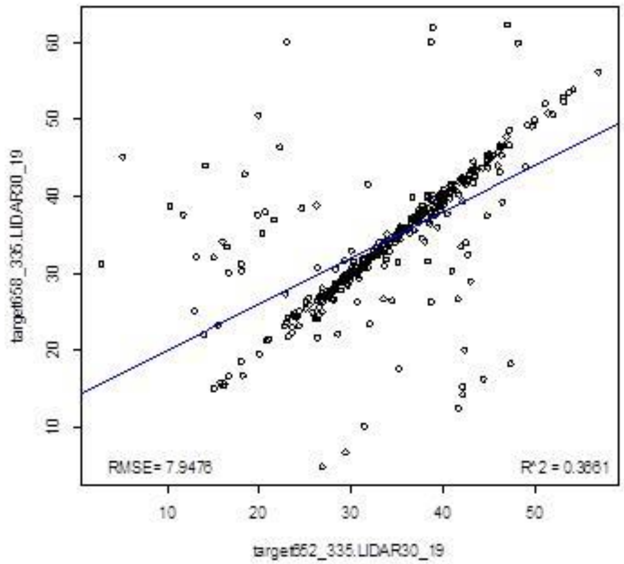
LiDAR _30 features – Arbolidar tool developed by Virppi and Juntilla containing a set of thirty features describing some vegetation parameters based on first and last laser pulse points.

1..10	Height of the 10%, 20%, 30% … 100% percentile for first pulse points.
11..20	Height of the 10%, 20%, 30% … 100% percentile for last pulse points.
21..23	Intensity for which the cumulative sum of ordered first pulse intensities is closed to 30%, 60% and 90% of the total intensity sum.
24..26	Intensity for which the cumulative sum of ordered first pulse intensities is closed to 30%, 60% and 90% of the total intensity sum.
27	Mean height of first pulse high vegetation points (points over highveg_threshold m).
28	Standard deviation of first pulse heights.
29	The ratio of the below vegetation first pulse points (points under ground_threshold m) and all first pulse points.
30	The ratio of the below vegetation last pulse points (points under ground_threshold m) and all last pulse points.

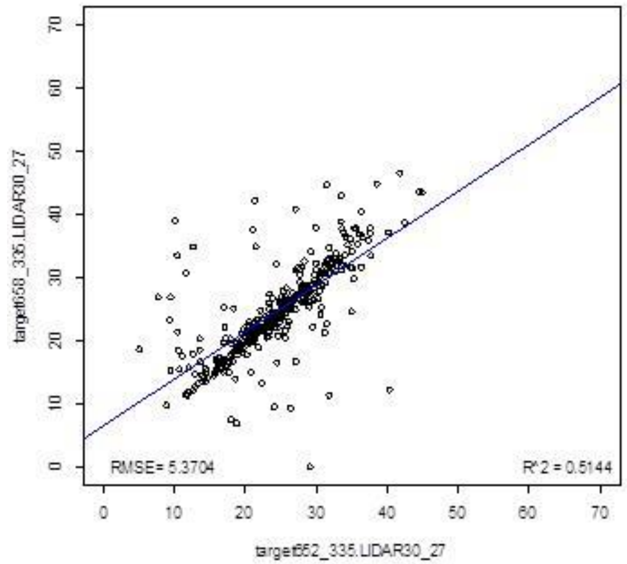
LiDAR_30 features analysis



90% percentiles of first pulse points between overlapping flightlines 652 and 658



90% percentiles of last pulse points between overlapping flightlines 652 and 658



Mean heights of first pulse high vegetation points between overlapping flightlines 652 and 658

LIDAR30 feature	R^2	LIDAR30 feature	R^2
1	0,5358	16	0,4791
2	0,5625	17	0,4418
3	0,5661	18	0,3957
4	0,5094	19	0,3661
5	0,4999	20	0,3168
6	0,4389	21	0,4353
7	0,4005	22	0,3323
8	0,3786	23	0,1680
9	0,3471	24	0,5188
10	0,3000	25	0,4528
11	0,5518	26	0,3943
12	0,5195	27	0,5144
13	0,5293	28	0,4552
14	0,4903	29	0,5463
15	0,4938	30	0,2428

Conclusions

- Similarity in Digital Terrain Models of overlapping flightlines data (despite dense vegetation)
- On some locations - significant differences in vegetation parameters between flightlines data due to outlying values
- Outliers are caused by scanning angles, measurement errors, positioning errors, varying ecotypes, varying topography and Above Ground Level of laser scanning altitude differences
- Outliers need to be eliminated by some method

Further research tasks (to be continued)

- ❑ Field measurements (not completed) as reference data
- ❑ Estimation of forest parameters (biomass)

References

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- Virpi Junttila (2010) Lidar-measurement based Forest stand parameter estimation using Sparse Bayesian model,
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- Form TECH-4: Description of Approach, Methodology and Work Plan for Performing the Assignment – Selection of Consultants for republic of Ghana

Thank you for your attention