Utilizing UAV and LiDAR technology for coastal erosion study: Importance of sensor calibration and methodology proposal

Régis GALLON[1], Antoine COLLIN[2], Dorothée JAMES[2], Emmanuel POIZOT[1]

[1] Conservatoire National des Arts et Métiers, INTECHMER, 50110 Cherbourg-en-Cotentin, France; (regis.gallon ; emmanuel.poizot)@lecnam.net

[2] Coastal GeoEcological Lab, Ecole Pratique des Hautes Etudes, PSL University, Dinard, France; (antoine.collin ; dorothee.james)@ephe.psl.eu

Why using AUV and limitations ?

2 k€ to 20 k€ for professional UAVs

Easy to deploy
Flight over 40 minutes

several sensors available
(photography, thermal, multispectal, LiDAR,...)

High temporal and spatial resolution
> 2km² per day
< 2cm per pixel

Useful tools for coastal zone management

- Coastal land cover mapping
- Sedimentary dynamics
- Coastal disaster management

BUT

How can you be sure of the quality of the data acquired ?

Can data from different drones/sensors be comparable ?

A proposal methodology for LiDAR sensors

1 *Find a flight site with different substrates and install GCPs (n=9)*

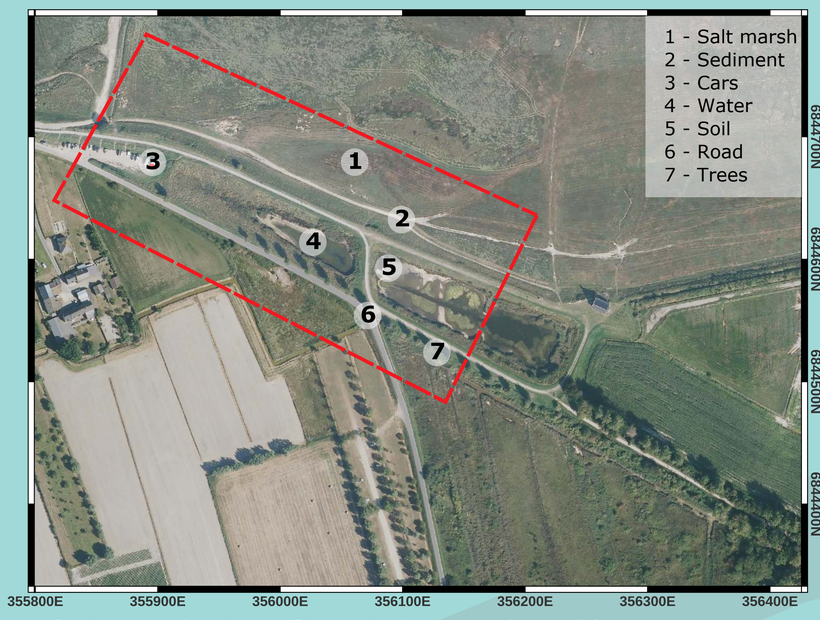


Fig 1 : Localisation of the study area, the red box represents the flight area.

2 *Test different flight configurations*

- Two configurations mixed (DJI M300 L1 + D RTK2)
- Two GNSS with NTRIP (Teria):Emlid and Trimble R12

Tab 1 : Description of each flight

	UAV	Antenna	Correction
Flight 1	M300_1	D RTK2_1	Emlid
Flight 2	M300_1	D RTK2_2	Emlid
Flight 3	M300_1	NTRIP	-
Flight 4	M300_2	D RTK2_1	R12
Flight 5	M300_2	D RTK2_2	R12
Flight 6a	M300_2	D RTK2_2	-
Flight 6b	M300_2	D RTK2_2	Post-correction*
Flight 7	M300_2	NTRIP	-

* alignment with CloudCompare

Altitude: 50m
Speed: 4m/s
Area: 0.3 km²
Time: 12 min

3 *Analysis process*

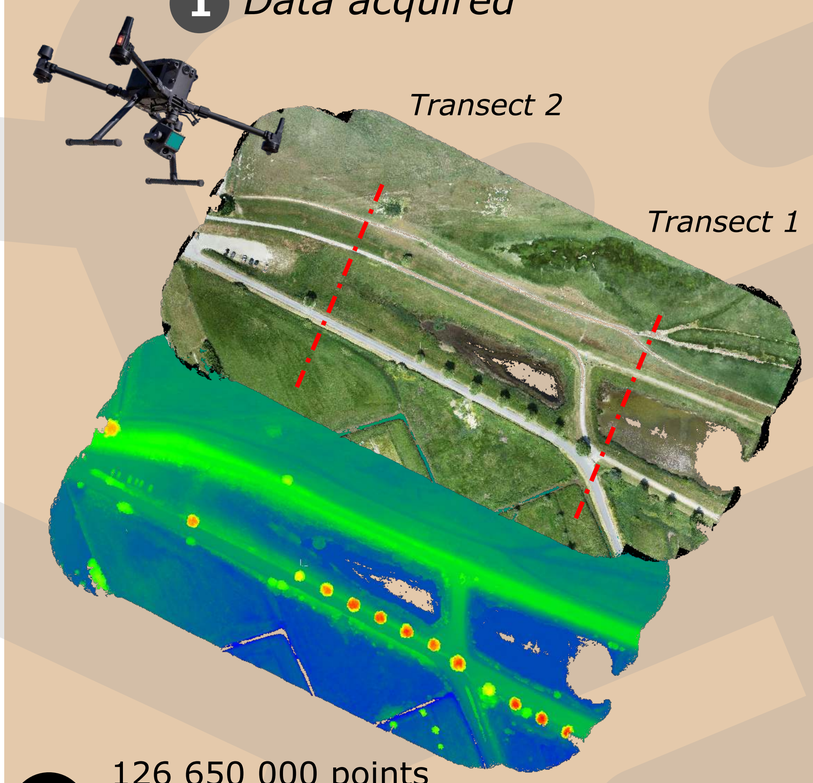
DJI Terra
- **Convert L1 to las files**
  - SCR : RGF93 / L93
  - Geoid : GRS80

CloudCompare
- **Cleaning las files**
  - Remove birds
  - isolated points
- **Alignment with GCPs**

lidR
- **Statistical analysis**

Results and discussion

1 *Data acquired*



126 650 000 points
2 447 points / m²
4Go per file

2 *Comparaison of GNSS data*

Emlid vs. Trimble R12

Tab 2 : Root-mean-square error of GCPs measurements between Emlidand Trimble R12

	RMSE
X(m)	0,003
Y(m)	0,005
Z(m)	0,007

3 *Comparaison L1 data vs. GCPs*

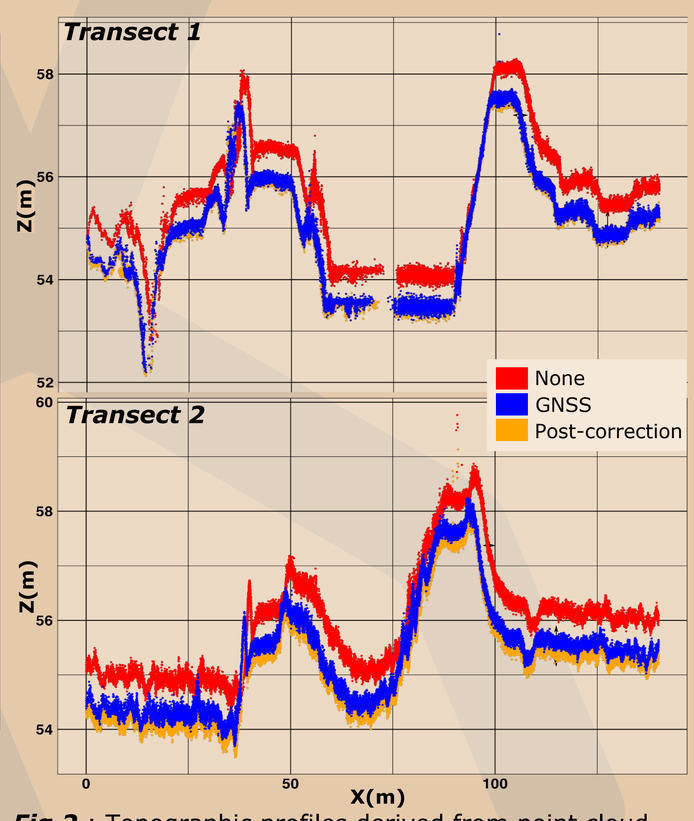


Fig 2 : Topographic profiles derived from point cloud without correction (red), with correction (blue), with post-correction (orange)

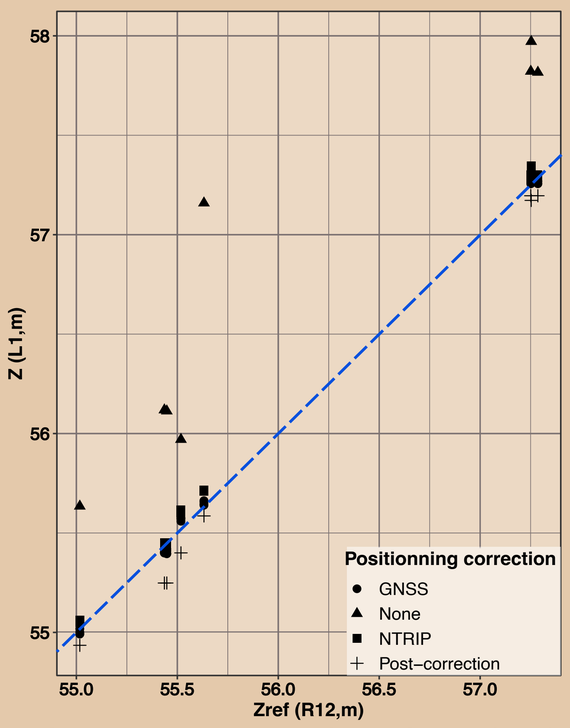


Fig 3 : Comparative Analysis of GCP altitude measurements obtained by LiDAR L1 with various corrections and altitude measurements acquired by the trimble R12.

Tab 3 : Root-mean-square error of GCPs measurements between four correction procedure

Z(m)	*GNSS*	*NTRIP*	*None*	*Post-correction*
RMSE	0,023	0,027	0,278	0,042

- ***High Precision GNSS Receivers (<1cm Accuracy) - Tab2***
- ***Without D-RTK2 antenna correction, there are offsets in X-Y (1.24m) and Z (0.72m) - Fig 2, Fig 3***
- ***Correction of the position D-RTK2 antenna by an RTK GNSS receiver significantly enhances precision.***
- ***Utilizing Differential GPS Corrections via the Internet also yields precise data; however, it needs a stable and robust internet connection throughout the entire flight.***

Conclusion

- The use of drones has enabled coverage of numerous coastal areas, but it is important to conduct calibration exercises to systematically compare sensor performances (LiDAR, photogrammetry, etc.)
- It is important and urgent to develop a national coastal study network utilizing drones.