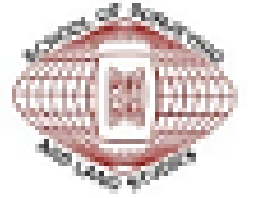


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‘Application of Aerial LiDAR Technology in Surveying and Mapping; A Case Study of Lae main Wharf Extension, PNG Ports, Lae, MP, PNG’

-Ongoing Research-

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58th Association of Surveyors PNG Congress, 01rd – 05th June., 2026



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1. Introduction

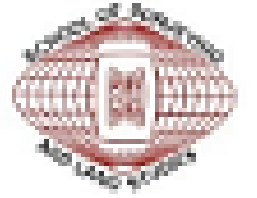
To cope up with the growth in technology, Surveying aspect of the engineering, construction, building or land acquisition has also been exposed to many updated survey technologies. Surveyors and Mappers in PNG are continuously in search of a safe, fast and accurate technology to tame the well-known unfriendly terrain of Papua New Guinea. One of those emerging surveying and Mapping technology that a very handful of surveyors are using in the country is the LiDAR (Light Detection and Ranging) technology.



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1.1. Background

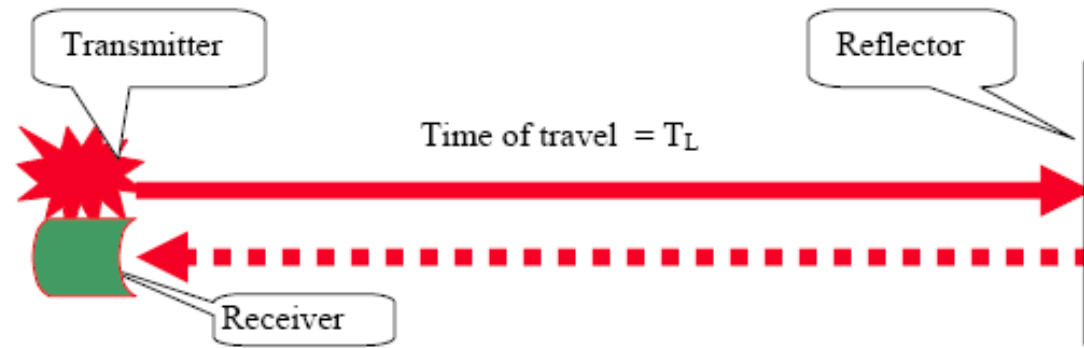
LiDAR (Light Detection and Ranging) is a remote sensing technology that uses laser beams to measure distances and create 3D models of the environment, offering precise and detailed data for various applications, including mapping, surveying, and autonomous navigation.

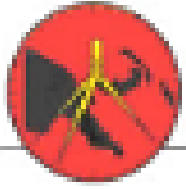




1.1. Background

The principle of LiDAR is similar to Electronic Distance Measuring Instrument (EDM), where a laser (pulse or continuous wave) is fired from a transmitter and the reflected energy is captured. Using the time of travel (ToT) of this laser the distance between the transmitter and reflector is determined.

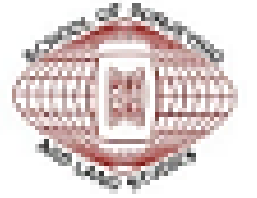




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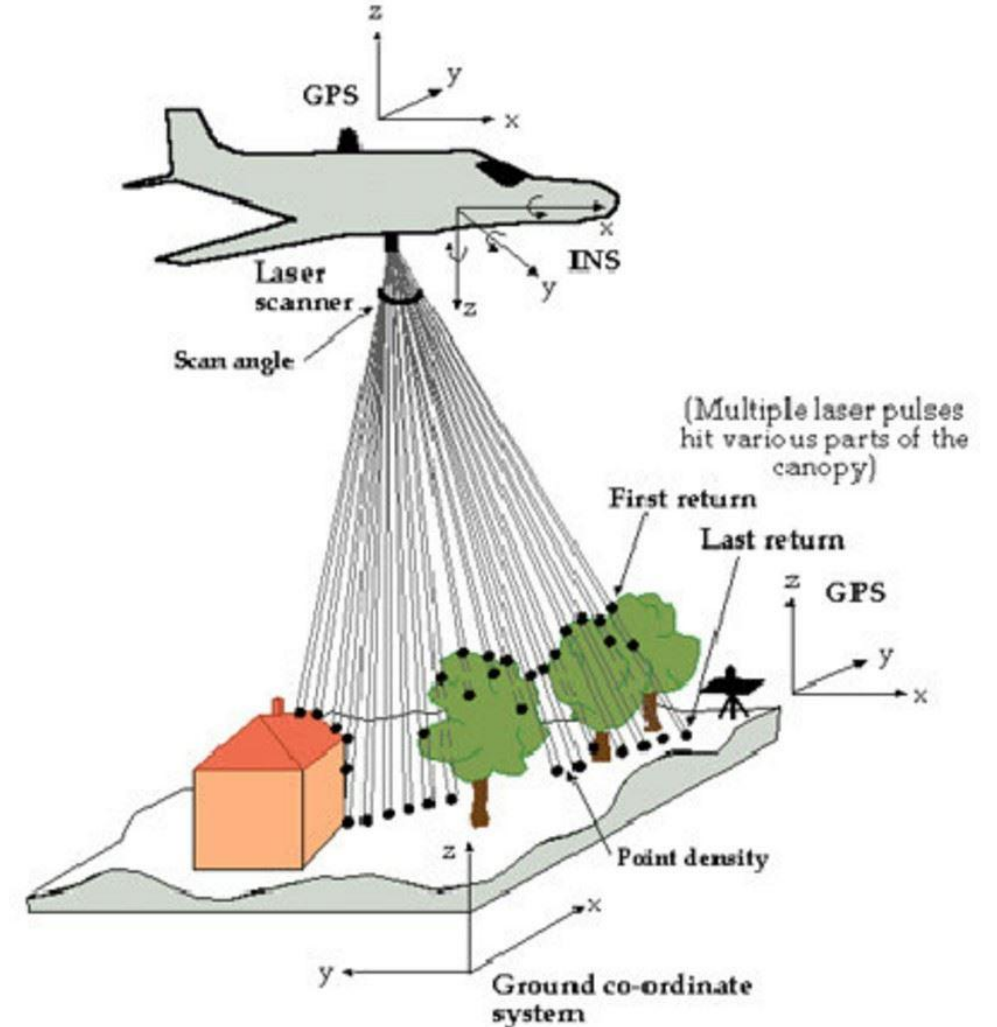


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1.1. Background

LiDAR is similar to Electronic Distance Measuring Instrument (EDM), where a laser (pulse or continuous wave) is fired from a transmitter and the reflected energy is captured. Using the time of travel (ToT) of this laser the distance between the transmitter and reflector is determined.





1.2. Project Objectives

- **Establish a reliable project control framework using existing survey marks and newly installed CPs/GCPs.**
- **Collect high-resolution UAV LiDAR data across the designated survey areas.**
- **Validate and process GNSS and LiDAR datasets to produce preliminary point clouds and digital elevation models (DEMs) for review**



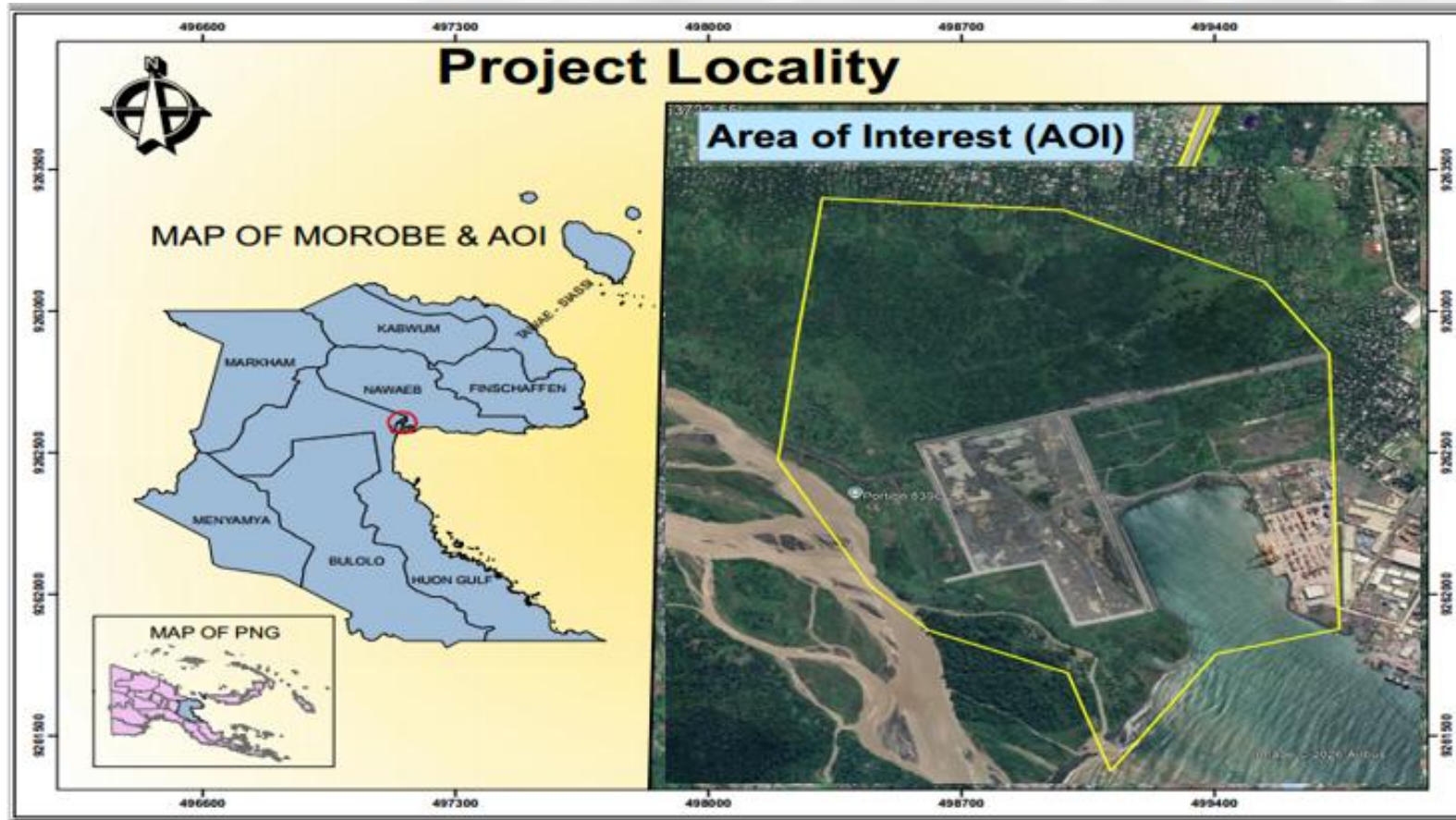
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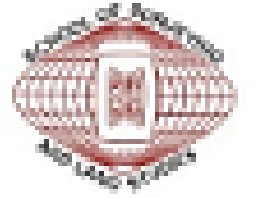
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1.3. Project Location and Site description



**Lae main Wharf
Extension, PNG
Ports, Lae, MP, PNG'**



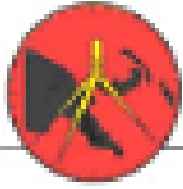
1.3. Project Location and Site description



Mostly Swamp – Walking the area is very difficult

- Not easy for TS and GNSS
- Drone Photogrammetry also not applicable because of too much reflective water surface

Approx. 450Ha



2. Methodology

2.1. Survey Control Establishment

- Established new GCPs across the project area to support accurate georeferencing of LiDAR data.

- Documented and photographed each GCP location for records and validation.
- Set up the GNSS receiver base station on the primary control point (PSM 2046) to serve as the baseline reference.



*Figure 2 Base Set up at
PSM 2046 PNG Ports
Gate*





2. Methodology

2.1. Survey Control Establishment

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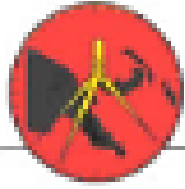
**Figure 2 Base Set up at
PSM 2046 PNG Ports
Gate**

Base station

- Hi-Target V200 GNSS Receiver*
- 9hours observation*
- Rinex Data sent to AUSPOS*
- Data converted to PNG94*

3.3 UTM Grid, GRS80 Ellipsoid, ITRF2020

Station	East (m)	North (m)	Zone	Ellipsoidal Height (m)	Derived Above Geoid Height(m)
PSM 2064	498297.611	9255181.407	55	76.065	4.044
ALIC	386353.428	7381852.654	53	603.249	588.105
CKTN	312225.781	8290082.804	55	72.415	8.131
COEN	735157.061	8455756.967	54	254.682	190.229
DARW	731470.288	8579191.543	52	125.106	74.646



2. Methodology

2.1. Survey Control Establishment

GCP and CP Establishments

- *30 minutes observations per station for 39 stations*
- *Data post-processed, baseline correction applied in Topcon/Magnet Tool software*
- *7 GCPs and 32 CPs/LVPs*



	E	F	G	
m)	Std Dev n	Std Dev e	Std Dev u	Co
	0	0	0	
	0.001	0.001	0.004	
	0.001	0.001	0.004	
	0.002	0.002	0.003	
	0.003	0.003	0.005	
	0.002	0.002	0.003	
	0.002	0.002	0.003	
	0.004	0.004	0.008	
	0.004	0.005	0.01	
	0.001	0.001	0.004	
	0.002	0.002	0.004	
	0.002	0.002	0.002	
	0.003	0.002	0.003	
	0.004	0.004	0.008	
	0.003	0.003	0.004	
	0.004	0.003	0.004	
	0.002	0.002	0.002	
	0.003	0.003	0.003	
	0.003	0.002	0.003	



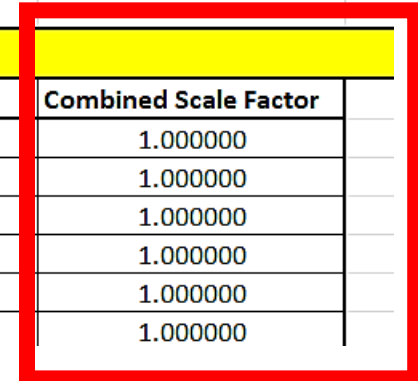
2. Methodology

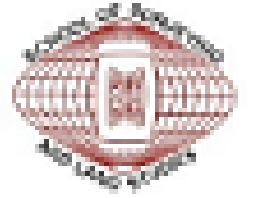
2.1. Survey Control Establishment

GCP and CP Establishments

- *Control points also projected on Local grid (Ports2020) to cater for scale distortions*

16	CP27	496431.837	9255514.29	4.013	0.002	0.002	0.002	1.000412
17	CP30	496892.799	9255298.247	4.39	0.003	0.003	0.004	1.000412
18	CP32	496284.684	9256264.036	3.549	0.002	0.002	0.001	1.000412
19	CP5	496958.424	9255454.542	4.168	0.003	0.003	0.004	1.000412
20	CP7	496377.133	9256090.894	4.078	0.002	0.002	0.002	1.000412
21	CP9	497086.819	9255575.475	3.547	0.003	0.002	0.003	1.000412
22	CP11	497082.836	9255936.903	3.668	0.007	0.006	0.011	1.000412
23	CP14	497329.767	9256082.546	3.139	0.005	0.006	0.008	1.000412
24								
25	PNG Ports Lidar Control Points on - LTM PORTS94							
26	Name	Easting (m)	Northing (m)	CH RL	Std Dev n (m)	Std Dev e (m)	Std Dev u (m)	Combined Scale Factor
27	PSM2046	4000	5000	4.47	0	0	0	1.000000
28	CH03	1917.836	5802.986	3.109	0.002	0.002	0.002	1.000000
29	CH04	1628.329	5947.925	3.521	0.003	0.002	0.003	1.000000
30	CH09	2525.74	5652.22	4.293	0.004	0.003	0.004	1.000000
31	CH12	2741.482	6322.446	3.838	0.002	0.002	0.002	1.000000
32	CH17	3242.52	6482.093	3.64	0.004	0.003	0.005	1.000000





2. Methodology

2.2. UAV/Drone Used



- *DJI Matrice 350 RTK*
- DJI Matrice 350 RTK (M350) is DJI's next-generation enterprise drone, evolving from the Matrice 300 RTK platform. It is designed for industrial, inspection, surveying, and emergency response applications, offering robust payload and expansion capabilities, advanced safety features, and a comprehensive hardware-software ecosystem.
- The DJI Matrice 350 RTK is a professional enterprise drone featuring up to 55 minutes of flight time
- *Source: DJI Website*



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2. Methodology

2.3. LiDAR Unit



- *DJI Zenmuse L1*
- The L1 was DJI's first integrated LiDAR payload. It made aerial LiDAR much cheaper and easier compared to systems from RIEGL, YellowScan, or Phoenix LiDAR.

It combines:

- IMU
- RGB camera
- 3-axis stabilized gimbal



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2. Methodology

2.3. LiDAR Unit - DJI Zenmuse L1



- *Main specs*
- *~240,000 points/sec*
- *Up to 3 returns*
- *20 MP RGB camera*
- *Detection range up to 450 m*
- *905 nm laser*



2. Methodology

2.3. LiDAR Unit - DJI Zenmuse L1



- Strengths

- *Much cheaper than traditional LiDAR*
- *Easy workflow with DJI Terra*
- Good for:
 - *stockpile surveys*
 - *corridor mapping*
 - *basic forestry*
 - *construction progress*
 - *terrain models*



2. Methodology

2.3. LiDAR Unit - DJI Zenmuse L1



- ***Weaknesses***
- *Noisy point clouds compared to higher-end systems*
- *Weaker canopy penetration*
- *Larger beam footprint*
- *Accuracy inconsistencies on larger sites reported by users*



2. Methodology

2.3. LiDAR Unit - DJI Zenmuse L1



- **Zenmuse L1 Accuracy**
 - **With ground controls (RTK/PPK and calibration flights), the Zenmuse L1 achieves a;**
 - ✓ **vertical accuracy of 5 cm**
 - ✓ **horizontal accuracy of 10 cm**
- at a 50 m flight altitude**

Source: DJI Website



2. Methodology

2.3. LiDAR Unit – DJI Zenmuse

<i>Feature</i>	<i>L1</i>	<i>L2</i>	<i>L3</i>
<i>Release</i>	2020	2023	2025
<i>Market Position</i>	<i>Entry LiDAR</i>	<i>Professional survey LiDAR</i>	<i>High-end enterprise LiDAR</i>
<i>Point Cloud Quality</i>	<i>Moderate</i>	<i>Very good</i>	<i>Excellent</i>
<i>Vegetation Penetration</i>	<i>Basic</i>	<i>Strong</i>	<i>Excellent</i>
<i>Returns</i>	3	5	16
<i>RGB Camera</i>	20 MP	4/3 CMOS	Dual 100 MP
<i>Long-Range Capability</i>	<i>Limited</i>	<i>Moderate</i>	<i>Exceptional</i>
<i>Best Use</i>	<i>Basic topo</i>	<i>Most survey work</i>	<i>Large-scale/high-precision projects</i>
<i>Typical Buyer</i>	<i>Small mapping company</i>	<i>Professional survey teams</i>	<i>Large enterprise/government</i>

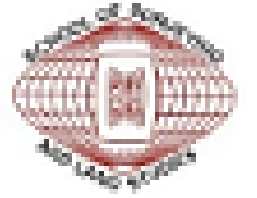
Source: DJI Website



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3. Data collection and processing

3.1. Data Collection – LiDAR Scanning – Zenmuse L1



Flight Height: 100m

Overlaps: 30%





3. Data collection and processing

3.1. Data Collection – LiDAR Scanning



Project snapshot

Item	Value
Coordinate system	WGS 84 / UTM zone 55S (Default)
Payload	DJI Zenmuse L1 (SN: 3FCDJ61004TXGR)
Flights	5
LiDAR point cloud blocks	124

Processing density setting	High (100%)
POS status	Fix 100%

Flight Height: 100m

Overlaps: 30%

5 Flights



3. Data collection and processing

3.2. Data Processing – DJI Terra (v 5.1.1)

DJI Terra Lidar requirement;

- Processor: i7
- RAM: 32GB
- Constant power plugged
- Free Storage of 500GB or more
- PGK 12K + /yr for License





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3. Data collection and processing

3.2. Data Processing – DJI Terra (v 5.1.1)

Horizontal Datum:

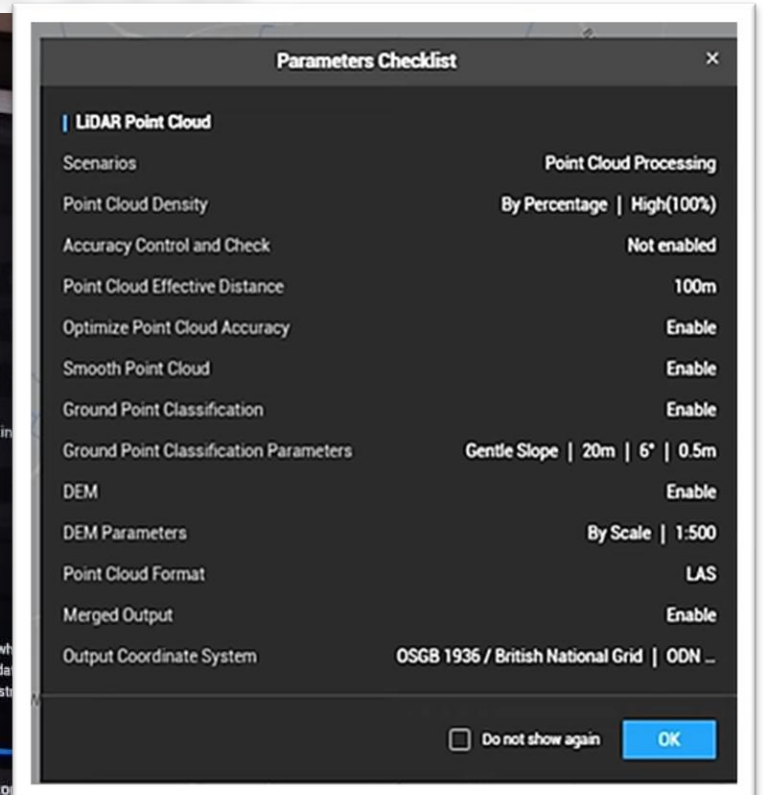
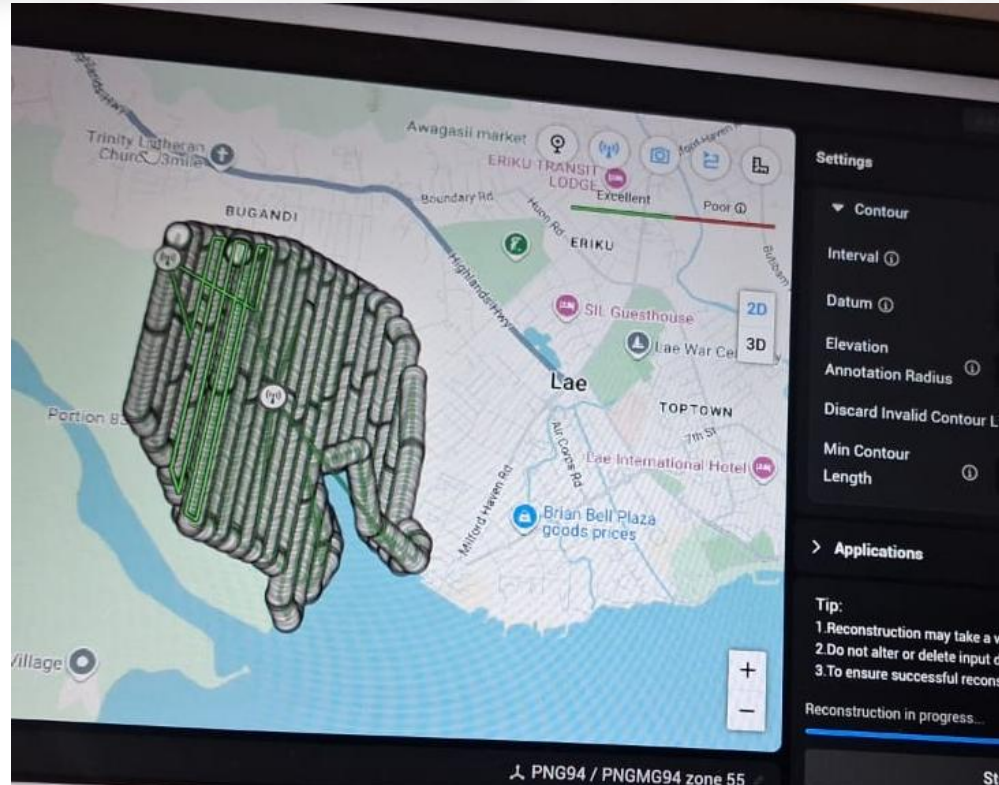
PNGMG94 UTM Zone 55

Ports2020 LTM

Vertical Datum:

PNG08

Chart Datum





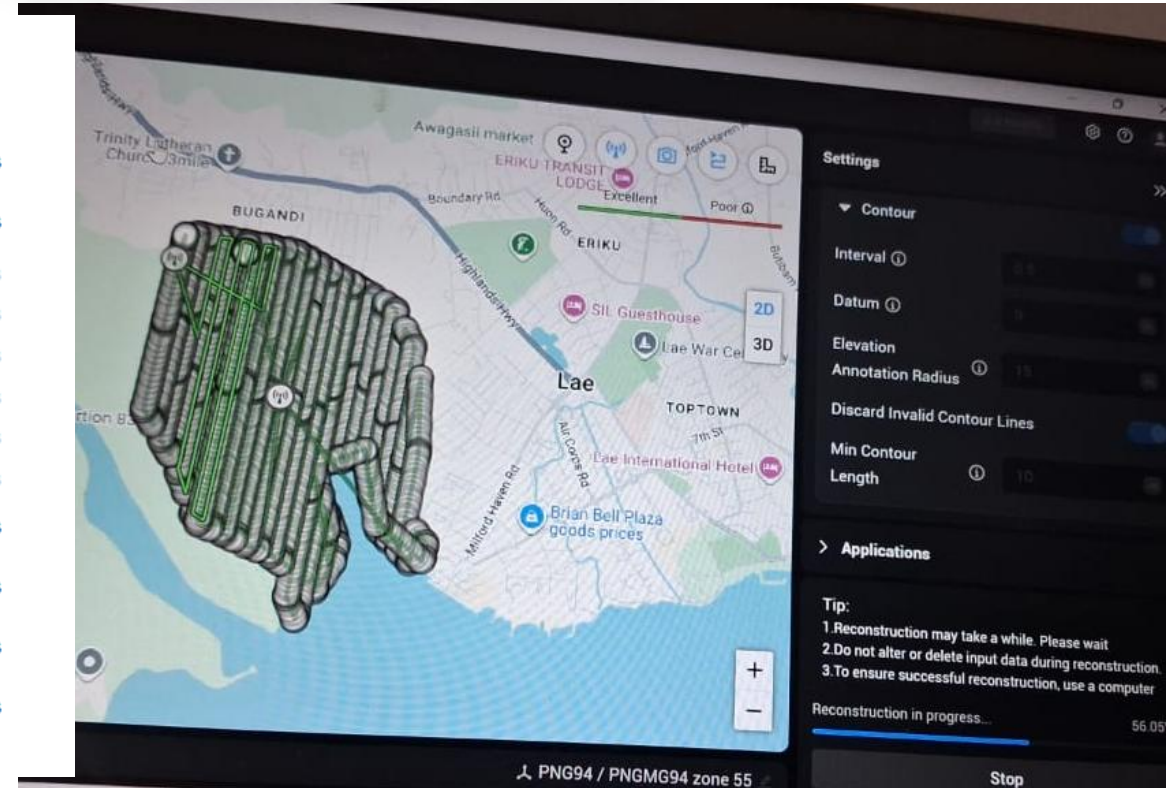
3. Data collection and processing

3.2. Data Processing – DJI Terra (v 5.1.1)

🕒 Software Processing Time



POS Calculation	1h 27min 38s
Point Cloud Optimization Time	15h 11min 4s
<ul style="list-style-type: none"> • POS Calculation • Point Cloud Accuracy Optimization Time • Smoothing Point Cloud Time • Point Cloud Colorization Time • Output Saving Time • Others 	<ul style="list-style-type: none"> 1h 27min 38s 6h 46min 11s 28min 9s 6min 38s 6min 2s 7h 44min 3s
2D Map Generation Time	4h 24min 6s
Ground Point Classification Time	9min 26s
DEM Generation Time	26min 48s
Contour Generation Time	10min 54s





3. Data collection and processing

3.2. Data Processing – DJI Terra (v 5.1.1) – Accuracy Validation

⊕ IMU Trajectory Error

Parameters	X(E) RMSE	Average X(E)	Y(N) RMSE	Average Y(N)	Z(U) RMSE	Average Z(U)
Location	0.00008 m	0.00565 m	0.00007 m	0.00563 m	0.00008 m	0.00575 m
Attitude	0.0000084 rad	0.0001876 rad	0.0000034 rad	0.0001838 rad	0.0001178 rad	0.0006406 rad

⊕ Point Cloud Control Point Error

Parameters	No. of Control Points	Average Altitude	Average Altitude Difference	Min Altitude Difference	Max Altitude Difference	Average Absolute Value of Altitude Difference	Root Mean Square	Standard Deviation
Value	7	3.775429 m	-0.004915 m	-0.04179 m	0.023011 m	0.013332 m	0.018831 m	0.020339 m

⊕ Point Cloud Check Point Error

Parameters	No. of Check Points	Average Altitude	Average Altitude Difference	Min Altitude Difference	Max Altitude Difference	Average Absolute Value of Altitude Difference	Root Mean Square	Standard Deviation
Value	30	3.8723 m	-0.000445 m	-0.460087 m	0.507148 m	0.223006 m	0.268472 m	0.27479 m

☐ Point Cloud Check Point List



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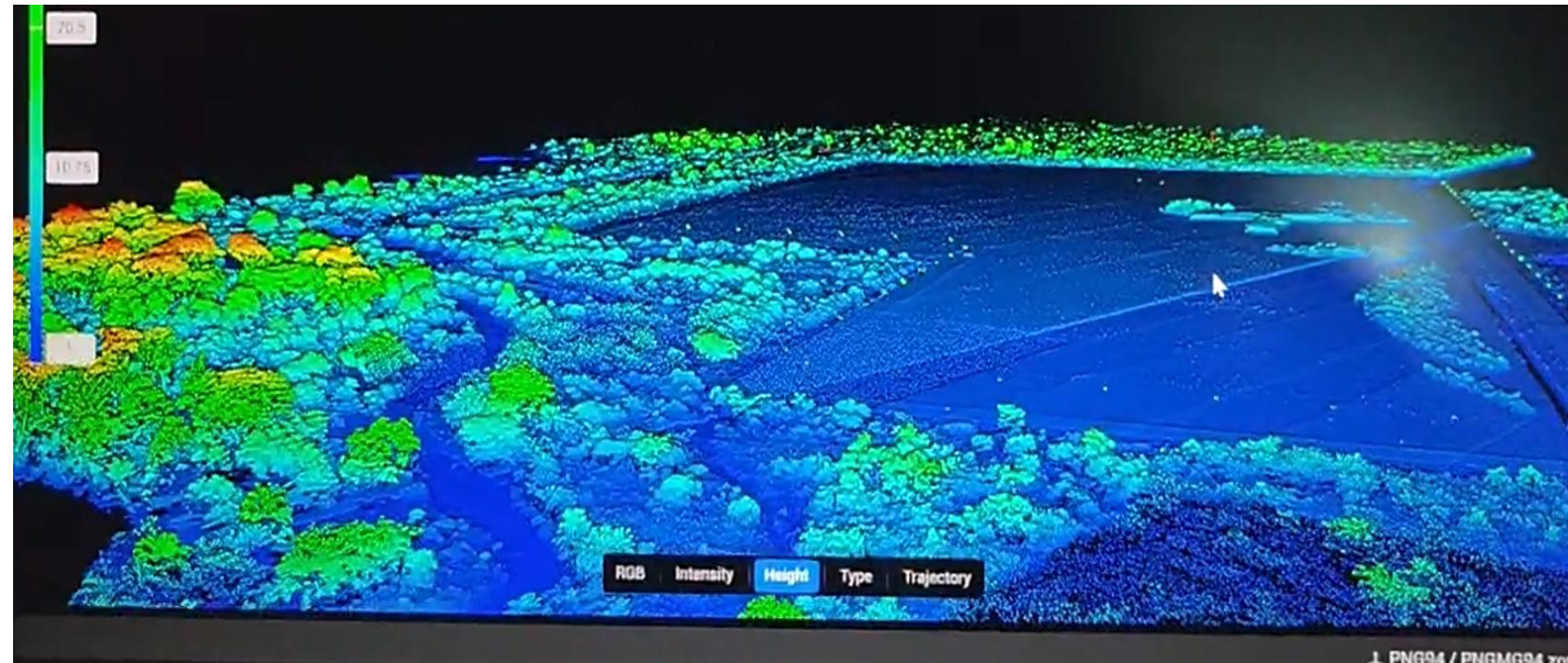
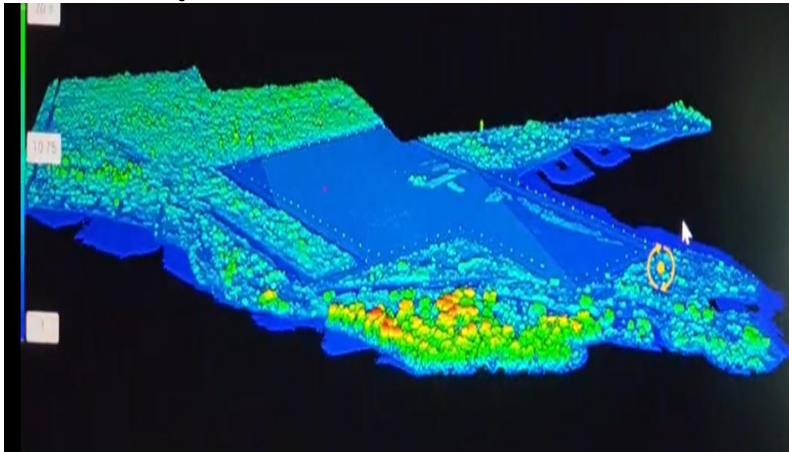
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3. Data collection and processing

3.2. Data Processing – DJI Terra (v 5.1.1)

Point Cloud
Density = 100%
Classified LiDAR
point cloud

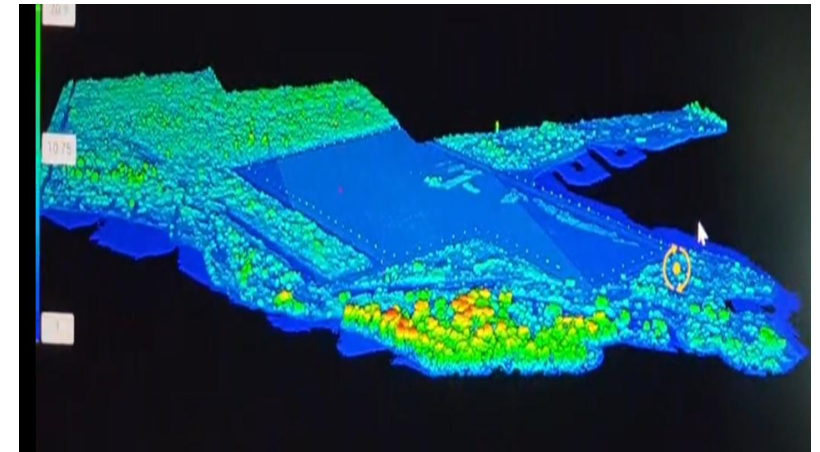
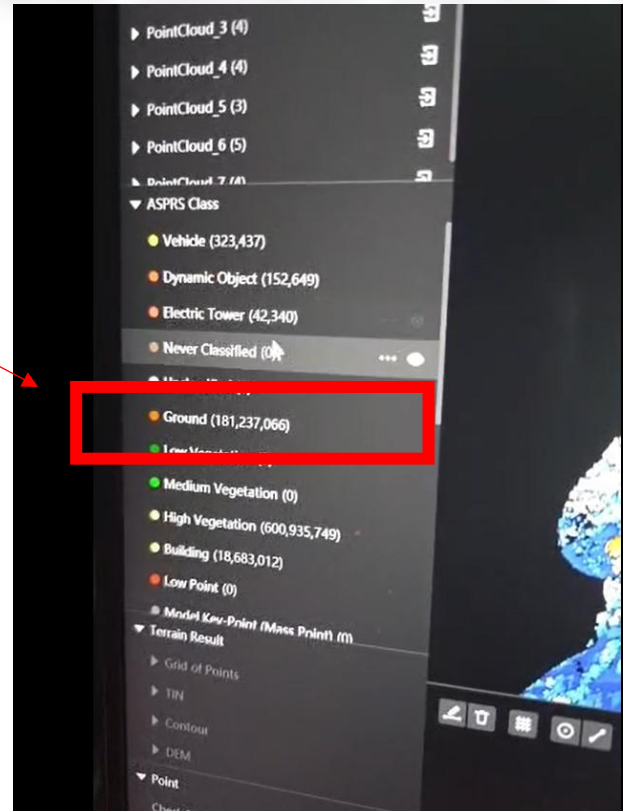




3. Data collection and processing

3.2. Data Processing – DJI Terra (v 5.1.1) – Exporting ground points

Point Cloud
Density = 100%
Classified Ground
points
= 181 237 066





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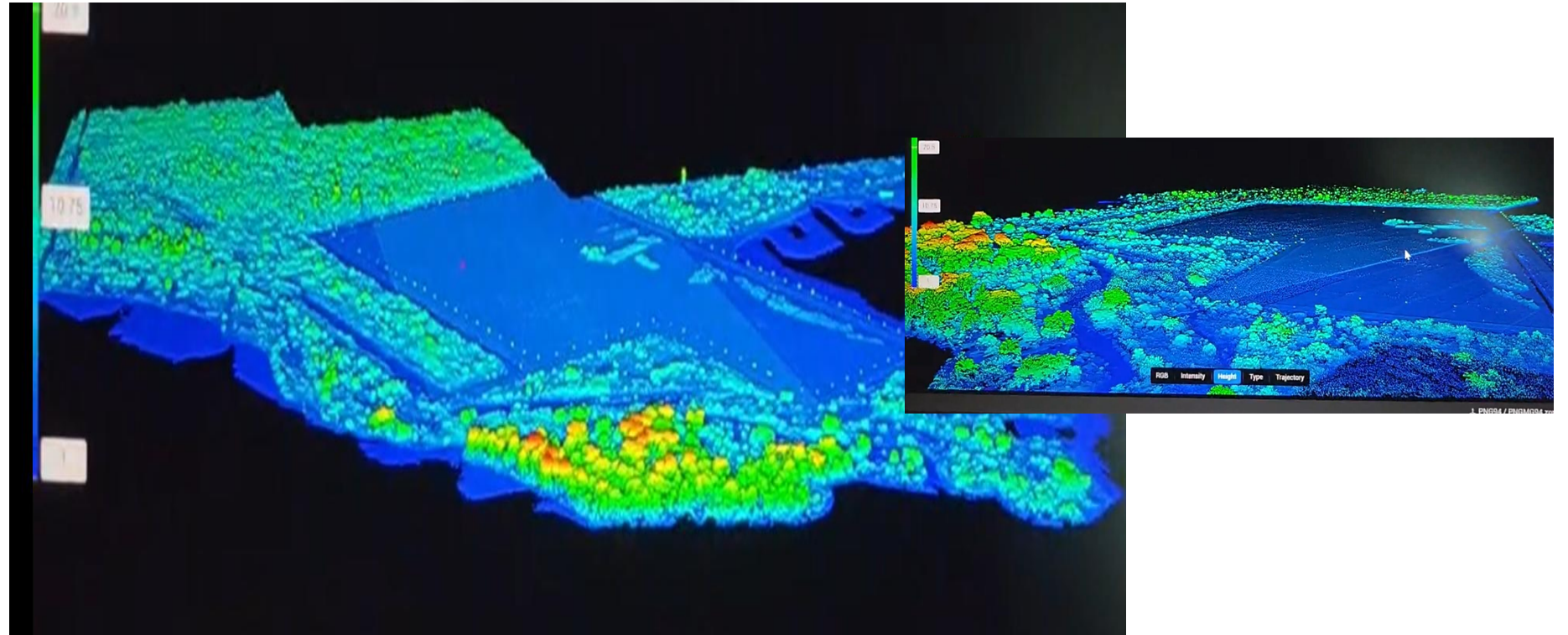
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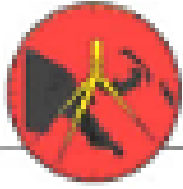


3. Results and Outputs

3.1. Deliveries

**Point Cloud
Density = 100%**
Classified LiDAR
point cloud
(.las/.laz)





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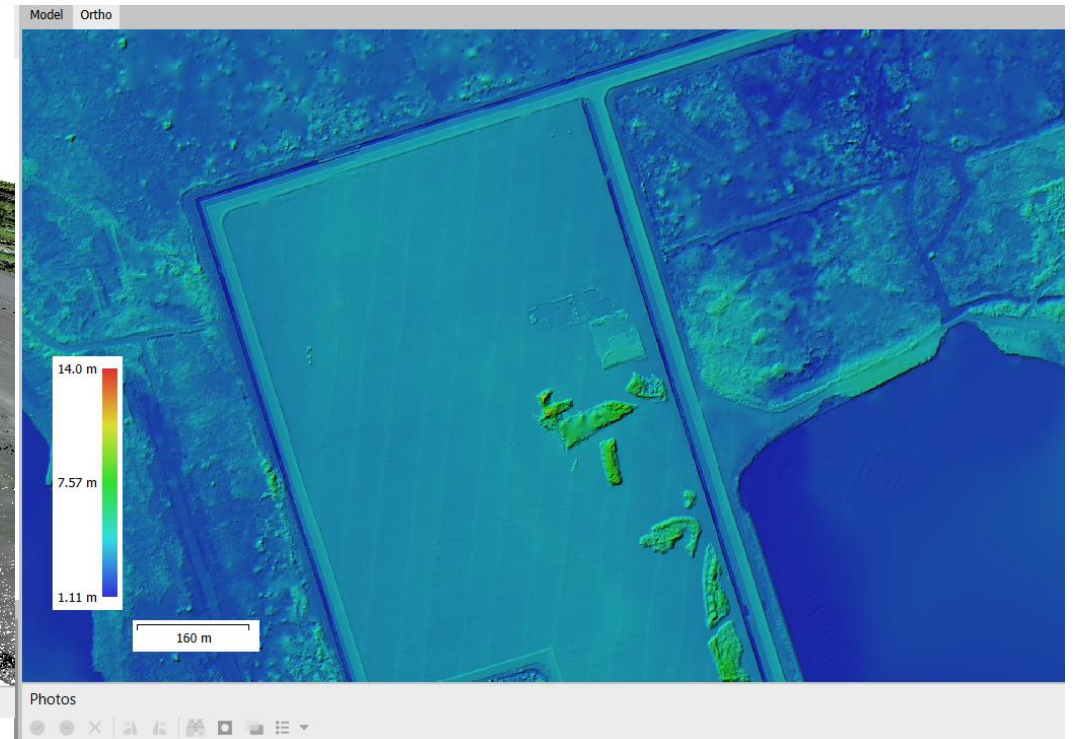
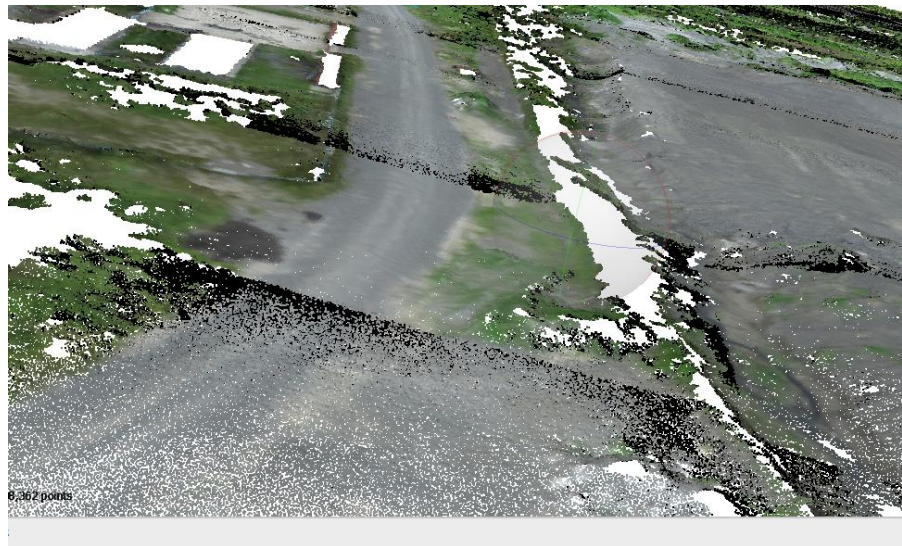
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3. Results and Outputs

3.1. Deliveries

DEM & DTM
(GeoTIFF)





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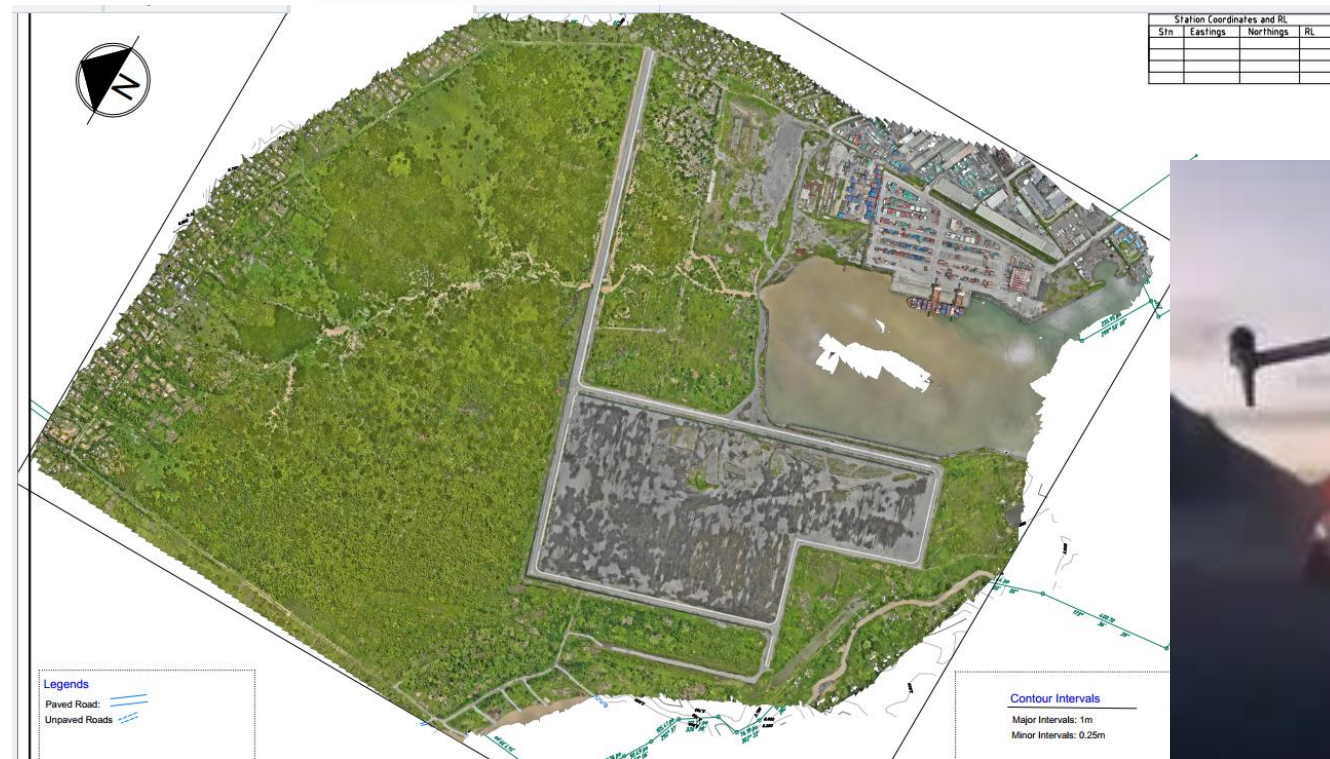
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3. Results and Outputs

3.1. Deliveries

Orthophoto mosaic
(GeoTIFF)



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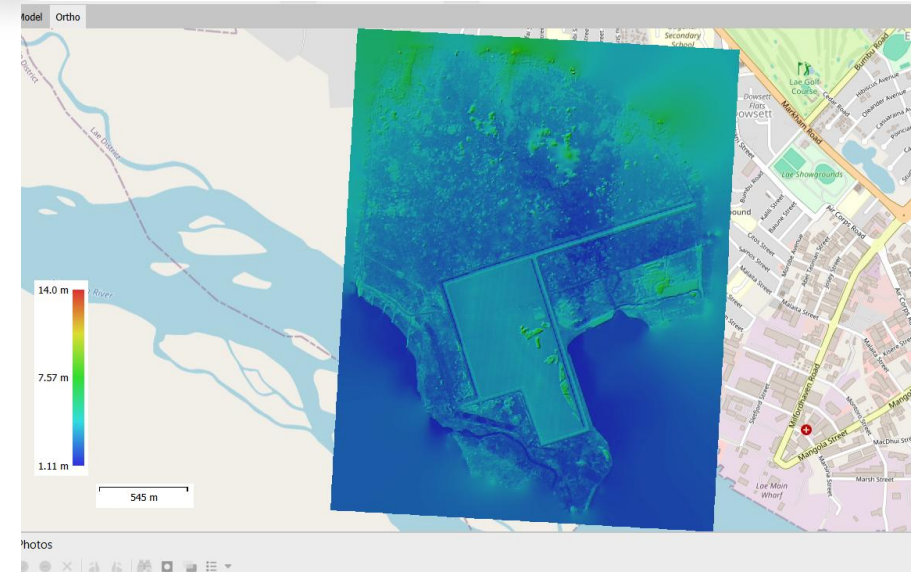
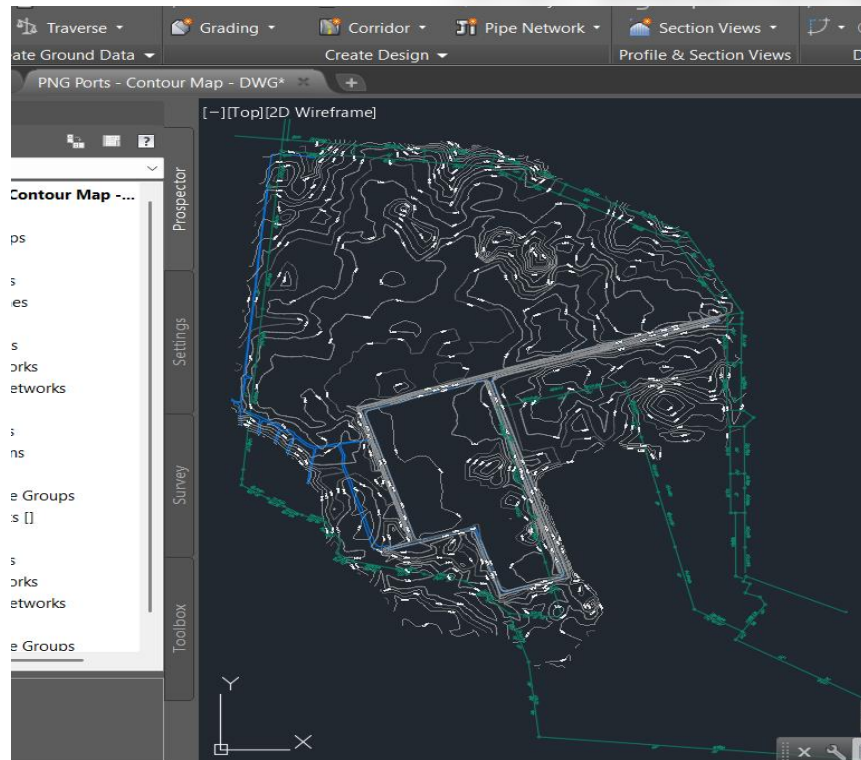
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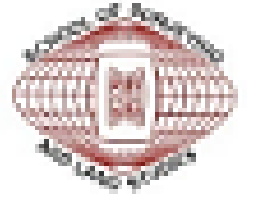


3. Results and Outputs

3.1. Deliveries

CAD drawings
(.dwg/.dxf)





4. Conclusions and Recommendations

4.2. Recommendations

- If you're looking to purchase an aerial Lidar – Purchase Zenmuse L2 or L3
- If you are using Zenmuse L1, Flight height should be below 50m.
- For dense areas or accurate engineering surveys, use Lidar with returns of 5 or more
- Have proper GCPs equally distributed
- Place CPs/VP on the center of an approx. flat area at least 3m radius out from point
- Lidar is best for 3D models, DEMs, DTMs which would assist in perfect designs and quality calculations/extractions
- With the help of accurate GCPs, Lidar can give exceptional positional accuracies for setout purposes when tied to controls and correction applied in field.



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-Ongoing Research-

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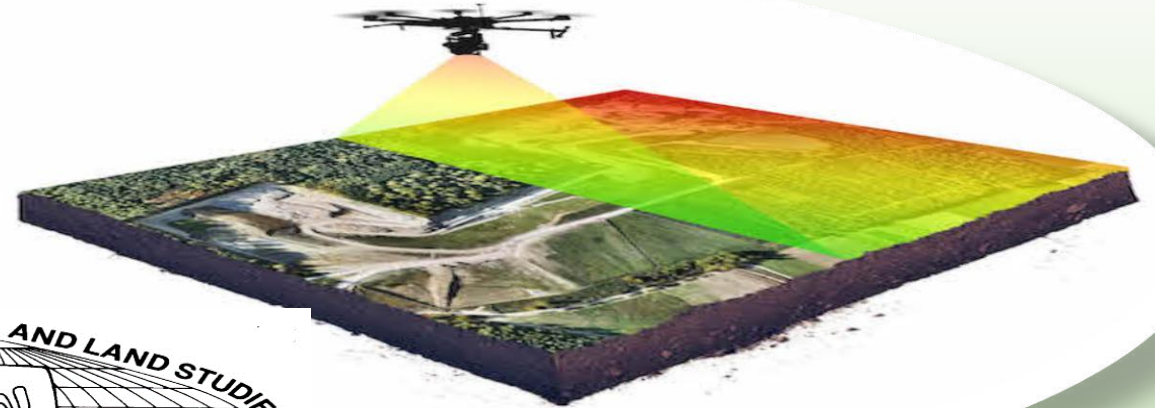
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Thank you!



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