UAV Technology Versus PNG's Conventional Surveying Methods in Cadastral Survey Applications

Author: Noel Peya

Department of Surveying & Lands Studies

Papua New Guinea University of Technology

noel.peya@pnguot.ac.pg

DEPT. OF SURVEYING AND LAND STUDIES
PNG UNIVERSITY OF TECHNOLOGY

Supervisor: Mr. Navua V. Kapi – DSLS, PNGUOT (Lecturer II)

55th Association of Surveyors PNG Congress, 16th – 18th August, 2023

Overview

1. Introduction & Background
2. Methods Used
3. Results & Discussion
4. Conclusion & Recommendations
5. References

Introduction/Background

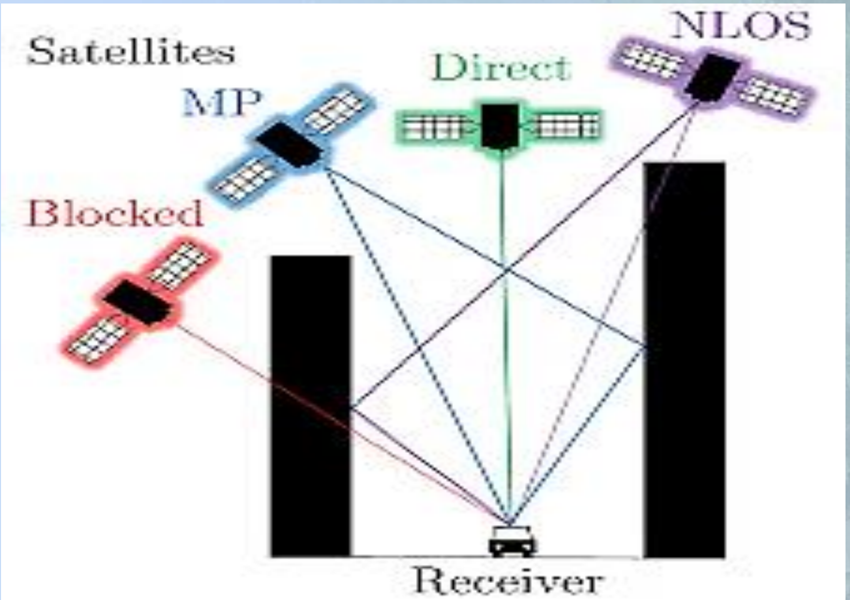
Surveyors in PNG are challenged with the country's difficult terrain which forces them to look for innovative ideas and latest technologies that could reduce risks, field exposure time while upholding the set accuracy specified for such surveys.

The conventional survey methods used in the country requires surveyors to be physically on the field/ground for data collections.

These surveying techniques and equipment that requires surveyors to be physically-on-field for data acquisition exposes surveyors to hazardous areas like difficult terrain, dense vegetation, inaccessible areas and sometimes leads to disagreements and 'violent landowner actions' due to misunderstanding. Thus, the safety of the surveyor is at risk most times.

Introduction/Background

Although the use of total station and GPS/GNSS receivers are widely accepted in PNG for cadastral surveys, they are sometimes unfavorable in some conditions. When surveying crowded urban areas, total station would require a point-to-point visibility and GNSS receivers would require enough satellite reception which is not that easy to meet resulting in time loss, increased cost and intense labor .



Introduction/Background

One of those emerging survey technology that a handful of surveyors are using in PNG is the Unmanned Aerial Vehicle (UAV), commonly known as Drone.

An increasing number of surveyors in PNG are using the UAV for many survey applications and even a lot of GIS specialists are using it for mapping application. UAVs in PNG are mostly in mine surveying for quantity/volume calculations and for topo/As-built Surveys.

Introduction/Background

- When it comes to cadastral surveying, the well-known and PNG's legally recognized surveys tools remains Total Station and GNSS receivers despite the advancement in survey technologies.
- Total Stations are mostly preferred because it performs real time measurement on the plain surface or terrain and achieve mm level accuracies (3mm + 2ppm).

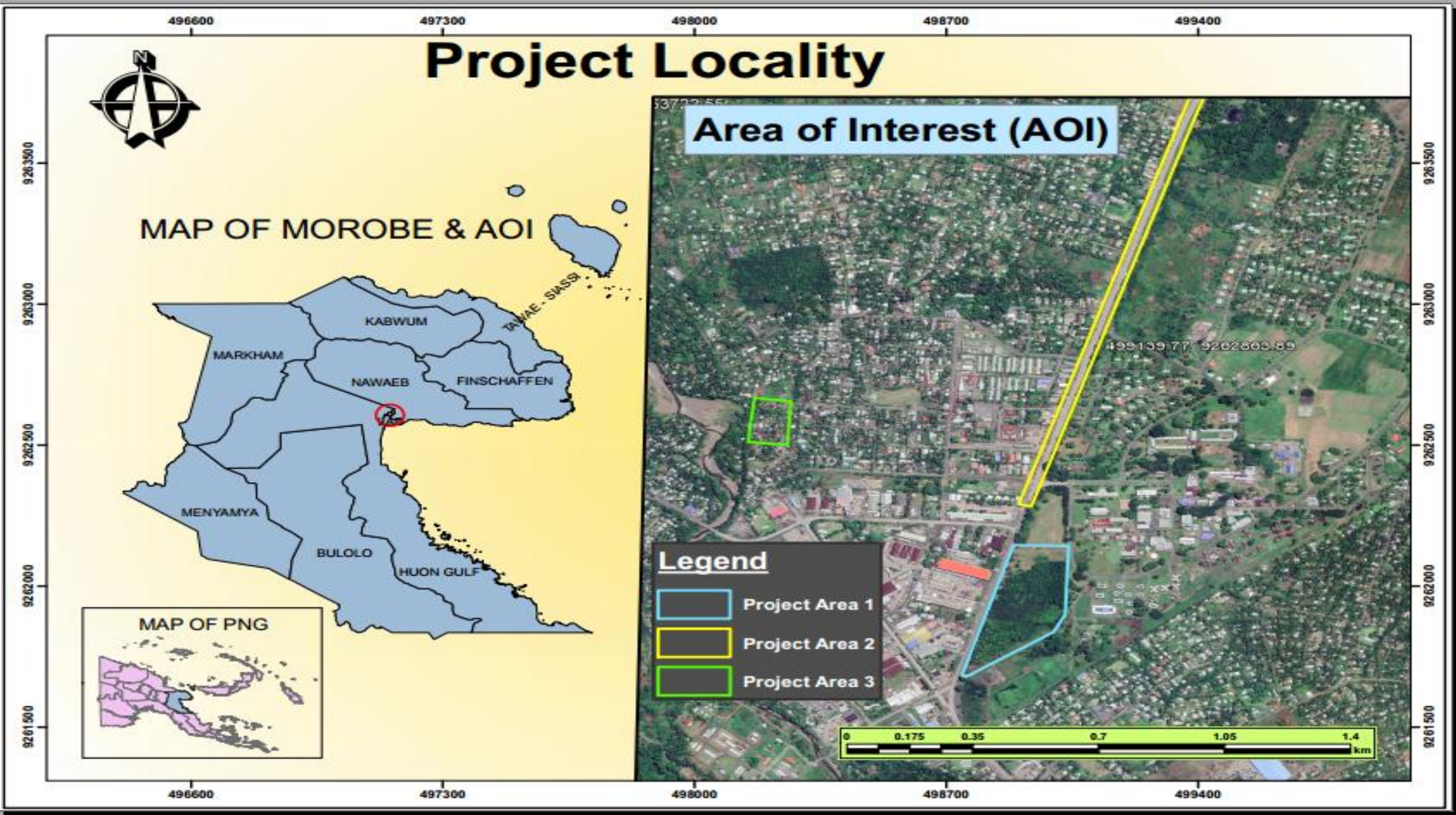
Introduction/Background

- Researchers have confirmed that UAVs have been able to deliver and have met the cadastral surveying and mapping requirements of many countries in terms of its accuracy, efficiency and the vast surveying and mapping data outputs from one UAV flight when surveying.

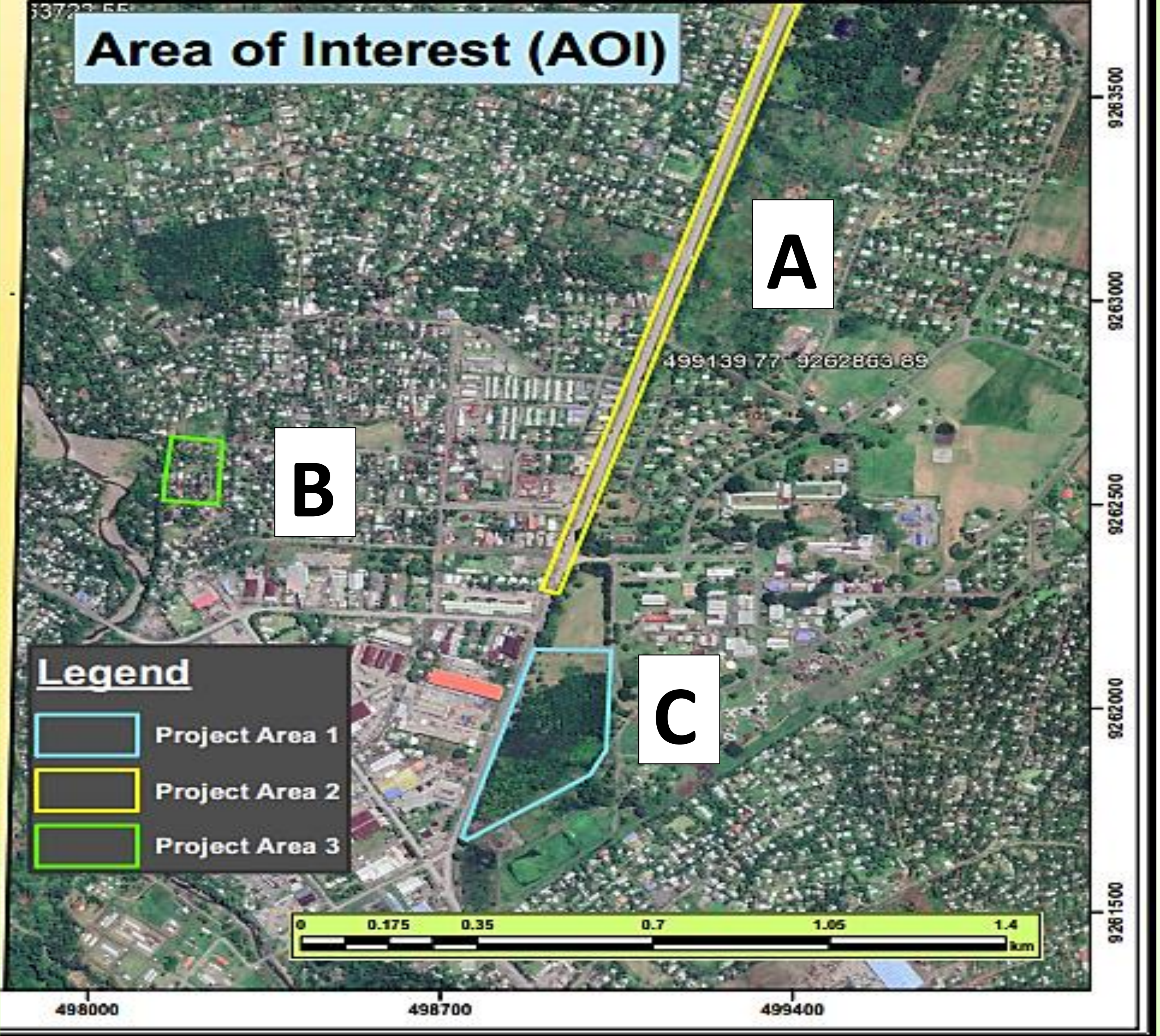
Can UAV satisfy/meet the cadastral survey requirements the country (PNG) sets as standard for such surveys?

<u>Introduction – Research Aim</u>

This study was specifically carried out with its objectives set to assess the accuracy and efficiency of UAV against total station (TS) and GPS/GNSS to find out if UAV can meet the cadastral survey specifications set as standards for such surveys in PNG *<u>grounds</u>*.



Project Locality
MAP OF MOROBE & AOI
KABWUM
TAWAE - SIASSI
MARKHAM
NAWAEB
FINSCHAFFEN
MENYAMYA
BULOLO
HUON GULF
MAP OF PNG
Area of Interest (AOI)
Legend
Project Area 1
Project Area 2
Project Area 3
0
0.175
0.35
0.7
1.05
1.4
km
496600
497300
498000
498700
499400
9263500
9263000
9262500
9262000
9261500



A. This area was selected for identification (ID) survey to check for encroachment. (UoT campus boundary and road Easement)
B. This area was selected for ID and topo survey of dense urban areas that could impose some sort of challenge.
c. This area was selected for a boundary survey for customary land registration.

All sites were surveyed with TS, GNSS and UAV respectively.

Methodologies

All practices in data collection were done in accordance with the country's survey Direction (SD 1990) and this includes the standard practices from datum adoption and positional accuracy, to equipment setup, to field observation methods etc. All the accuracies and precisions required for such surveys were all given sufficient attention.

Methodologies

Phase 1 – Survey with Total Station (Sokkia Set 550)

a. ID Survey for Encroachment

- five control stations were placed along the road
- three old cement pegs (OCPs) were found through identification
- detail topography was done for the 1.4km road length

Methodologies

Phase 1 – Survey with Total Station (Sokkia Set 550)

b. ID & Topo Survey for Dense Populated Area.

- Traversed 2.2km from two PSMs
- 5 GCPs found
- Detail/topo Survey carried out for the 2.3ha land (2 portions)

Methodologies

Phase 1 – Survey with Total Station (Sokkia Set 550)

c. Boundary Survey for Customary Land Registration

- eight (8) boundary cement pegs were placed around the property boundary and were coordinated adapting datum from two PSMs

Methodologies

Phase 2 – Survey with GNSS (Topcon HiPer SR)

- Same PSMs used as datum for TS earlier were used as Base station for Static GNSS Observations.

- Few Control Stations along the road and Cement pegs placed for the boundary Survey were observed using Static GNSS Obs.

- OCPs found through ID with TS were picked up using RTK GNSS

Methodologies

Phase 2 – Survey with GNSS (Topcon HiPer SR)

- The Static GNSS coordinates were reduced to the plane surface through normal calculation.
- The RTK GNSS Picked-up coordinates (the Point cloud) were reduced to plane surface through transformations in Magnet Office software
- The bearings between stations/vectors were converted to Grid Bearing.
- Plane Coordinates recalculated for all stations with reference to the datum PSMs (baseline)

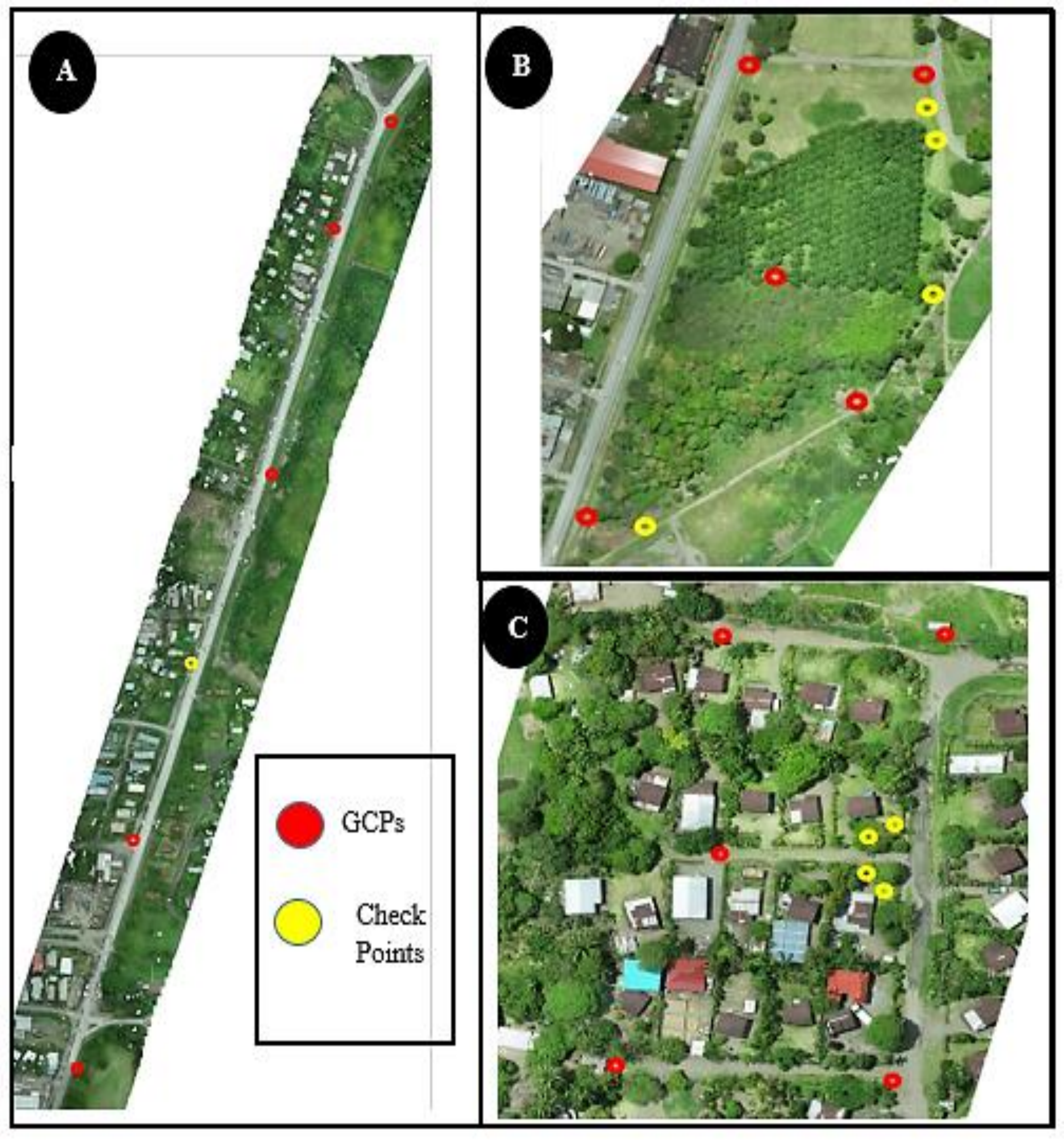
Methodologies

Phase 3 – Survey with UAV (DJI Phantom 4 RTK)

- All images captured at an overlap of 80% (recommended = 70% (Kateryna, 2016))
- Flight speed – Default = 9m/s
- Flight height = 60 – 80m resulting in
- GSD = 1.5 – 2.5cm/px
- GCP boards were placed on control stations and Cement Pegs/OCPs
- Some stations were used as GCP in Post-processing; others were used as Check Points for QA/QC.

Methodologies

Phase 3 – Survey with UAV (DJI Phantom 4 RTK)



GCPs and Check Points

Methodologies

Throughout the period of survey using each of the equipment for each of the sites, the number of human resources, the total field survey and office processing time period were also recorded and noted during the data collection and processing period for efficiency assessment purposes.

Results & Discussions

a – Conventional Equipment Analysis – TS vs GNSS

- TS survey carried out with an overall linear Accuracy of 1:70 000 (Above recommended)
- Static GNSS observations with a mean positional precision of 7mm and 9mm respectively for all processed vectors.
- Least square adjustments made for all vector loops with 25mm E, 28mm N and 46mm in elevation as mean residuals.

Vs

Results & Discussions

a – Conventional Equipment Analysis – TS vs GNSS

1. Boundary Survey for Encroachment - Control Stations

Line	Difference in Distance (m)	Bearing		
PSM 3374 - CS 44	*0.009*	0°	0'	14''
CS 44 - CS 1	*0.005*	0°	0'	12''
CS 1 - CS 2	*0.003*	0°	0'	04''
CS 2 - CS 3	*0.001*	0°	0'	05''
CS 3 - CS 4	*0.002*	0°	0'	03''
CS 4 - CS 5	*0.007*	0°	0'	14''
CS 5 - CS 6	*0.007*	0°	0'	28''

Mean Difference in Distance (TS vs GNSS)

0.005m

Mean Difference in Bearing (TS vs GNSS)

0° 00' 11''

2. Boundary Survey for Land Title – Boundary Cement Pegs

Line	Difference in Distance (m)	Bearing		
CP01-CP02	*0.001*	0°	0'	28''
CP02-CP03	*0.021*	0°	01'	55''
CP03-CP04	*0.030*	0°	0'	44''
CP04-CP04	*0.049*	0°	0'	27''
CP05-CP06	*0.017*	0°	0'	56''
CP06-CP07	*0.032*	0°	0'	29''
CP07-CP08	*0.004*	0°	0'	25''
CP08-CP01	*0.027*	0°	01'	15''

Mean Difference in Distance (TS vs GNSS)

0.023m

Mean Difference in Bearing (TS vs GNSS)

0° 00' 50''

3. Topo Survey of Densely Populated area – Old Cement Pegs' (OCP)

Line	Difference in Distance (m)	Bearing		
OCP1-OCP2	*0.015*	0°	14'	28''
OCP2-OCP3	*0.014*	0°	12'	09''
OCP3-OCP1	*0.011*	0°	02'	47''

Mean Difference in Distance (GNSS RTK vs Cadasta)

0.013m

Mean Difference in Bearing (RTK vs Cadasta)

0° 09' 48''

- Average difference in Distance = 5-23mm and as low as 1mm to 2mm
- Average difference in Bearing = 11"-50"
- GNSS coordinates vs Cadasta for the OCPs = 11-15mm difference

Results & Discussions

a – Conventional Equipment Analysis – TS vs GNSS

1. Boundary Survey for Encroachment - Control Stations

Line	Difference in Distance (m)	Bearing		
PSM 3374 - CS 44	*0.009*	0°	0'	14"
CS 44 - CS 1	*0.005*	0°	0'	12"
CS 1 - CS 2	*0.003*	0°	0'	04"
CS 2 - CS 3	*0.001*	0°	0'	05"
CS 3 - CS 4	*0.002*	0°	0'	03"
CS 4 - CS 5	*0.007*	0°	0'	14"
CS 5 - CS 6	*0.007*	0°	0'	28"

Mean Difference in Distance (TS vs GNSS)

0.005m

Mean Difference in Bearing (TS vs GNSS)

0° 00' 11"

2. Boundary Survey for Land Title – Boundary Cement Pegs

Line	Difference in Distance (m)	Bearing		
CP01-CP02	*0.001*	0°	0'	28"
CP02-CP03	*0.021*	0°	01'	55"
CP03-CP04	*0.030*	0°	0'	44"
CP04-CP04	*0.049*	0°	0'	27"
CP05-CP06	*0.017*	0°	0'	56"
CP06-CP07	*0.032*	0°	0'	29"
CP07-CP08	*0.004*	0°	0'	25"
CP08-CP01	*0.027*	0°	01'	15"

Mean Difference in Distance (TS vs GNSS)

0.023m

Mean Difference in Bearing (TS vs GNSS)

0° 00' 50"

3. Topo Survey of Densely Populated area – Old Cement Pegs' (OCP)

Line	Difference in Distance (m)	Bearing		
OCP1-OCP2	*0.015*	0°	14'	28"
OCP2-OCP3	*0.014*	0°	12'	09"
OCP3-OCP1	*0.011*	0°	02'	47"

Mean Difference in Distance (GNSS RTK vs Cadasta)

0.013m

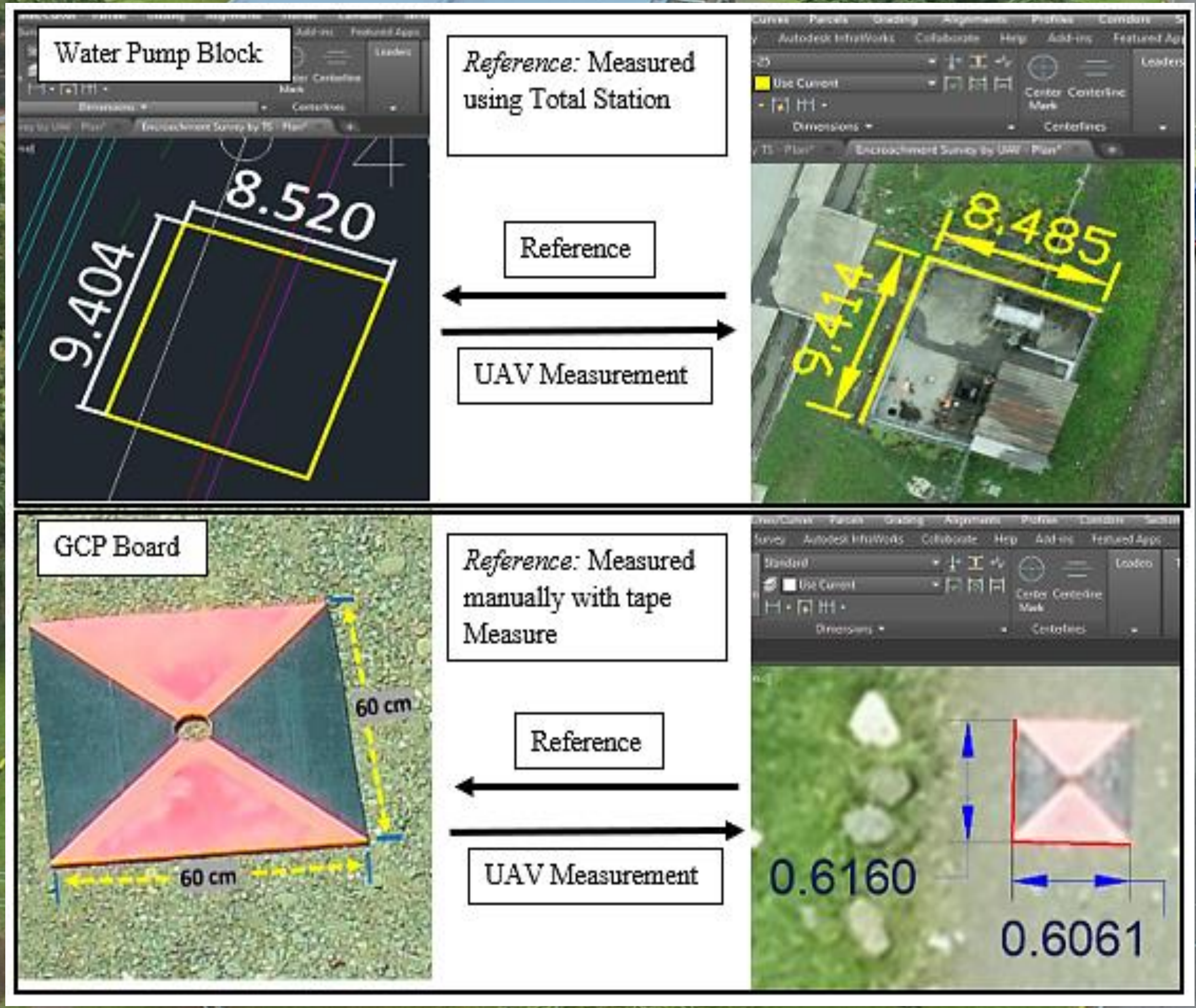
Mean Difference in Bearing (RTK vs Cadasta)

0° 09' 48"

- Portrays how accurate and useful GNSS receivers can be for cadastral surveys in PNG.
- For the difference in distance and bearing between the boundary cement pegs from the boundary survey for land title, some differences are very low but one or two are a bit higher with few centimeters because of the fact that boundary pegs were placed where they supposed to be. Thus, few were under canopy and thus the accuracy dropped to few centimeters.
- The accuracy in distance measurement using GNSS RTK was surprisingly high. This is because the RTK pickup data were brought to the plane surface through transformation in the Magnet Office software.

Results & Discussions

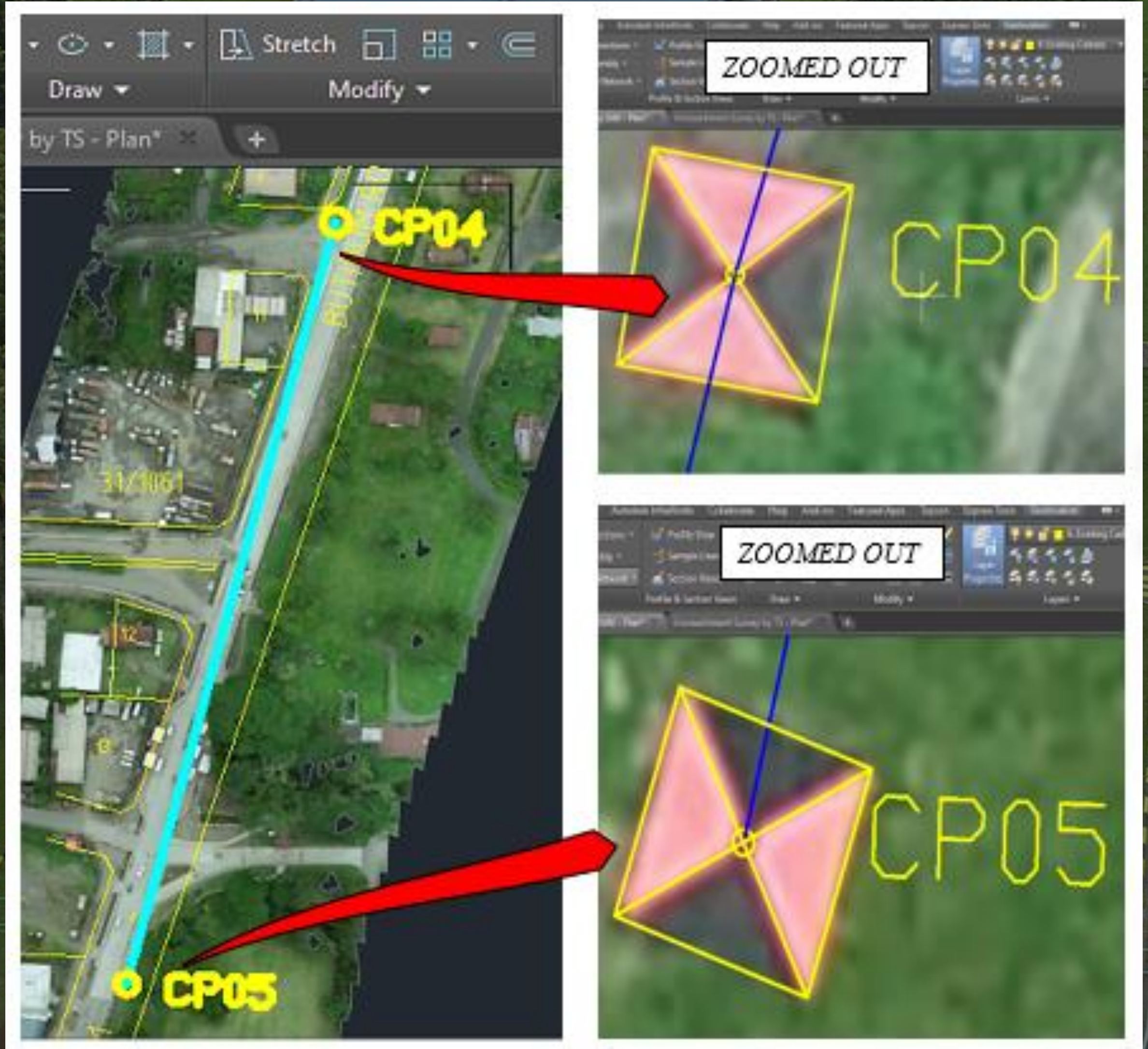
b – UAV Internal Accuracy Assessment



- Captured at an Height of 80m and 60m respectively
- UAV has the ability to measure unobstructed objects down to a level of about 6mm (0.006m) error compared to the true value at a height of 60m and about 10 to 30mm (0.01-0.03m) error at a height of 80m
- The lower the flight height and the lower the GSD, the higher the accuracy in Object/Feature measurement and vice versa for a survey grade UAVs.

Results & Discussions

c – UAV Vector Measuring Accuracy



1. *Boundary Survey for Encroachment - Control Stations*

Line	UAV vs Total Station				UAV vs GNSS Receiver			
	Δ Dist (m)	*Δ Bearing*			*Δ Dist (m)*	*Δ Bearing*		
CS 44 - CS 1	*0.007*	0°	0'	10"	*0.002*	0°	0'	23"
CS 1 - CS 2	*0.002*	0°	0'	01"	*0.005*	0°	0'	03"
CS 2 - CS 3	*0.066*	0°	0'	23"	*0.067*	0°	0'	28"
CS 3 - CS 4	*0.052*	0°	0'	22"	*0.050*	0°	0'	19"
CS 4 - CS 5	*0.029*	0°	0'	06"	*0.036*	0°	0'	08"

2. *Boundary Survey for Land Title – Boundary Cement Pegs*

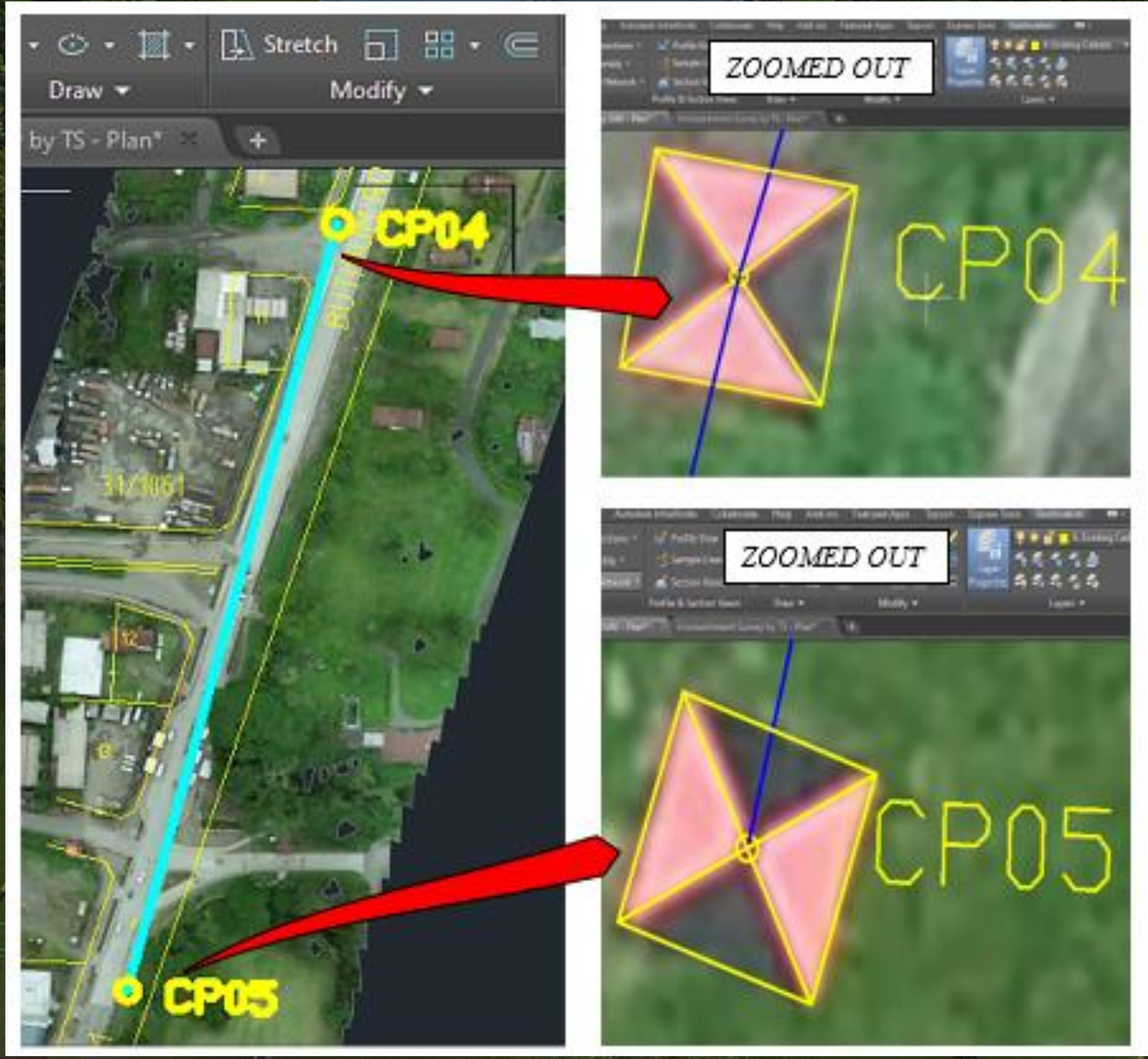
Line	UAV vs Total Station				UAV vs GNSS Receiver			
	Δ Dist (m)	*Δ Bearing*			*Δ Dist (m)*	*Δ Bearing*		
CP01-CP02	*0.011*	0°	01'	26"	*0.012*	0°	01'	54"
CP02-CP03	*0.02*	0°	01'	03"	*0.041*	0°	01'	42"
CP03-CP04	*0.036*	0°	0'	10"	*0.066*	0°	0'	54"
CP04-CP04	*0.036*	0°	0'	30"	*0.013*	0°	0'	57"
CP05-CP06	*0.021*	0°	0'	10"	*0.004*	0°	0'	46"
CP06-CP07	*0.003*	0°	2'	28"	*0.029*	0°	01'	59"
CP07-CP08	*0.005*	0°	0'	03"	*0.001*	0°	0'	18"
CP08-CP01	*0.001*	0°	01'	34"	*0.026*	0°	01'	44"

3. *Topo Survey of Densely Populated area – Old Cement Pegs' (OCP)*

Line	UAV vs Total Station				UAV vs GNSS Receiver			
	Δ Dist (m)	*Δ Bearing*			*Δ Dist (m)*	*Δ Bearing*		
OCP1-OCP2	*0.006*	0°	24'	53"	*-0.009*	0°	10'	25"
OCP2-OCP3	*0.006*	0°	10'	54"	*-0.008*	0°	01'	15"
OCP3-OCP1	*0.034*	0°	14'	20"	*0.023*	0°	17'	07"

Results & Discussions

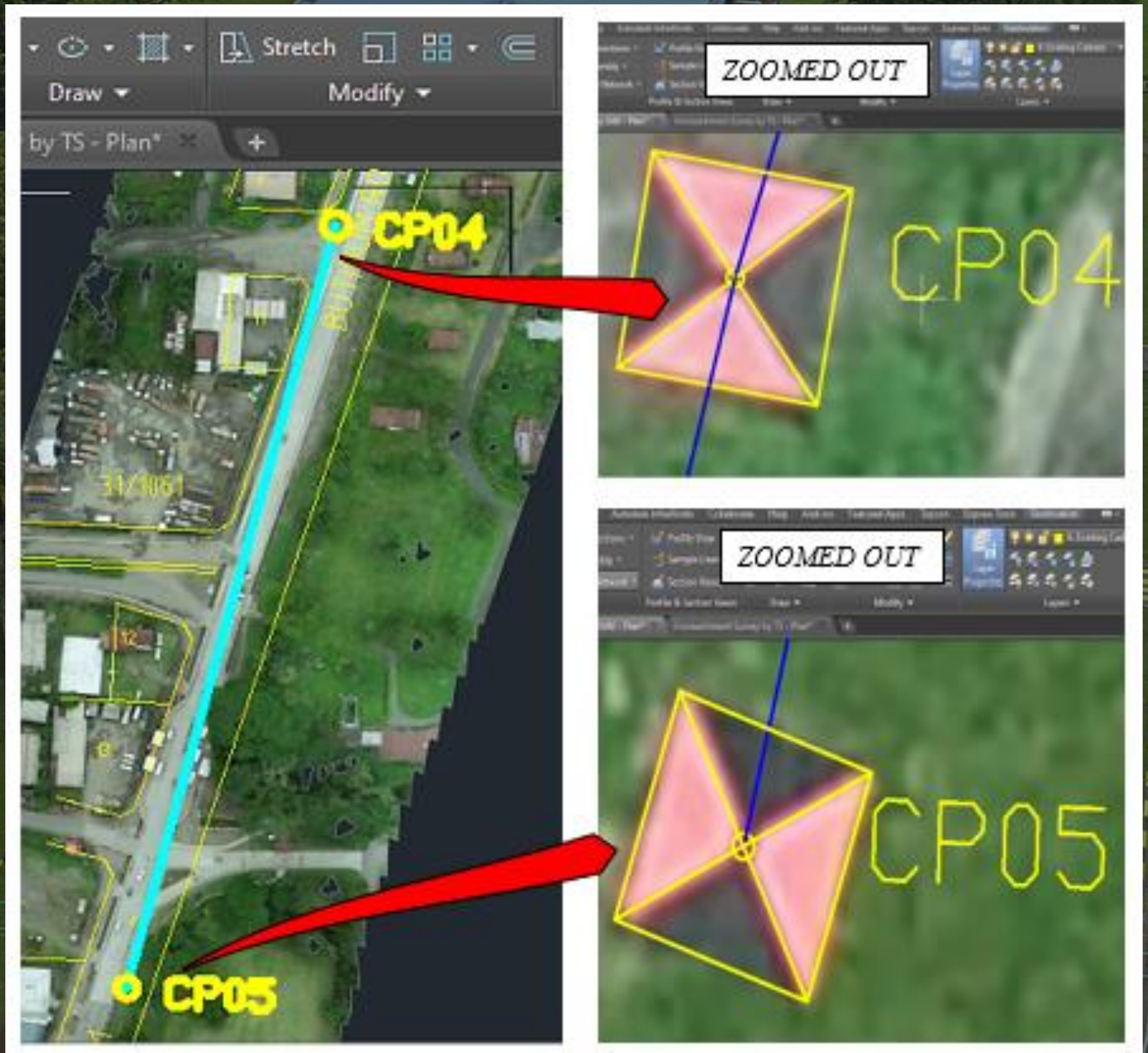
c – UAV Vector Measuring Accuracy



- at an average (13 vectors/lines), UAV measured distances deviated from that of *total station* by 21mm (0.021m) and 33 seconds (0°00’33”)
- at an average (13 vectors/lines), UAV measured distances deviated from that of *GNSS* by 25mm (0.025m) and 44 seconds (0°00’44”)
- The UAV measurement, when compared against pre-surveyed lines with total station and GNSS, can drop as low 2mm to 3mm with proper GCP coordination and georeferencing when post processing UAV aerial data.

Results & Discussions

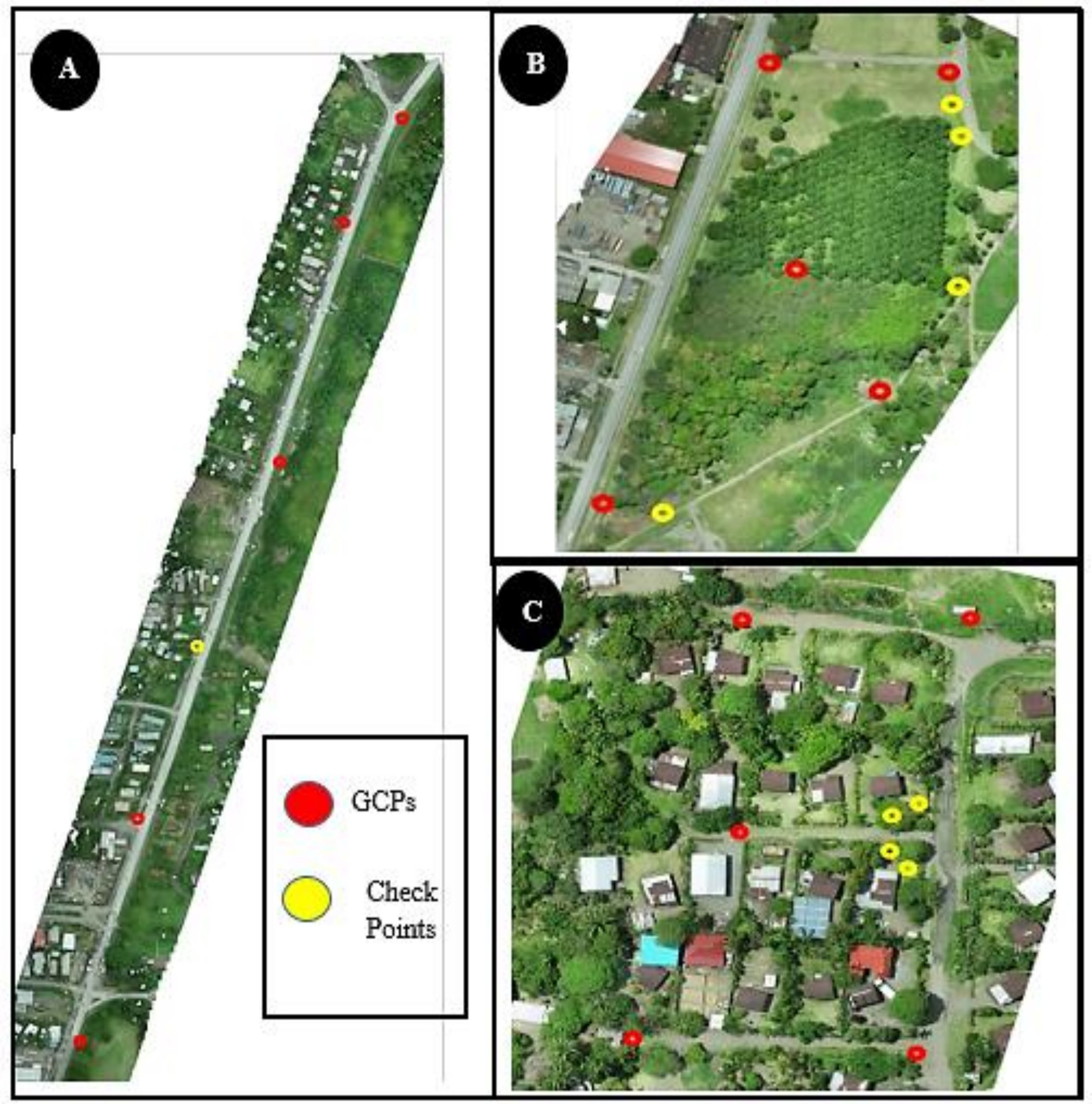
c – UAV Vector Measuring Accuracy



- The average deviation of 21mm and 25mm in distance and 33seconds and 44seconds in bearing is within the country's tolerance of 30mm (0.03m) linear error and 1minute 30secods (0°01'30") in bearing set as standard for Urban class one surveys as specified in the Survey Direction 1990.

Results & Discussions

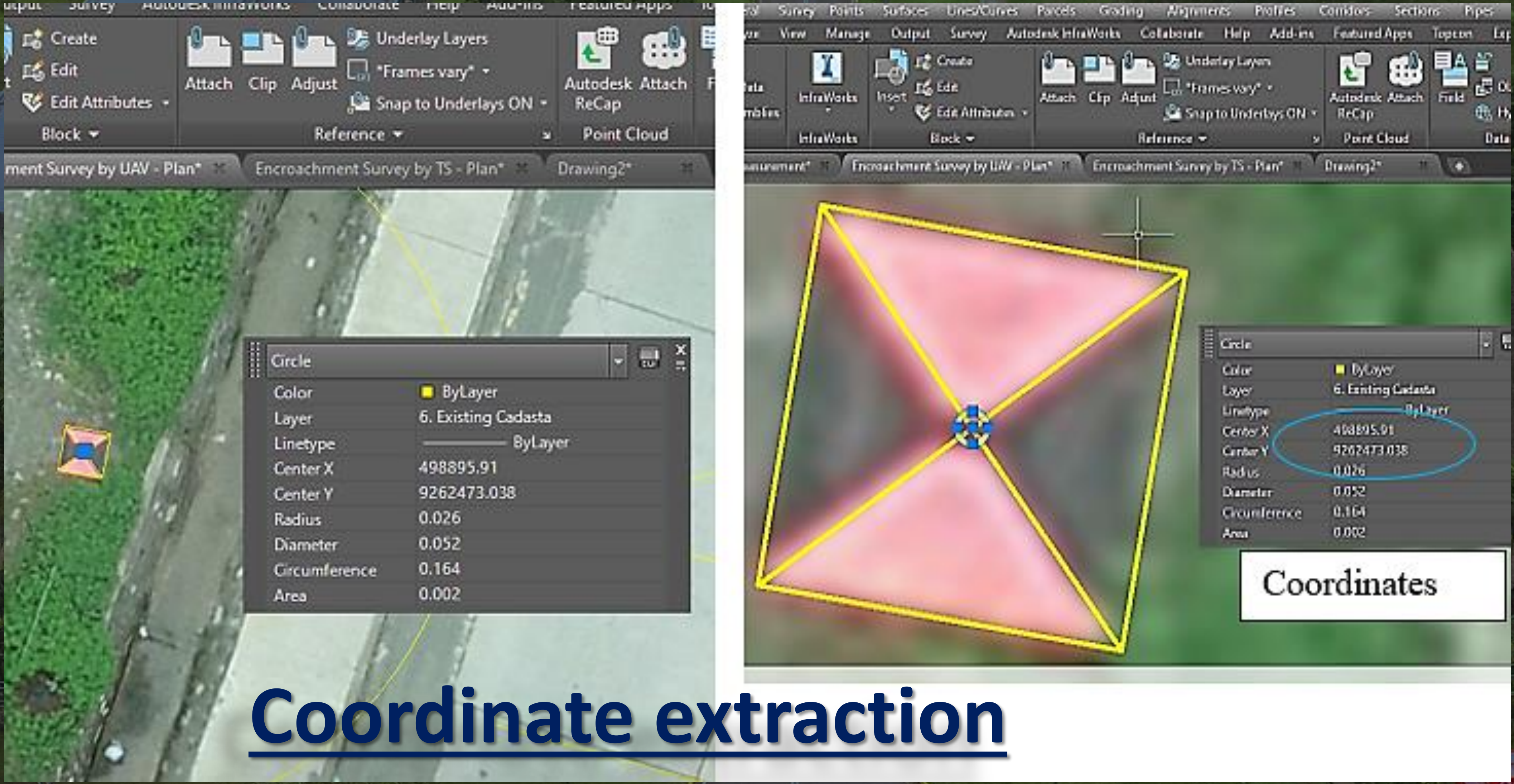
c – UAV Relative Position/Point Measuring Accuracy



- The check points were the ones assessed for the overall positional accuracy. Ground control points are what actually geo-references/geotags the images captured with the default GPS module of the UAV. GCPS adjusts, corrects and transforms the point's positions on the image to improve the accuracy of the data captured.
- However, check points do not affect the images but are captured for the purpose of validating the accuracy of the survey data. Check points are just like any point on the map and how it co-relates to the pre-measured/true values actually portrays the accuracy of the UAV.

Results & Discussions

c – UAV Relative Position/Point Measuring Accuracy



Coordinate extraction

Results & Discussions

c – UAV Relative Position/Point Measuring Accuracy

1. Boundary Survey for Encroachment - Control Station as Check point						
ChkPt	UAV against TS			UAV against GNSS		
	Δ E	Δ N	Δ RL	Δ E	Δ N	Δ RL
CS 3	0.018	0.081	0.176	0.015	0.087	0.027
2. Boundary Survey for Land Title – Boundary Cement Pegs as Check point						
ChkPt	UAV against TS			UAV against GNSS		
	Δ E	Δ N	Δ RL	Δ E	Δ N	Δ RL
CP02	0.012	0.007	NA	0.031	0.021	0.253
CP03	0.019	0.012	NA	0.024	0.022	0.251
CP04	0.027	0.027	NA	0.063	0.046	0.204
CP06	0.002	0.011	NA	0.126	0.003	0.210
3. Topo Survey of Densely Populated area – Old Cement Pegs' (OCP) as Check Point						
ChkPt	UAV against TS			UAV against GNSS		
	ΔE	ΔN	ΔRL	Δ E	Δ N	Δ RL
OCP1	0.059	0.032	0.011	0.024	0.005	NA
OCP2	0.077	0.010	0.089	0.064	0.008	NA
OCP3	0.013	0.011	0.057	0.072	0.016	NA

- the position of a UAV point can differ from that of a total station observed position by an average of 28mm (0.028m) in easting, 24mm (0.024m) in northings and about 8.3cm in elevation.
- UAV coordinates differs from that of GNSS established points at an average by 52mm (0.052m) in eastings, 26mm (0.026m) in northings and 0.189m in elevation.

Results & Discussions

c – UAV Relative Position/Point Measuring Accuracy

1. Boundary Survey for Encroachment - Control Station as Check point						
ChkPt	UAV against TS			UAV against GNSS		
	Δ E	Δ N	Δ RL	Δ E	Δ N	Δ RL
CS 3	0.018	0.081	0.176	0.015	0.087	0.027
2. Boundary Survey for Land Title – Boundary Cement Pegs as Check point						
ChkPt	UAV against TS			UAV against GNSS		
	Δ E	Δ N	Δ RL	Δ E	Δ N	Δ RL
CP02	0.012	0.007	NA	0.031	0.021	0.253
CP03	0.019	0.012	NA	0.024	0.022	0.251
CP04	0.027	0.027	NA	0.063	0.046	0.204
CP06	0.002	0.011	NA	0.126	0.003	0.210
3. Topo Survey of Densely Populated area – Old Cement Pegs' (OCP) as Check Point						
ChkPt	UAV against TS			UAV against GNSS		
	ΔE	ΔN	ΔRL	Δ E	Δ N	Δ RL
OCP1	0.059	0.032	0.011	0.024	0.005	NA
OCP2	0.077	0.010	0.089	0.064	0.008	NA
OCP3	0.013	0.011	0.057	0.072	0.016	NA

From those results, it can be seen that UAV positions deviated from that of total station by less values (better) than that of GNSS receiver and this is because of the fact that Total Station coordinates were used to coordinate the GCPs and were used in geotagging the UAV aerial data when post-processing.

Results & Discussions

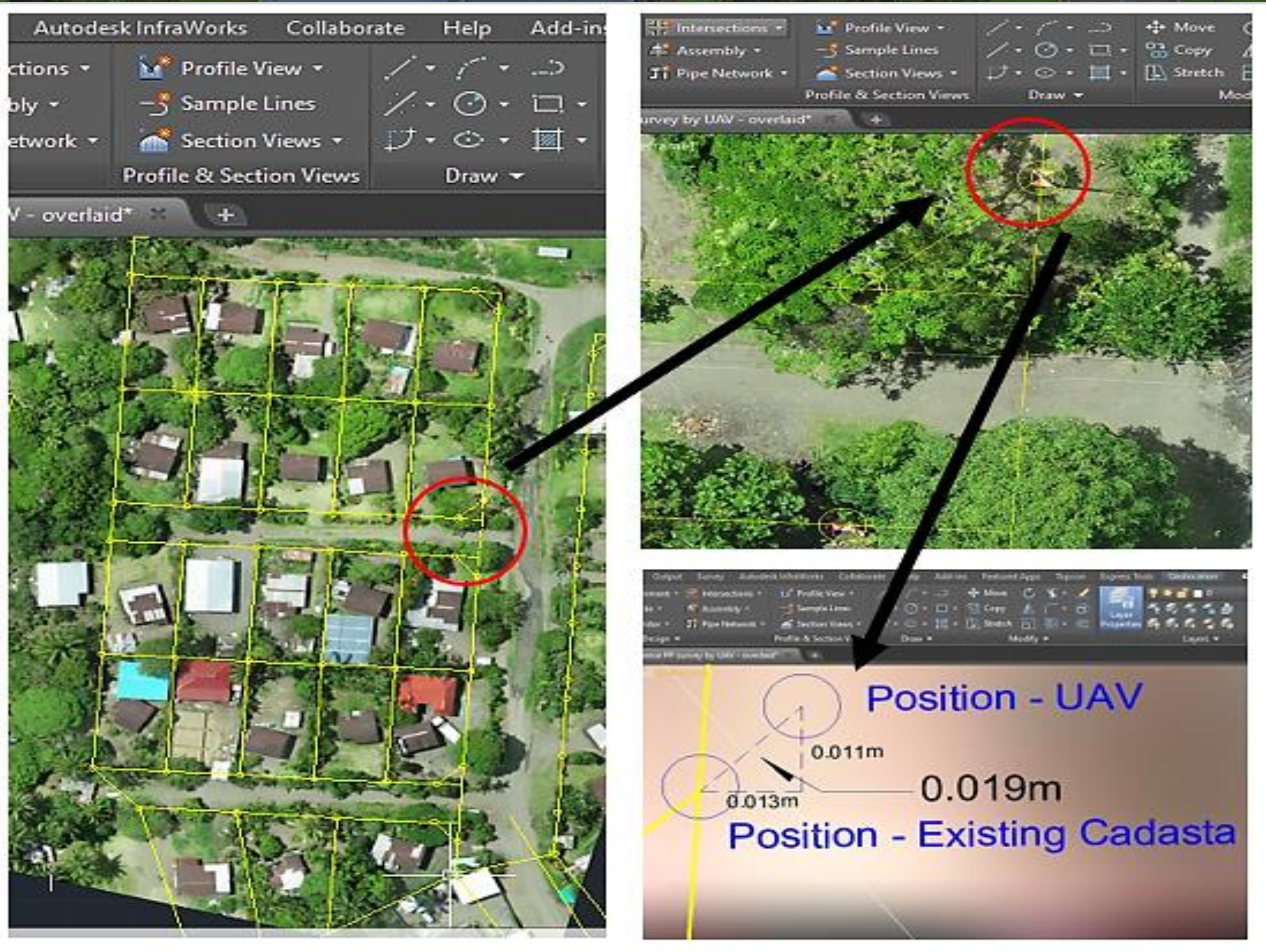
c – UAV Relative Position/Point Measuring Accuracy

1. *Boundary Survey for Encroachment - Control Station as Check point*						
ChkPt	UAV against TS			UAV against GNSS		
	Δ E	Δ N	Δ RL	Δ E	Δ N	Δ RL
CS 3	0.018	0.081	0.176	0.015	0.087	0.027
2. *Boundary Survey for Land Title – Boundary Cement Pegs as Check point*						
ChkPt	UAV against TS			UAV against GNSS		
	Δ E	Δ N	Δ RL	Δ E	Δ N	Δ RL
CP02	0.012	0.007	NA	0.031	0.021	0.253
CP03	0.019	0.012	NA	0.024	0.022	0.251
CP04	0.027	0.027	NA	0.063	0.046	0.204
CP06	0.002	0.011	NA	0.126	0.003	0.210
3. *Topo Survey of Densely Populated area – Old Cement Pegs' (OCP) as Check Point*						
ChkPt	UAV against TS			UAV against GNSS		
	ΔE	ΔN	ΔRL	Δ E	Δ N	Δ RL
OCP1	0.059	0.032	0.011	0.024	0.005	NA
OCP2	0.077	0.010	0.089	0.064	0.008	NA
OCP3	0.013	0.011	0.057	0.072	0.016	NA

It can be observed that the difference in UAV point positioning against total station & GNSS receiver can drop as low as 2mm to 5mm if appropriate measures are taken in carrying out the UAV survey.

Results & Discussions

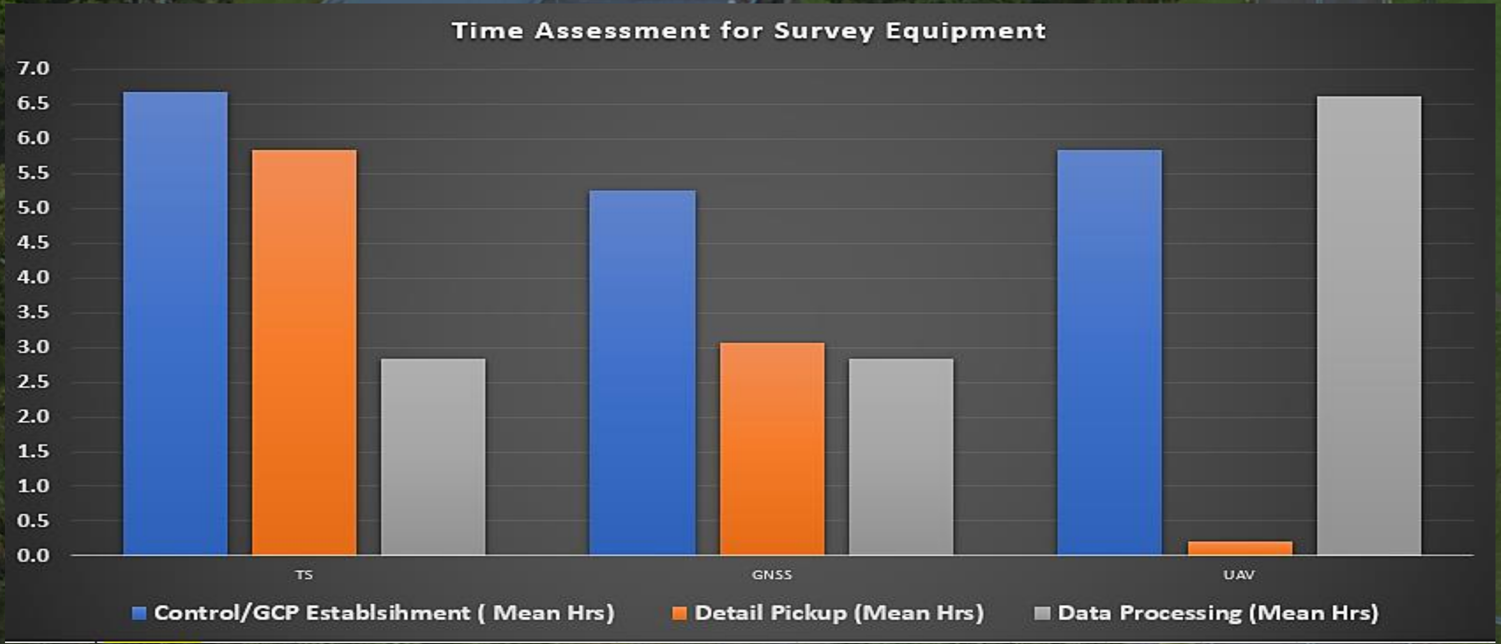
c – UAV Relative Position/Point Measuring Accuracy



When compared against existing Cadasta by superimposition or overlaying cadasta with the Orthomosaic, Easting and Northings positioned by UAV can deviate from the true value by as low as 13mm and 11mm respectively.

Results & Discussions

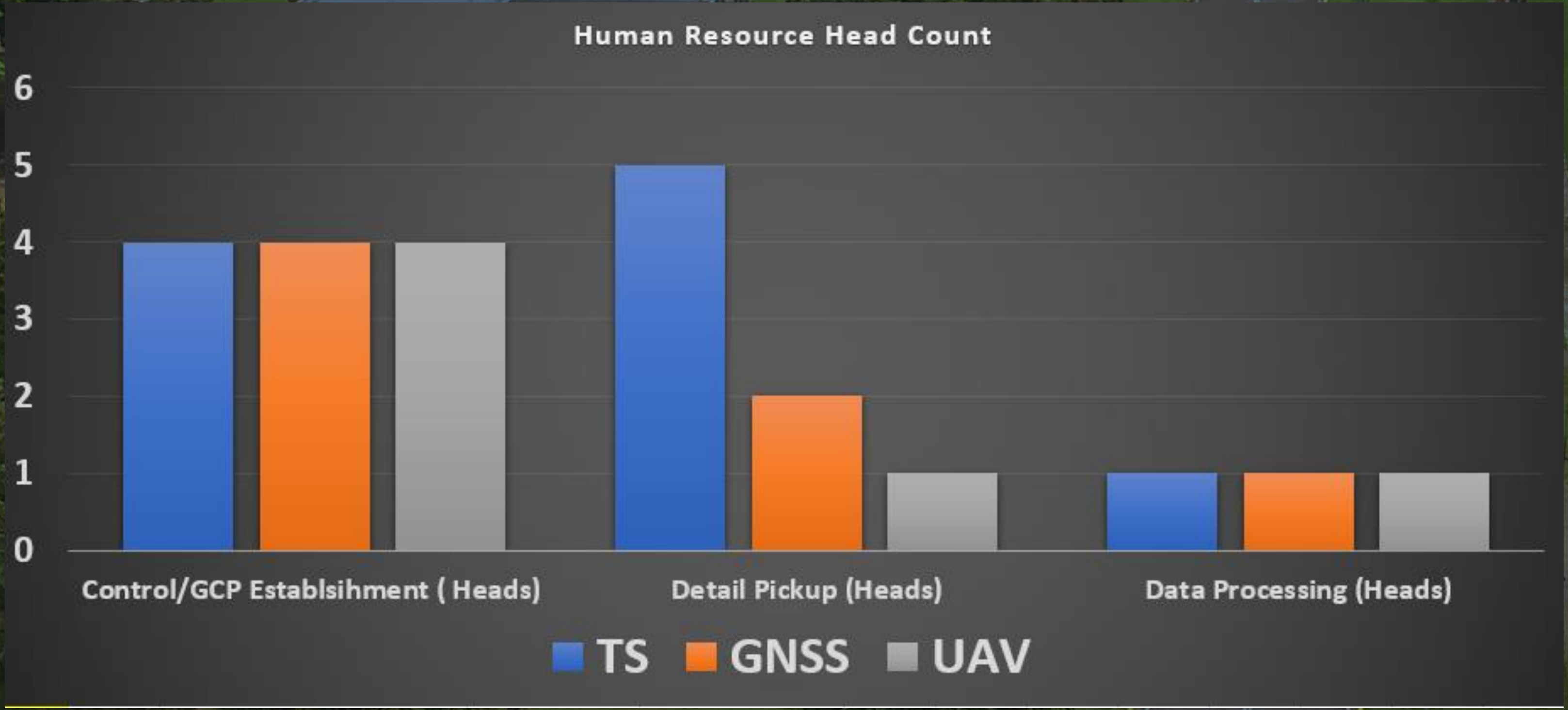
d – UAV Efficiency Measurement



For TS, the field exposure time for control establishment and detail survey were way more than the office/processing time while for GNSS receiver, the field exposure time was less than that of the total station. The detail pickup part of the data collection using GNSS (RTK) reduces the time for total station by almost 50% while the processing time is almost the same. For the UAV, field exposure time for GCP establishment is almost the same as that of Total station and GNSS but when it comes to the detail pickup part of the survey, UAV takes only about 3.5% (reducing 96.5%) field exposure time taken for total station and about 6.5% (reducing 93.5%) field exposure time of GNSS RTK pickups. However, the processing time is way higher, almost 440% or 4.4 times more compared to that of total station and GNSS receiver.

Results & Discussions

d – UAV Efficiency Measurement



For total station, GNSS and UAV, it would require almost equal amount of people for the control/GCP establishment but for detail pickup, total station is more laborious compared to GNSS and UAV which would require 2 or 1 human resource respectively.

“For UAVs with RTK GNSS that does not require GCPs, the time and human resources needed for GCP establishment as displayed would go down to zero making UAV way efficient in data collection in a fraction of time compared to total station and GNSS receivers and would require only one person to carry out a whole survey project..”

Conclusion and Recommendations

With proper HD cameras/sensors, enough lighting, at a reasonably lower height of 60m to 80m with GSD ranging from 1.6cm/px to 2.2cm/px, proper coordination of GCPs (taking into consideration the appropriate reductions and transformations either from total stations or GNSS receivers) can deliver accurate cadastral survey data to sub-centimeter or even to millimeter level.

Thus, yes, UAV can meet the cadastral survey specifications outlined in the country's survey Direction 1990 in terms of its accuracy and it can be used for cadastral surveys in the country.

UAV does not only meet the country's cadastral survey requirements but is concluded to be the most efficient equipment in the market reducing field exposure and data collection time to a fraction of an hour and reduces field surveyors down to 1 to 2 surveyor and thus reduces redundant costs and labor associated with total station and GNSS receiver which are PNG's conventional survey tools.

Conclusion and Recommendations

Survey Principles in UAV Survey

- UAV survey without GCP, even with RTK connected is till on the default datum (WGS84) and needs the assistance to GCP in post processing to transform to local coordinates.

- GCP coordinates on WGS 84

Conclusion and Recommendations

Survey Principles in UAV Survey

- UAV survey without GCP, even with RTK connected is till on the default datum (WGS84) and needs the assistance to GCP in post processing to transform to local coordinates.

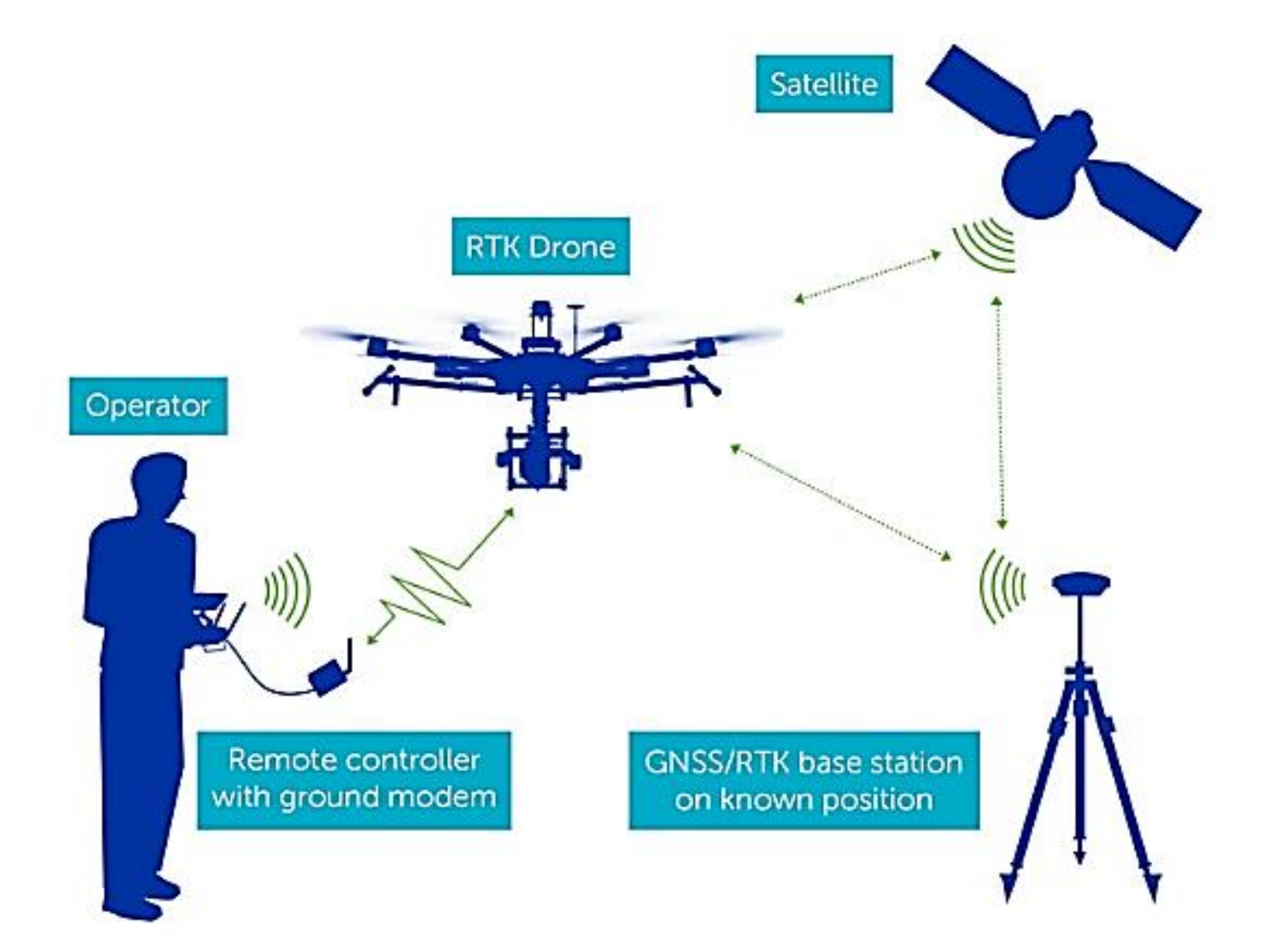
- GCP coordinates on AGD66

- 202m difference

(WGS84 and AGD66)

Conclusion and Recommendations

Survey Principles in UAV Survey



- RTK base for the UAV applies positional correction to the UAV which acts as the rover collecting data in the form of images.

Conclusion and Recommendations

Survey Principles in UAV Survey

- Total stations uses PSMs/known marks for station orientation, GNSS uses base stations, or IGS for corrections, transformations or as orientation. Likewise, UAV uses GCPs for its orientation and transformation to local datum.
- The internal accuracy of the UAV depends on the components of the UAV, the absolute accuracy (correlation to the true value / existing cadasta) depends on the accuracy of the GCPs coordinated.

Conclusion and Recommendations

Survey Principles in UAV Survey

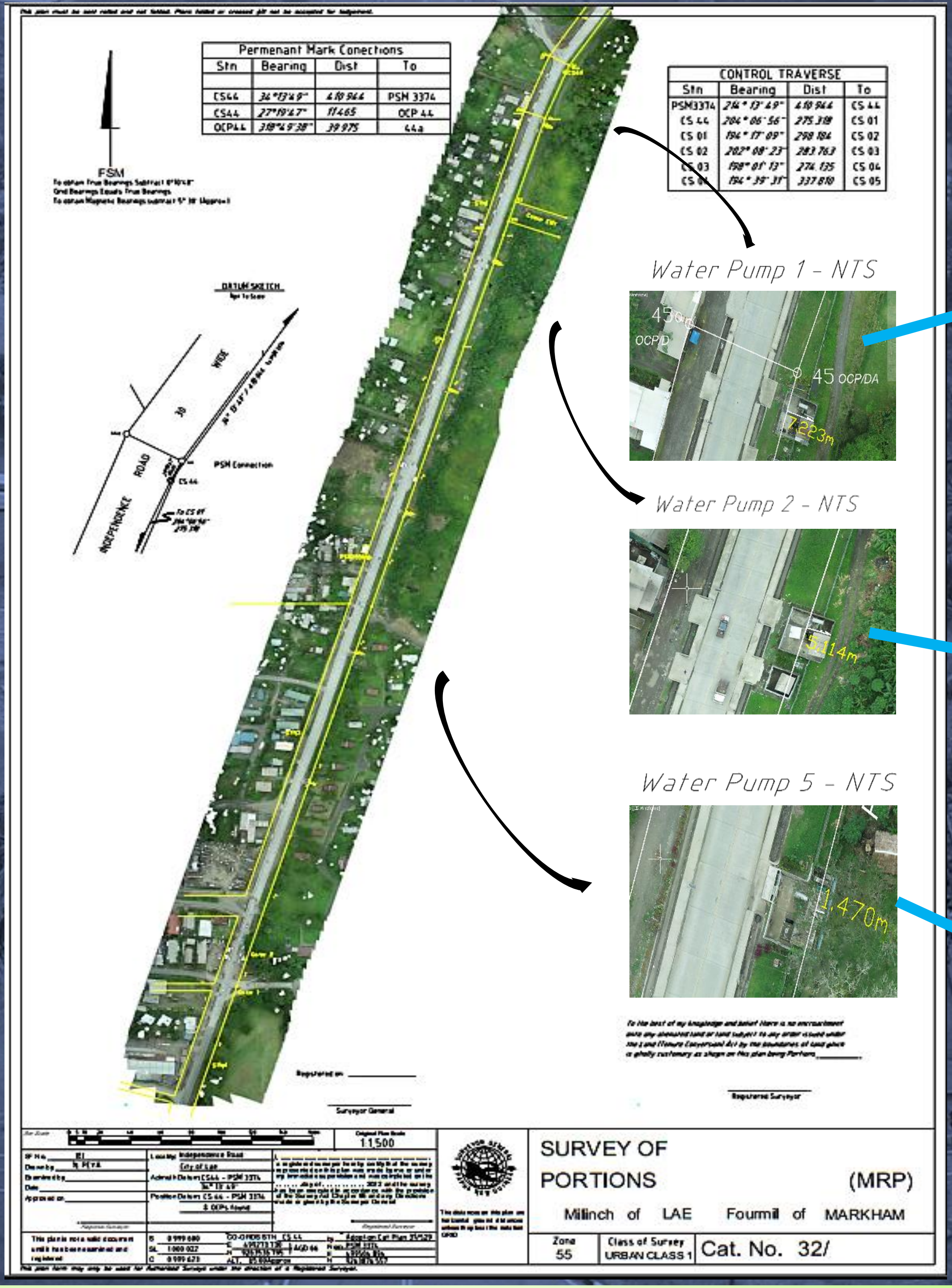
- TS does direct point-to-point pickups for DTMs, GNSS also does direct pickups as points for DTMs. Likewise UAV does point-to-point pickups but in the form of pixels which makes up the image. Through post-processing, the individual pixels are coordinated as points and are exported as point clouds. The point cloud contains points captured in 1-2cm intervals which creates a very detailed model compared to TS and RTK GNSS that picks' points in meter intervals.

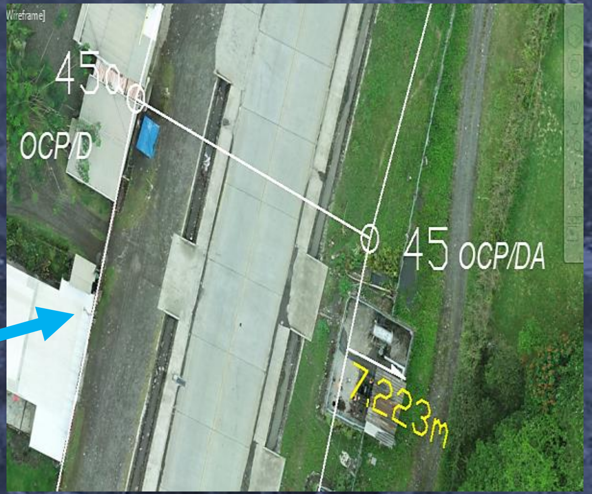
UAV Survey Results

1. Property boundary Survey for Encroachment

30m wide road,
 - 1.5 km long

Survey by Unmanned Aerial Vehicle (UAV)



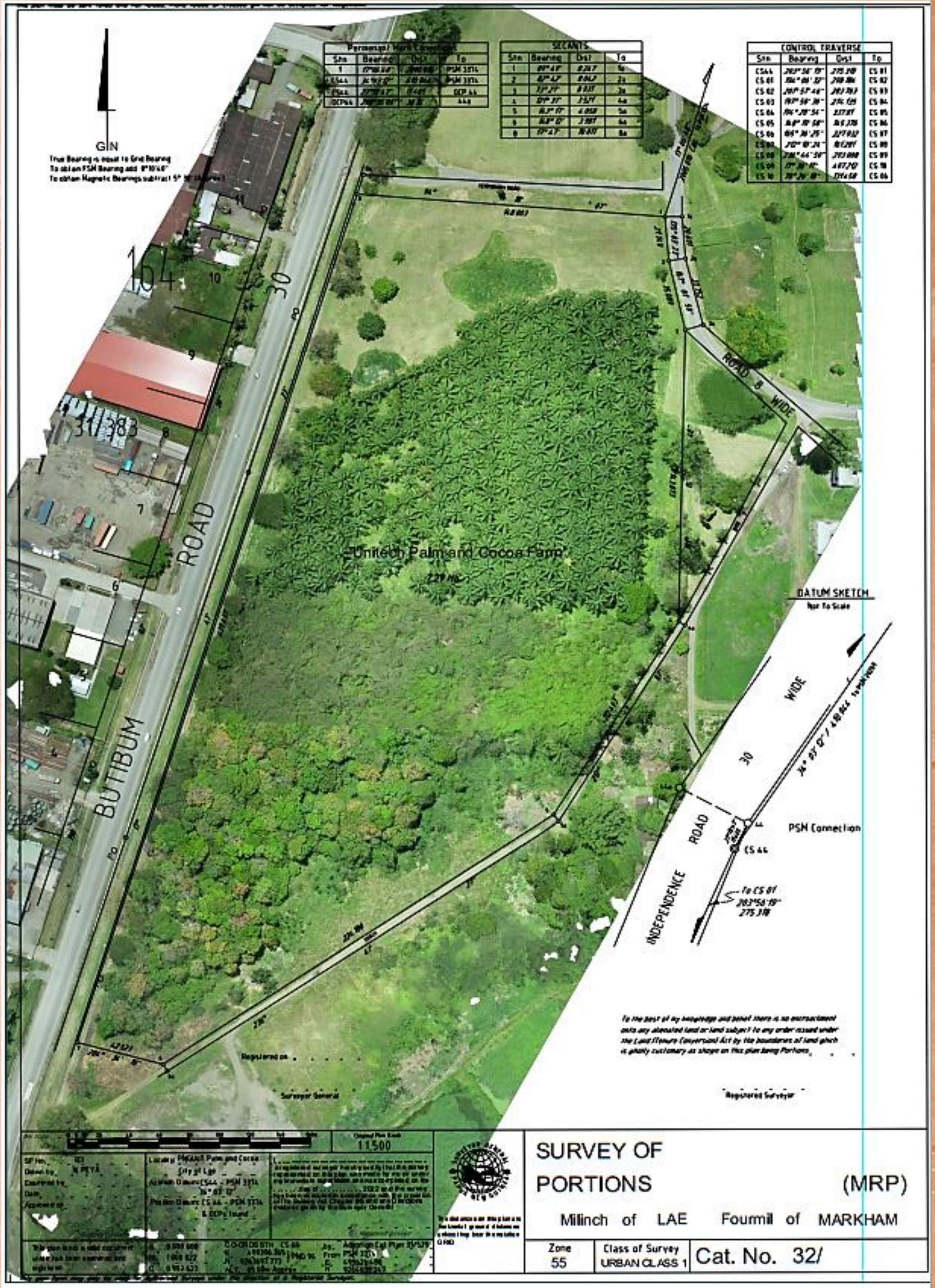


UAV Survey Results

2. Customary Land Boundary Survey for Land Title

Area of 7.29 ha.

Survey by Unmanned Aerial Vehicle (UAV)



Things to consider

a. UAV (Urban Class 1)

- ✓ Weather – Clear Sky
- ✓ Survey area, flight path and battery life. (30 minutes)
- ✓ Ground Sampling Distance – 2.19cm - 2.5 cm recommended for higher accuracy. *(Vision Aerial, 2021)*
- ✓ Overlap – FOL 80% & SOL 80% / 80% and 70% recommended (Kateryna, 2016)
- ✓ Internal Accuracy – Internal component/modules – GPS module, sensor size, gimble/camera stability..
- ✓ Absolute Accuracy – accuracy related to its true position, greatly dependent on GCPs
- ✓ Ground Control Points (GCPs)

- The image takes the coordinate system of the GCPs, and the accuracy of the Equipment used for the Establishment of those GCPs.

UAV Survey Results

3. Topography Survey of Dense Populated Area

Area of 2.3 ha.

Overlay Cadasta with UAV survey Data. Best for DCDB

Limitations of UAV Survey

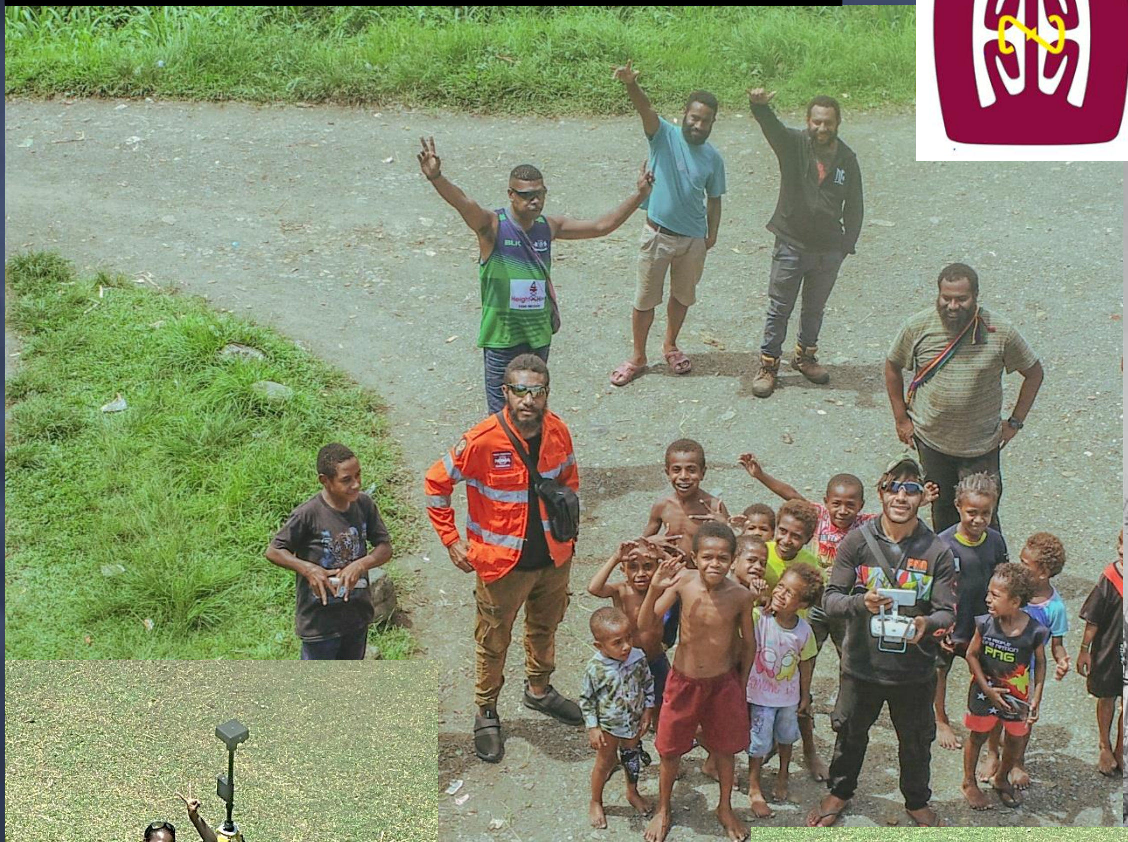
- UAV with the mounted camera cannot capture features under canopies, unless camera is replaced by LiDAR Sensor.
- Processing higher resolution images captured at lower height or images of a large area may freeze laptops with lower than i7 processor or lower than 8GB RAM and may crash the Laptop.
- Cannot deploy UAV during dull and rainy days or strong windy days. Day lighting affects the image texture and Wind can deviate the UAV from its planned path.
- Cannot deploy the UAV with 5km of geo-restricted zones line Airports, unless access in granted.
- Careless villagers can shoot down the UAV if its flown at a lower height for the sake of higher accuracy which can be costly to purchase again.
- **Sky animals like eagle can also be a threat.**

Recommendation

- Emerging technologies like Unmanned Aerial Vehicle (UAV) that diminishes the exposure of cadastral surveyors to hazardous areas through distant data acquisition, fast and efficient, produces additional mapping data such as high-resolution orthoimages, coordinated point clouds, three-dimensional (3D) models of structures, elevation models, DSM/DTM etc. needs to be accepted and legally recognized by the country and be used for its surveys for the overall good of the surveying Profession.

Acknowledgement

DEPT. OF SURVEYING AND LAND STUDIES
PNG UNIVERSITY OF TECHNOLOGY



References

Abdulla, S. R. (2007). *The Role of Cadastral Surveys in Land Management Practices in Zanzibar.* Hong Kong SAR, China.

Barnes, G., Volkmann, W., Sherko, R., & Kelm, K. (2014). *Design and Testing of a UAV-based Cadastral Surveying and Mapping Methodology in Albania.* Florida, USA.

Gerea, A. (2020, March 3). *GLOBAL TECHNOLOGY TRANSFORMATION – AI, AUTOMATION AND ROBOTICS IN MINING AND OTHER INDUSTRIES.* Retrieved August 2, 2021, from PNG Chamber of Mines and Petroleum : https://www.pngchamberminpet.com.pg/images/news/PNG_Chamber_-_PNG_Security_Congress%2C02.03.20_%28FINAL%29_compressed_.pdf

Lukitasari, F. (2017). *The Usability of Unmanned Aerial Vehicle (UAV) for Land Cadastral Registration in Indonesia.* Wageningen, The Netherlands.

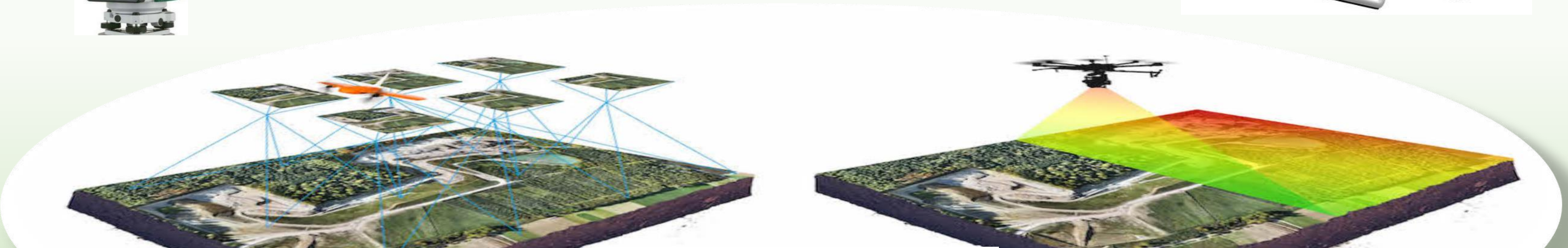
Mantey, S., & Tagoe, D. N. (2019, June). Suitability of Unmanned Aerial Vehicles for Cadastral Surveys. *Ghana Mining Journal, 19*(1), 1-8.

Manyoky, M., Theiler, P., Steudler, D., & Eisenbeiss, H. (2011, September 14-16). Unmanned Aerial Vehicle in Cadastral Applications. *International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, 38*(1), 57-62.

Pilot institute. (2020, March 22). *What's the Difference Between Drones, UAV, and UAS? Definitions and Terms*. Retrieved August 25, 2021, from Pilot Institute: https://pilotinstitute.com/drones-vs-uav-vs-uas/

Post Courier. (2018, July 10). The Role of Land Surveying and Mapping in National Development is Essential. *Land Surveying and Mapping Vital*. Papua New Guinea. Retrieved August 19, 2021, from https://postcourier.com.pg/land-surveying-mapping-vital/

Thank you!



DEPT. OF SURVEYING AND LAND STUDIES
PNG UNIVERSITY OF TECHNOLOGY

55th Association of Surveyors PNG Congress, 16th – 18th August, 2023