FIG Working Week 2016

CHRISTCHURCH, NEW ZEALAND 2–6 MAY 2016

Recovery
from disaster

Organised by FIG NZIS

Platinum Partners Trimble. esri

Diamond Partner Land Information New Zealand Toitū te whenua

FIG Working Week 2016
CHRISTCHURCH, NEW ZEALAND 2–6 MAY 2016
Recovery
from disaster

COMPARISON BETWEEN MULTICOPTER UAV AND TOTAL STATION FOR ESTIMATING STOCKPILE VOLUMES

Cesar ARANGO and Daniel PAEZ

Colombia

Universidad de los Andes

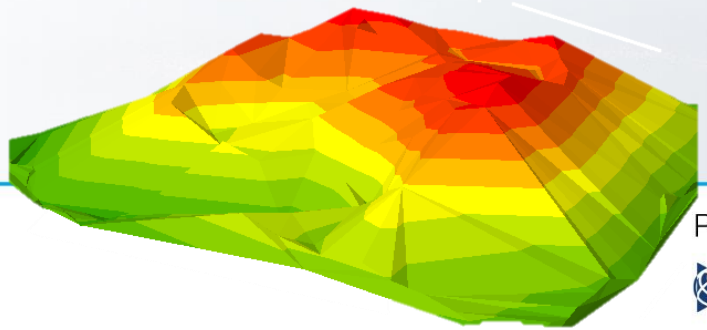


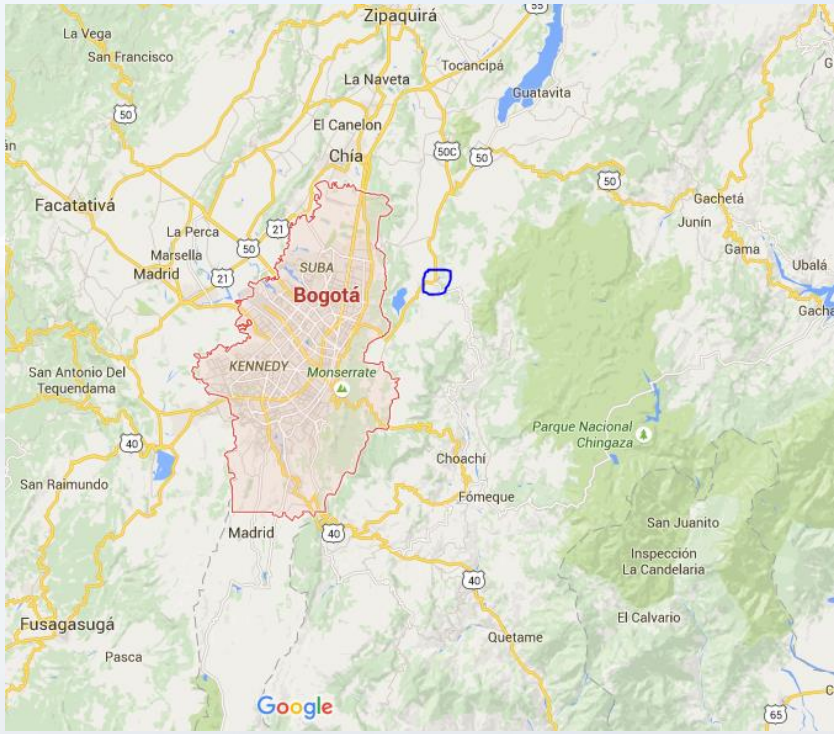
FIG NZIS

Platinum Partners: Trimble. esri

Diamond Partner Land Information New Zealand Toitū te whenua

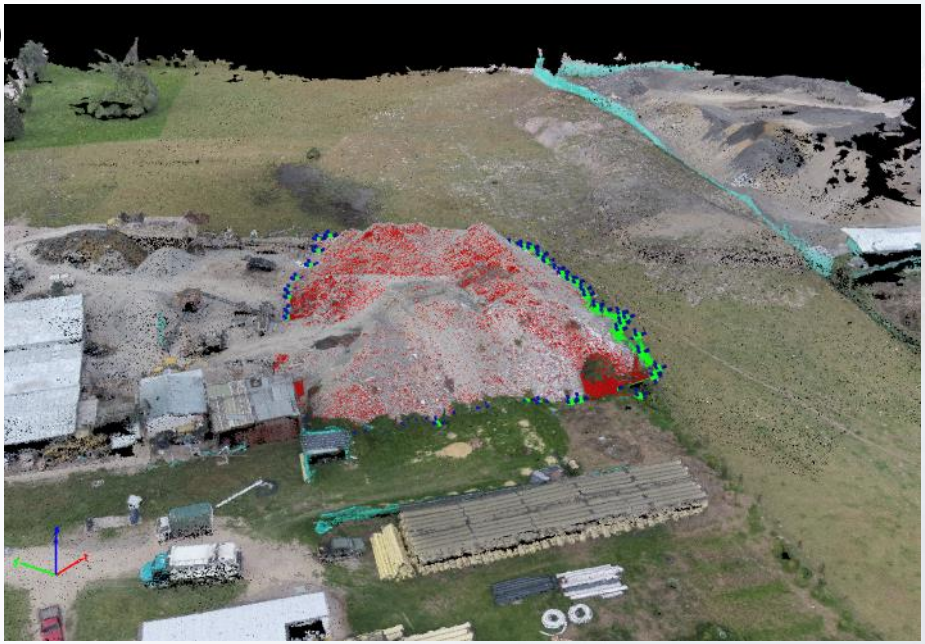
Location


Caribbean Sea
Aruba
Curaçao
Barranquilla
Maracaibo
Caracas
Cartagena
Panamá
Panama
Bucaramanga
Medellín
Venezuela
Bogotá
Cali
Colombia
Quito
Ecuador
AMAZONAS
Porto Velho
Google


Zipaquirá
La Vega
San Francisco
La Naveta
Tocancipá
Guatavita
El Canelon
Chía
Facatativá
La Perca
Marsella
Madrid
SUBA
Bogotá
Gachetá
Junín
Gama
Ubalá
KENNEDY
Monserrate
San Antonio Del Tequendama
Parque Nacional Chingaza
Choachí
San Raimundo
Fómeque
San Juanito
Madrid
Inspección La Candelaria
El Calvario
Fusagasugá
Quetame
Pasca
Google

Currently the UAV (Unmanned Aerial Vehicle) have become an alternative for different engineering applications, especially in surveying, one of these applications is the calculation of volumes of stockpiled material, but there are questions about its accuracy and efficiency

The purpose of this investigation was compare the traditional surveying methods for estimating total volumes through data obtained by total stations and data obtained by a multico



METHODOLOGY

Data Acquisition

Total Station

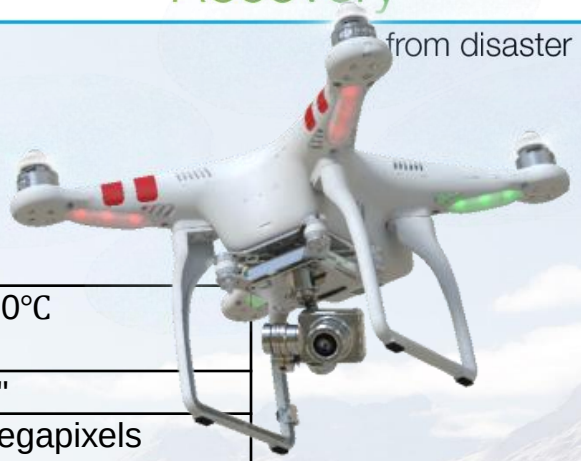
Description	TS02plus
1" angular accuracy	-
Enhanced measurement accuracy to prism	1.5 mm + 2 ppm
Reflectorless measurement range	500 m option
Display with graphics and display illumination	Black & White high resolution

We set up the TST in different geo-referenced points (with GNSS) around the stockpile

METHODOLOGY

Data Acquisition

Multicopter



Camera

Operating Environment Temperature	0℃-40℃
Sensor Size	1/2,3"
Effective Pixels	14 Megapixels
Resolution	4384×3288

Flight configuration

2 flights

Flight duration (average of the two flights)	14 min
Altitude above ground	50 m
Speed of flight	2 m/s

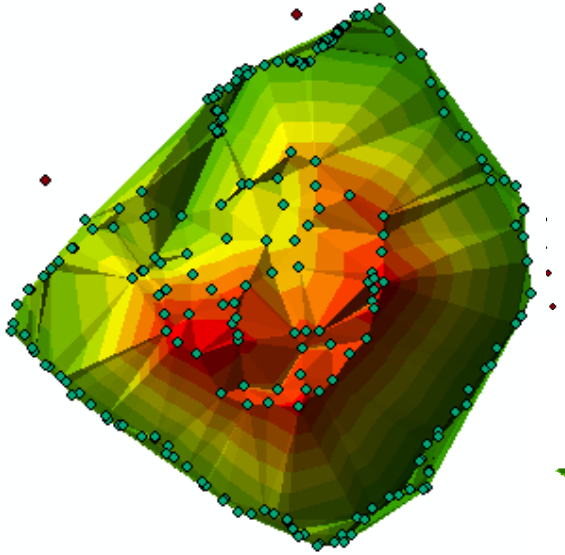
We use the geo-referenced points (with GNSS) around the stockpile as ground control points (GCP), in order to calibrate the image before.

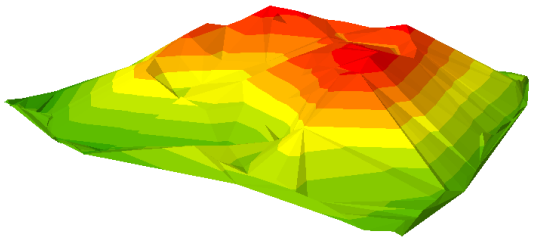
METHODOLOGY

Volume Estimation with TST Data

We use a software methodology to calculate the volume of the stock pile, with the data obtained by the TST.

1. The data was downloaded to the in .shp format, (point cloud readable by ArcGIS)
2. “Create TIN” Tool (convert the point cloud into a representation of continuous surfaces)
3. “Surface Volume” tool (calculates the volume of a TIN)



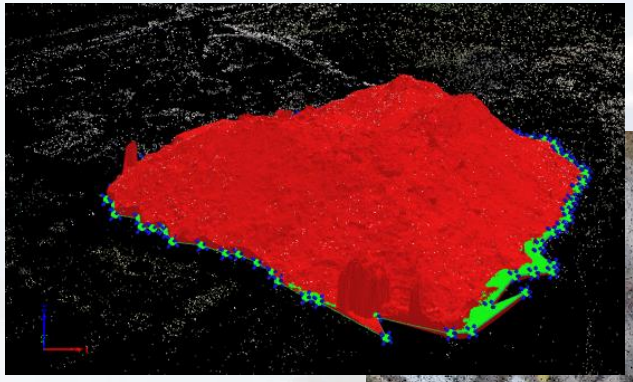


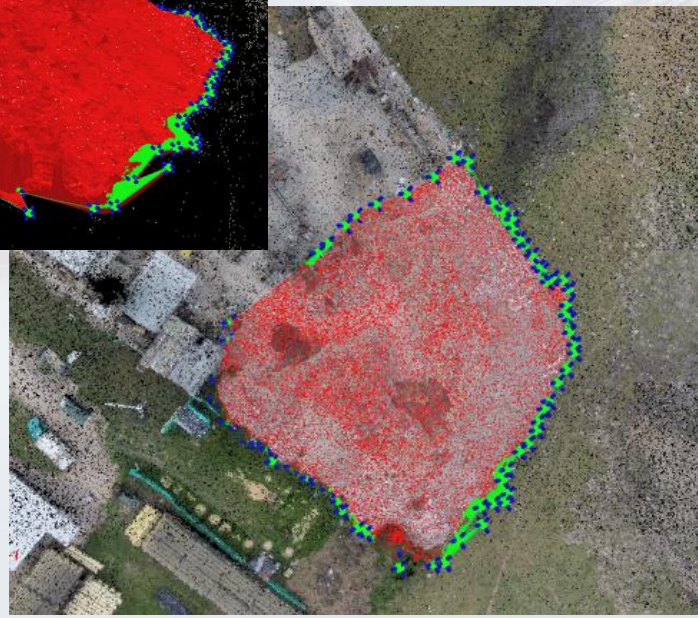
METHODOLOGY

Volume Estimation with UAV Data

Pix4D software

1. Draw a stockpile object
2. Change the manual tie points of the stockpile base to 3D GCPs
3. Change the altitude of the 3D GCPs to the desired altitude of the volume base.
4. Open the *rayCloud* and select the stockpile object to get the new volume calculation.





METHODOLOGY

Volume Estimation with UAV Data

$$V_i = L_i * W_i * H_i$$

Where:

L_i = the length of the cell.
W_i = the width of the cell.
H_i = the height of the cell.

The lenght (Li) and Width (Wi) are equal to the project ´s GSD.

$$L_i = W_i = GSD$$

GSD= Ground Sample Distance

$$L_i = W_i = GSD$$

GSD= Ground Sample Distance

$$H_i = Z_{Ti} - Z_{Bi}$$

Where:
Z_{Ti} = the terrain altitude of each cell at the center of the cell.
Z_{Bi} = the base altitude of each cell at the center of the cell.

Therefore, the volume V_i of cell j is given by:

$$V_i = GSD * GSD * (Z_{Bi} - Z_{Bi})$$

RESULTS

Comparison of Stockpile Volumes

	Volume m^3	Error (+/-) m^3	Difference Volume m^3	Percentage	Percentage Difference
Actual	11500.00	n/a	-	-	-
TST	11831.20	n/a	331.20	102,88%	2.88%
UAV	11423.58	81.28	−76.42	99,34%	−0.67%

The difference of percentage shows that the volume obtained with **UAV data is more accurate** than the volume obtained with TST data.

RESULTS

Time spent for data acquisition

Time taken for	TST	UAV
Setup equipment	5 minutes	5 minutes
Obtain data	3 hours	30 minutes

The table shows a clear difference between the two methods of data collection, the UAV is about 6 times faster than the TST

Conclusions

- There was a 2.88% difference between the volume calculated with the TST data and the actual volume, and −0.67% difference between the volume calculated with the UAV data and the actual volume
- The UAV is about 6 times faster than the TST
- Risks of obtaining the data with the UAV are much lower, this because people are not exposed to unstable locations.