

Aerial Survey Report



COMPAGNIE SUCRIÈRE KWILU-NGONGO

DRC

July 2017

Compiled by



Introduction

Compagnie Sucrière Kwilu-Ngongo (CSKN) are currently farming approximately 12 000ha of sugarcane in the DRC. CSKN has contracted Agri-Sense through Agricane Consulting Limited (Agricane) to do an aerial survey and terrain model of the northern section of the estate to assist Agricane in their permanent Irrigation Feasibility Study. The entire scheme is situated in the valley bottom created from the two rivers Kwilu and Ngongo from the north and the Kwilu Mtenda from the South, and Lulewa and South East respectively. See image 1 below

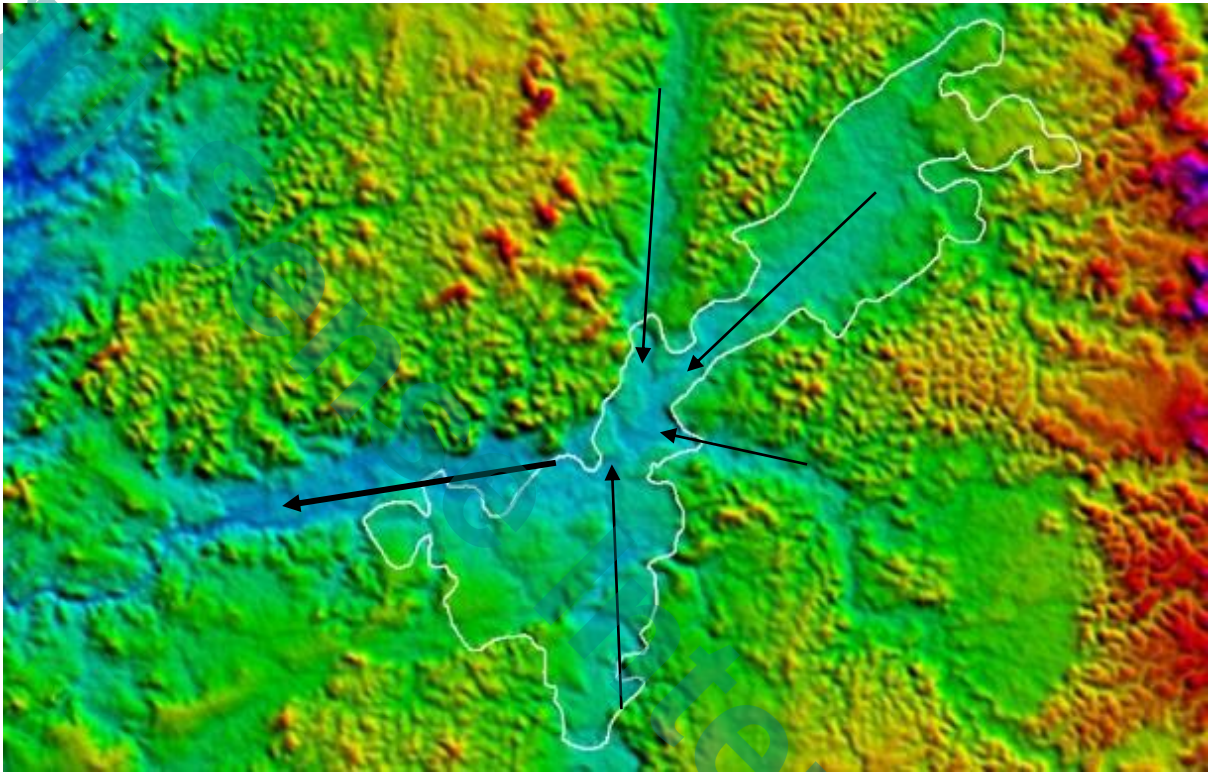


Image 1: View of the CSKN Estate Northern Block showing the River locations and valley bottom.

Furthermore, to the detailed survey, CSKN requested that Agri-Sense do an additional survey of the entire estate and GIS the fields to provide an up to date picture of their current land use plan on the estate. See image 2 below.

The current contract is split into 3 phases

Phase 1:

- High resolution aerial imagery covering an area of Approx 4 000 ha (area to be confirmed after the end of the project), at a resolution of 8cm GSD.
- Detailed elevation model and contour maps for the area

Phase 2:

- High resolution aerial imagery covering an area of Approx 9 500 ha (area to be confirmed after the end of the project), at a resolution of 10cm GSD.

Phase 3:

- GIS all fields on the entire estate and produce accurate net cane areas.



Image 2: View of the entire CSKN Estate surveyed by Agri-Sense

Mobilisation, Personal and Logistics

The Agri-Sense survey team mobilised on the 26th May 2017 from Durban, South Africa. The team consisting of Russell Longhurst and Ross Walters, arrived in Kinshasa in the morning and drove to site, and arrived in the evening the 26th May. Transportation to site and back from Kinshasa was supplied by CSKN.

Accommodation was provided on site by the CSKN in a shared house which was comfortable with good food.

The Agri-Sense team met with Mr Ananth.A.V in the morning to discuss and organise logistics followed by a meeting with Mr Jean Arthur Lagesse. During the meeting, the final areas were agreed upon and the extent of the additional works requested quantified.

The initial area quoted on for Phase 1 was for 4 000ha of detailed survey and terrain modelling. On further investigation, the actual net field area was closer to 5600 ha however it was agreed that the additional area would be calculated at the end of the project.

It was also agreed that due to the placement of the fields in phase 1 and 2, avoiding wet and gravel areas, that it would be impossible to avoid mapping these fall out areas during the survey and that this area would exceed the net field areas

Additionally, 4 new areas to the north of virgin bush and local cropping were requested to be surveyed. These additional areas were estimated at about 300ha. The boundaries for these areas were supplied by Keith Snyman after his initial soil reconnaissance survey of these areas.



Image 3: View of the CSKN Estate showing the field layout

Vehicles on site were supplied by the CSKN, Site access varied throughout the site however the only limitations experienced was that of trying to gain access to the river's edge in some areas. All GCPs locations and UAV launch/landing sites were easily accessed by vehicle saving time.



Image 4: View of the various road access at CSKN Estate

Ground Control and Geo-Rectification

Ground control and geo-rectification involves marking and measuring numerous points across the survey area to improve the accuracy of the elevation model to survey grade. Points were marked on the ground using Agricultural lime that was supplied by CSKN and were visible in the imagery captured by the UAV. Each point was measured with a survey grade Trimble PPK GPS to establish absolute accuracy for each point within 2 cm. During processing, the GPS survey data was added in order to geo-rectify the model to survey grade accuracy. In total 199 Ground control points were used across the area of interest see image 4 below and a full list in Appendix 3.



Image 5: Locations of the Ground Control Points for the CSKN North Block.

The survey was done on the world geodetic system. The Survey Team calibrated the Trimble RTK GPS unit on WGS 84 Datum, UTM Projection Zone 33S. Height system was adjusted for Geoid Separation using NGA EGM 2008 Geoid Calculator. No national height coordinated beacons were found in the area.



Image 6: Installing a Ground Control Point and measuring the point with the GPS Rover.

Agri-Sense established 3 permanent bench marks throughout the Northern block. These permanent bench marks were placed with a 400mm steel rod and encased by cement see Image below and a full description in Appendix 6



Image 7: Installing a Ground Control Point and measuring the point with the GPS Rover.

The whole survey was done using a Trimble R4 PPK Smart GPS unit, the accuracy reports are included in the Appendix 4 and equipment specifications in Appendix 5.

Drone Survey

The final areas for the drone survey was confirmed on site, and differed from the original area of interest as explained above. Due to the geographic locations and different requirements, the project was split into 3 blocks, the North Block (this required GCPs), and the South Block & Yanga block (did not need GCPs). As the South Block and Yanga Block did not require GCPs the drone Survey could commence immediately without the need to wait for GCPs to be placed first.

The survey commenced in the South and progressed to the Northern block with the Yanga block being surveyed on the second last day leaving the last day to capture the areas that had not been covered with the initial flights. The evenings were used to process the initial for each flight to ensure all the area was covered before leaving the site. Some sections in the South were not on the original AOI shape so onsite adjustment were made to accommodate this area.

The UAV used for the project was the Sky-Watch Cumulus 1, long range UAV. The Sensefly Ebee was also used to survey smaller sections that were missed by the cumulus or on sections of the imagery that needed to be re surveyed due to smoke.

A target Ground Resolution of < 10.5 cm was achieved by maintaining an average altitude 420 m above mean ground level.

The entire area was flown in 19 flights from 3 take-off and landing locations and required 22 hours of flying time with the C1 and an additional 11 flights (6 hours) from the Ebee.

Finding suitable soft-landing sites for the UAV was difficult due to the lack of low soft vegetation, and resulted in some damage to the C1 UAV's Wing. Flying was delayed by half a day whilst repairs were carried out.

A total of 17020 images (123 Gigabytes of Data) were captured over the area of interest. Flights were programmed to capture imagery with an overlap of 70% side overlap and 75% front overlap to enable a high degree of photogrammetry accuracy.



Image 8: Ross Walters launching the Cumulus 1 Long Range UAV.

Weather and Environmental Conditions

Atmospheric Conditions were mostly partly cloudy/overcast with low light conditions in the mornings. Wind was relatively calm during the day and did not affect the flying. The resulting light conditions were mostly favourable for aerial imagery. See image 8 above

Data Processing

Processing of flight data was done using Pix4D photogrammetric software. At the first stage of processing the images are processed in an “Initial Process”, where all images are matched and the elevations are corrected to the ground control points. This is to establish how accurate their matching is relative to the surrounding images, along with their elevations and the visibility of the ground (Clarity). Re-optimisation and re-matching are carried out until the results are acceptable. The second stage of processing is the actual generation of the map image and the surface model.

Processing Variables	North Block	South Block	Yanga Block
Computer Time taken for Initial Processing	7d	3d	1d
Computer time taken for Orthomosaic/DSM Generation	1d	1d	1d
Average ground sampling distance (resolution)	10.37 cm	10.94 cm	10.82 cm
Image Coordinate System	WGS84	WGS84	WGS84
Output Coordinate System	WGS84 UTM Zone 33S	WGS84 UTM Zone 33S	WGS84 UTM Zone 33S
Key points per image	14901	13751	13656
Image Calibration	100% with 38 of 5614 images disabled	99% with 1 of 4964 images disabled	99% with all of 1375 images enabled
Camera Optimisation	0.33%	0.33%	0.38%
Matching	Median of 3555.44 per image	Median of 4519.28 per image	Median of 4037.14 per image
Geo-referencing	Mean RMS error of 0.022 m	N/A	N/A

Table 1: Summary of processing report

The key points per image are well above the recommended minimum of 10 000, with above 99% image calibration (no image errors). Camera optimisation for all blocks were excellent and well below the 5% maximum allowed. Matches per calibrated image are very good, well above the 1000 acceptable minimum at over 3555 matches. Geo-referencing displays how the imagery was conformed to the GCP's, to improve the accuracy of the map. The RMS error across the entire project, that is the geo-referencing error, was less than 5cm.

Quality reports are generated at the end of stage 1 and are attached in Appendix 1 with an explanation of terms in Appendix 2.

Post Processing and GIS

Phase 1 on the contract was to produce a detailed terrain model for irrigation design, this involved post processing of the point cloud data to ensure that the true ground level was reflected see image 7 below. The yellow and green points represent the vegetation at various depths and the brown represents the actual ground level. The black dots represent the field boundary vertices.

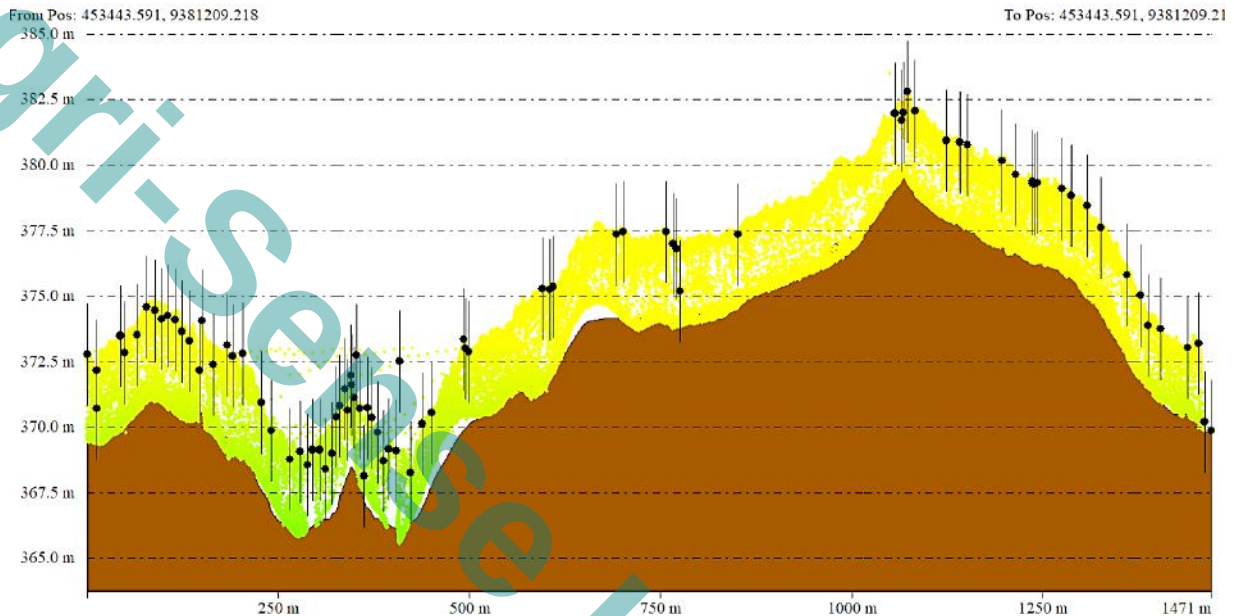


image 9: A cross section on one field displaying the vegetation point cloud and actual terrain level

For Phase 1 and 2 the team were contracted to digitise all the fields and features on the estate see image 4 below

Whilst on site the team collected all the information they could for all the fields from the CSKN GIS department. The GIS Department are operating ArcView, which although is a good program, it is limited in certain functionality and is only limited to one user licence.

The field and feature data was abstracted from Arc view but unfortunately there was no projection data and the information did not seem to be current with the actuals on the ground. Agri-Sense have re mapped and digitised the entire estate. Agri-Sense have digitised to leaf's edge, this is to the sugarcane's edge which excludes roads, drains and island areas that are determined to not be able to produce sugarcane and excludes areas of bad growth that could be improved over time. See image 10 below



Image 10: Fields digitised to leaf's edge showing the exclusion of roads, drains and islands.

With the corrected field boundaries digitised to leaf edge we are now able to determine the accurate net cane area for the estate.

this is summarised in the table below

	Net Field area	Net Survey area	Gross survey area
North Block	5 407	7 674	10 029
South Block	5 610	7 517	8 763
Yanga Block	1 519	1 922	2 261
New fields	232	310	inc in North block
Total	12 767	17 423	21 053

Table 2: Summary Areas surveyed

In Some cases when the field data was transferred from the old field layout to the new field layout it was unclear to which field should receive the data as the actuals on the ground varied from the shape files provided. It is recommended that the CSKN team review this data and make modifications to ensure continuity. Agri-Sense have placed the information onto their MIS system which will enable the management to review the data and make changes infield or in the office.

It is highly recommended that the CSKN look at alternatives from a GIS and Data management perspective. The current system although works is limited in functionality and is a standalone licence. It is Proposed that Agri-Sense implement a simple GIS system for the GIS staff and provide the training and backup. Additionally, we can supply all the information on our MIS system for the management to use which can be complemented by the GIS departments input.

Agri-Sense have vast experience in GIS in agriculture and have GIS specialists who are qualified to train and can provide training to the CSKN staff.

Summary

Despite a few minor challenges with the UAV, the field work at CSKN went very well. The friendliness and hospitality shown, as well as the willingness work late hours by the team, meant that the work was done very efficiently, and with a high level of moral. The Agri-Sense team concluded all processing and exported the results on the 3rd July 2017. It was a pleasure working with the CSKN team, we wish them every success with project.

Appendix 1

Image Processing Report

Quality Report



Generated with Pix4Dmapper Pro version 3.2.10 Preview



Important: Click on the different icons for:



Help to analyze the results in the Quality Report



Additional information about the sections



Click [here](#) for additional tips to analyze the Quality Report

Summary



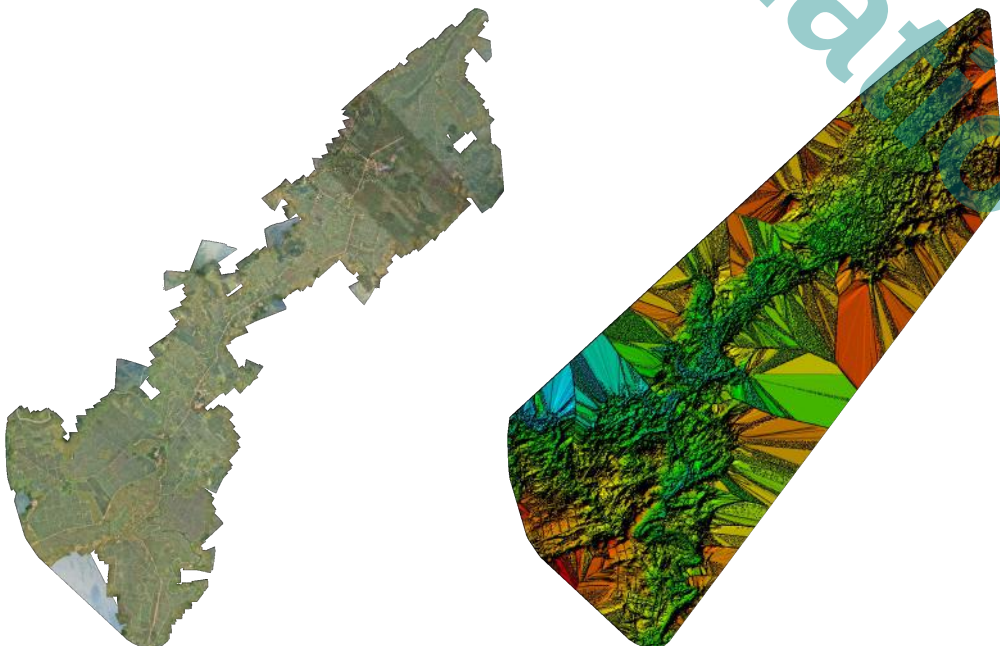
Project	cskn3d_20170612
Processed	2017-06-18 09:25:35
Camera Model Name(s)	ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(1), ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(2), ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(3), ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(4), ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(5), ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(6), ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(7), ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(8)
Average Ground Sampling Distance (GSD)	10.37 cm / 4.08 in
Area Covered	110.469 km ² / 11046.9 ha / 42.6745 sq. mi. / 27311.7 acres

Quality Check



Images	median of 14901 keypoints per image	
Dataset	5576 out of 5576 images calibrated (100%), 38 images disabled	
Camera Optimization	0.33% relative difference between initial and optimized internal camera parameters	
Matching	median of 3555.44 matches per calibrated image	
Georeferencing	199 GCPs (199 3D) mean RMS 0.22m	

Preview



Calibration Details



Number of Calibrated Images	5610 out of 5614
Number of Geolocated Images	5603 out of 5614

? Initial Image Positions

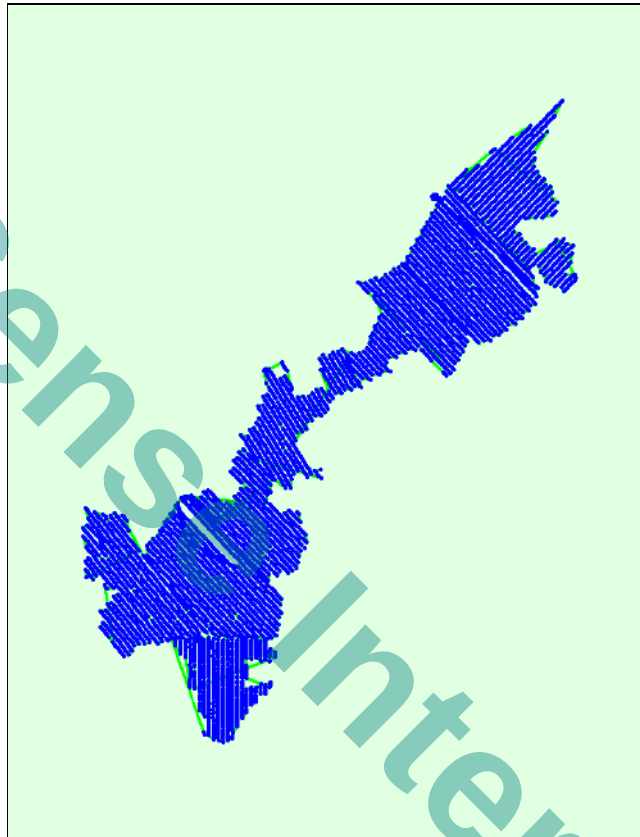


Figure 2: Top view of the initial image position. The green line follows the position of the images in time starting from the large blue dot.

? Computed Image/GCPs/Manual Tie Points Positions



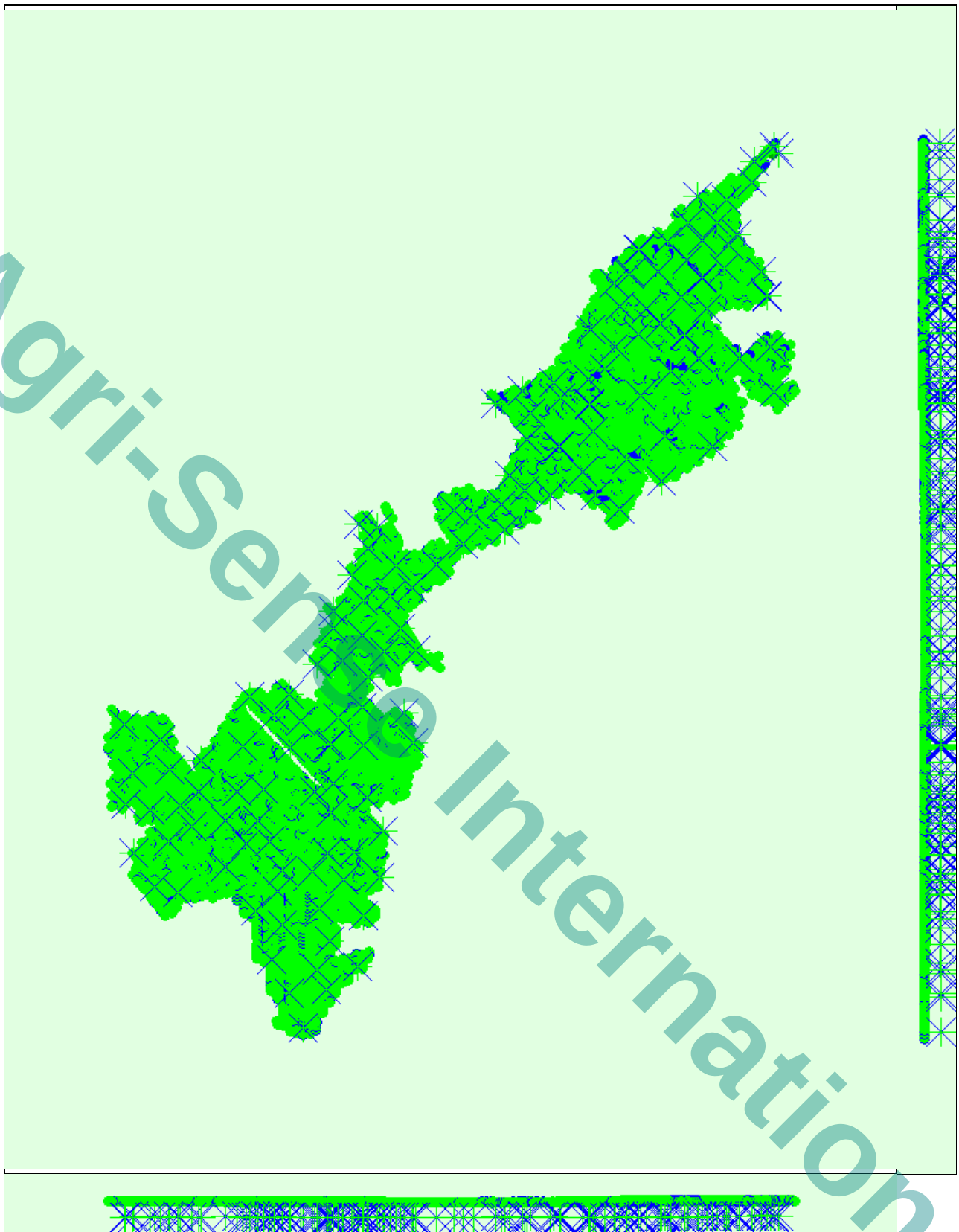


Figure 3: Offset between initial (blue dots) and computed (green dots) image positions as well as the offset between the GCPs initial positions (blue crosses) and their computed positions (green crosses) in the top-view (XY plane), front-view (XZ plane), and side-view (YZ plane). Red dots indicate disabled or uncalibrated images.

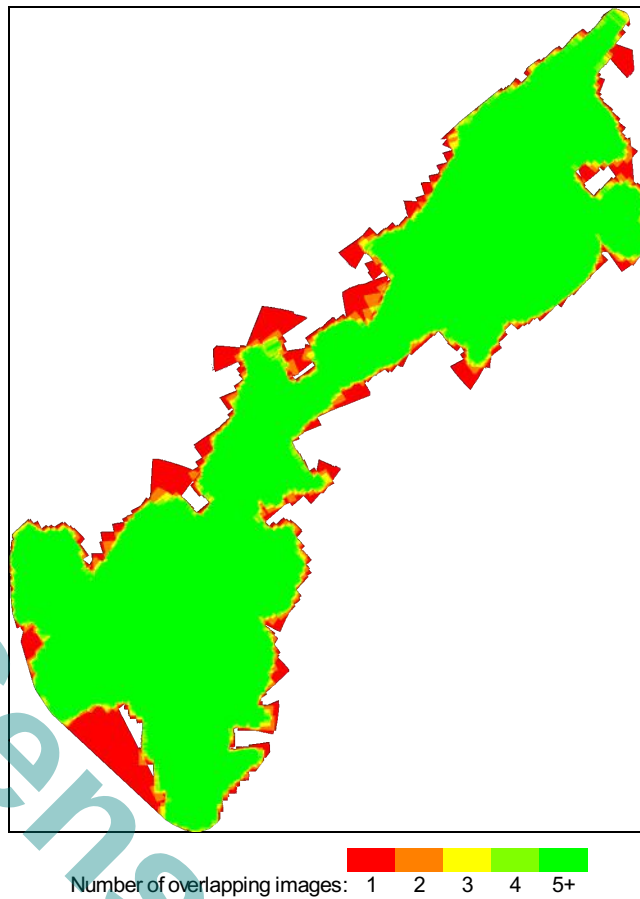


Figure 4: Number of overlapping images computed for each pixel of the orthomosaic. Red and yellow areas indicate low overlap for which poor results may be generated. Green areas indicate an overlap of over 5 images for every pixel. Good quality results will be generated as long as the number of keypoint matches is also sufficient for these areas (see Figure 5 for keypoint matches).

Bundle Block Adjustment Details

Number of 2D Keypoint Observations for Bundle Block Adjustment	24205436
Number of 3D Points for Bundle Block Adjustment	9159473
Mean Reprojection Error [pixels]	0.128

Internal Camera Parameters

ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(1). Sensor Dimensions: 23.333 [mm] x 15.533 [mm]

EXIF ID: ILCE-QX1_E16mmF2.8_16.0_5456x3632

	Focal Length	Principal Point x	Principal Point y	R1	R2	R3	T1	T2
Initial Values	3741.257 [pixel] 16.000 [mm]	2728.000 [pixel] 11.667 [mm]	1816.000 [pixel] 7.766 [mm]	0.000	0.000	0.000	0.000	0.000
Optimized Values	3731.380 [pixel] 15.958 [mm]	2706.118 [pixel] 11.573 [mm]	1787.858 [pixel] 7.646 [mm]	-0.069	0.099	-0.003	-0.002	-0.003

The number of Automatic Tie Points (ATPs) per pixel, averaged over all images of the camera model, is color coded between black and white. White indicates that, on average, more than 16 ATPs have been extracted at the pixel location. Black indicates that, on average, 0 ATPs have been extracted at the pixel location. Click on the image to see the average direction and magnitude of the re-projection error for each pixel. Note that the vectors are scaled for better visualization.

Internal Camera Parameters

📷 ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(2). Sensor Dimensions: 23.333 [mm] x 15.533 [mm]



EXIF ID: ILCE-QX1_E16mmF2.8_16.0_5456x3632

	Focal Length	Principal Point x	Principal Point y	R1	R2	R3	T1	T2
Initial Values	3741.257 [pixel] 16.000 [mm]	2728.000 [pixel] 11.667 [mm]	1816.000 [pixel] 7.766 [mm]	0.000	0.000	0.000	0.000	0.000
Optimized Values	3726.897 [pixel] 15.939 [mm]	2703.201 [pixel] 11.561 [mm]	1786.593 [pixel] 7.641 [mm]	-0.068	0.097	-0.002	-0.002	-0.003



The number of Automatic Tie Points (ATPs) per pixel, averaged over all images of the camera model, is color coded between black and white. White indicates that, on average, more than 16 ATPs have been extracted at the pixel location. Black indicates that, on average, 0 ATPs have been extracted at the pixel location. Click on the image to see the average direction and magnitude of the re-projection error for each pixel. Note that the vectors are scaled for better visualization.

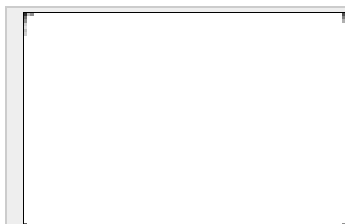
🔍 Internal Camera Parameters

📷 ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(3). Sensor Dimensions: 23.333 [mm] x 15.533 [mm]



EXIF ID: ILCE-QX1_E16mmF2.8_16.0_5456x3632

	Focal Length	Principal Point x	Principal Point y	R1	R2	R3	T1	T2
Initial Values	3741.257 [pixel] 16.000 [mm]	2728.000 [pixel] 11.667 [mm]	1816.000 [pixel] 7.766 [mm]	0.000	0.000	0.000	0.000	0.000
Optimized Values	3726.264 [pixel] 15.936 [mm]	2701.320 [pixel] 11.553 [mm]	1795.216 [pixel] 7.677 [mm]	-0.070	0.102	-0.006	-0.002	-0.002



The number of Automatic Tie Points (ATPs) per pixel, averaged over all images of the camera model, is color coded between black and white. White indicates that, on average, more than 16 ATPs have been extracted at the pixel location. Black indicates that, on average, 0 ATPs have been extracted at the pixel location. Click on the image to see the average direction and magnitude of the re-projection error for each pixel. Note that the vectors are scaled for better visualization.

🔍 Internal Camera Parameters

📷 ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(4). Sensor Dimensions: 23.333 [mm] x 15.533 [mm]



EXIF ID: ILCE-QX1_E16mmF2.8_16.0_5456x3632

	Focal Length	Principal Point x	Principal Point y	R1	R2	R3	T1	T2
Initial Values	3741.257 [pixel] 16.000 [mm]	2728.000 [pixel] 11.667 [mm]	1816.000 [pixel] 7.766 [mm]	0.000	0.000	0.000	0.000	0.000
Optimized Values	3724.355 [pixel] 15.928 [mm]	2706.722 [pixel] 11.576 [mm]	1783.772 [pixel] 7.629 [mm]	-0.067	0.094	0.000	-0.002	-0.002



The number of Automatic Tie Points (ATPs) per pixel, averaged over all images of the camera model, is color coded between black and white. White indicates that, on average, more than 16 ATPs have been extracted at the pixel location. Black indicates that, on average, 0 ATPs have been extracted at the pixel location. Click on the image to see the average direction and magnitude of the re-projection error for each pixel. Note that the vectors are scaled for better visualization.

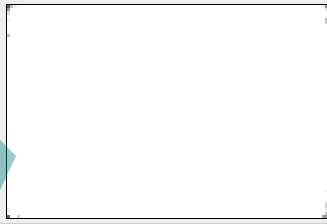
🔍 Internal Camera Parameters

📷 ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(5). Sensor Dimensions: 23.333 [mm] x 15.533 [mm]



EXIF ID: ILCE-QX1_E16mmF2.8_16.0_5456x3632

	Focal Length	Principal Point x	Principal Point y	R1	R2	R3	T1	T2
Initial Values	3741.257 [pixel] 16.000 [mm]	2728.000 [pixel] 11.667 [mm]	1816.000 [pixel] 7.766 [mm]	0.000	0.000	0.000	0.000	0.000
Optimized Values	3737.057 [pixel] 15.982 [mm]	2705.204 [pixel] 11.569 [mm]	1778.585 [pixel] 7.606 [mm]	-0.067	0.094	0.001	-0.002	-0.002



The number of Automatic Tie Points (ATPs) per pixel, averaged over all images of the camera model, is color coded between black and white. White indicates that, on average, more than 16 ATPs have been extracted at the pixel location. Black indicates that, on average, 0 ATPs have been extracted at the pixel location. Click on the image to see the average direction and magnitude of the re-projection error for each pixel. Note that the vectors are scaled for better visualization.

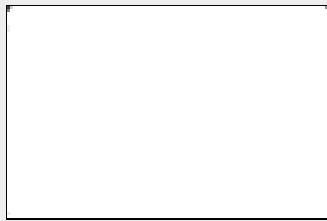
Internal Camera Parameters

ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(6). Sensor Dimensions: 23.333 [mm] x 15.533 [mm]



EXIF ID: ILCE-QX1_E16mmF2.8_16.0_5456x3632

	Focal Length	Principal Point x	Principal Point y	R1	R2	R3	T1	T2
Initial Values	3741.257 [pixel] 16.000 [mm]	2728.000 [pixel] 11.667 [mm]	1816.000 [pixel] 7.766 [mm]	0.000	0.000	0.000	0.000	0.000
Optimized Values	3740.729 [pixel] 15.998 [mm]	2700.897 [pixel] 11.551 [mm]	1775.859 [pixel] 7.595 [mm]	-0.067	0.094	0.001	-0.002	-0.002



The number of Automatic Tie Points (ATPs) per pixel, averaged over all images of the camera model, is color coded between black and white. White indicates that, on average, more than 16 ATPs have been extracted at the pixel location. Black indicates that, on average, 0 ATPs have been extracted at the pixel location. Click on the image to see the average direction and magnitude of the re-projection error for each pixel. Note that the vectors are scaled for better visualization.

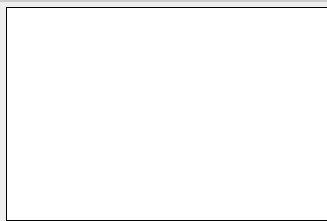
Internal Camera Parameters

ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(7). Sensor Dimensions: 23.333 [mm] x 15.533 [mm]



EXIF ID: ILCE-QX1_E16mmF2.8_16.0_5456x3632

	Focal Length	Principal Point x	Principal Point y	R1	R2	R3	T1	T2
Initial Values	3741.257 [pixel] 16.000 [mm]	2728.000 [pixel] 11.667 [mm]	1816.000 [pixel] 7.766 [mm]	0.000	0.000	0.000	0.000	0.000
Optimized Values	3720.998 [pixel] 15.913 [mm]	2705.374 [pixel] 11.570 [mm]	1777.815 [pixel] 7.603 [mm]	-0.065	0.088	0.003	-0.002	-0.002



The number of Automatic Tie Points (ATPs) per pixel, averaged over all images of the camera model, is color coded between black and white. White indicates that, on average, more than 16 ATPs have been extracted at the pixel location. Black indicates that, on average, 0 ATPs have been extracted at the pixel location. Click on the image to see the average direction and magnitude of the re-projection error for each pixel. Note that the vectors are scaled for better visualization.

Internal Camera Parameters

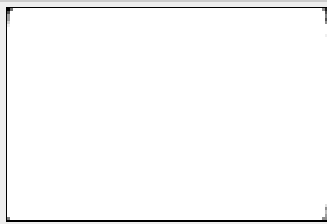
ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(8). Sensor Dimensions: 23.333 [mm] x 15.533 [mm]



EXIF ID: ILCE-QX1_E16mmF2.8_16.0_5456x3632

	Focal Length	Principal Point x	Principal Point y	R1	R2	R3	T1	T2
Initial Values	3741.257 [pixel] 16.000 [mm]	2728.000 [pixel] 11.667 [mm]	1816.000 [pixel] 7.766 [mm]	0.000	0.000	0.000	0.000	0.000

Optimized Values	3720.758 [pixel] 15.912 [mm]	2688.978 [pixel] 11.500 [mm]	1779.635 [pixel] 7.611 [mm]	-0.072	0.107	-0.011	-0.002	-0.003
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The number of Automatic Tie Points (ATPs) per pixel, averaged over all images of the camera model, is color coded between black and white. White indicates that, on average, more than 16 ATPs have been extracted at the pixel location. Black indicates that, on average, 0 ATPs have been extracted at the pixel location. Click on the image to see the average direction and magnitude of the re-projection error for each pixel. Note that the vectors are scaled for better visualization.

2D Keypoints Table

	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	14901	3555
Min	7661	43
Max	34797	16556
Mean	17169	4340

2D Keypoints Table for Camera ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(1)

	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	14791	3295
Min	10703	380
Max	25465	7549
Mean	15055	3345

2D Keypoints Table for Camera ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(2)

	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	13519	2927
Min	8895	436
Max	24345	7833
Mean	13535	2919

2D Keypoints Table for Camera ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(3)

	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	15164	4027
Min	8764	526
Max	30201	11648
Mean	16019	4230

2D Keypoints Table for Camera ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(4)

	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	13755	2847
Min	9209	414
Max	24774	6833
Mean	14022	2900

2D Keypoints Table for Camera ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(5)

	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	14459	2593
Min	9062	264
Max	29355	6955
Mean	14711	2650

2D Keypoints Table for Camera ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(6)

	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	13814	2874
Min	7661	420
Max	27412	10811
Mean	14422	3021

2D Keypoints Table for Camera ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(7)

	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	29182	9709
Min	14232	1128
Max	34797	16556
Mean	28557	9390

2D Keypoints Table for Camera ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(8)

	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	15551	3443
Min	8958	43
Max	22216	7859
Mean	15287	3433

Median / 75% / Maximal Number of Matches Between Camera Models

	ILCE-QX1_E16... (RGB)(1)	ILCE-QX1_E16... (RGB)(2)	ILCE-QX1_E16... (RGB)(3)	ILCE-QX1_E16... (RGB)(4)	ILCE-QX1_E16... (RGB)(5)	ILCE-QX1_E16... (RGB)(6)	ILCE-QX1_E16... (RGB)(7)	ILCE-QX1_E16... (RGB)(8)
ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(1)	62 / 213 / 4597							
ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(2)		45 / 158 / 4395						
ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(3)			45 / 187 / 6702					
ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(4)				34 / 142 / 4435				
ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(5)					41 / 149 / 4021			
ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(6)						44 / 159 / 6485		
ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(7)							103 / 483 / 10573	
ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(8)								48 / 183 / 5901

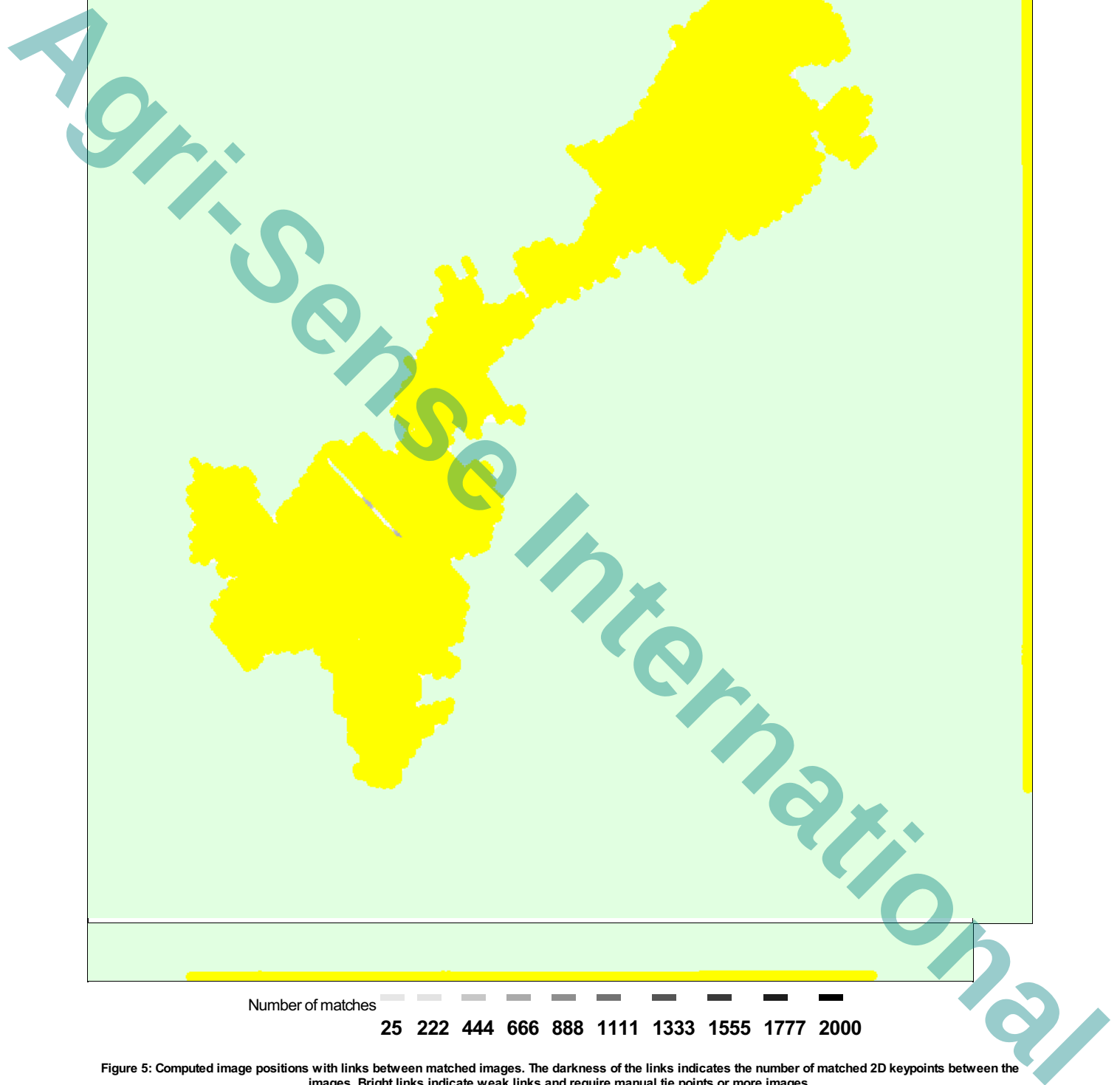
3D Points from 2D Keypoint Matches

	Number of 3D Points Observed
In 2 Images	6323658
In 3 Images	1592407
In 4 Images	600811
In 5 Images	253739
In 6 Images	134014
In 7 Images	82419
In 8 Images	55095

In 9 Images	35629
In 10 Images	24079
In 11 Images	18571
In 12 Images	14824
In 13 Images	10285
In 14 Images	6203
In 15 Images	3720
In 16 Images	2113
In 17 Images	1178
In 18 Images	529
In 19 Images	143
In 20 Images	40
In 21 Images	10
In 22 Images	5
In 23 Images	1

2D Keypoint Matches





Geolocation Details



GCP Name	Accuracy XY/Z [m]	Error X [m]	Error Y [m]	Error Z [m]	Projection Error [pixel]	Verified/Marked
GCP1 (3D)	0.020/ 0.020	-0.045	0.070	0.017	0.327	16 / 16
GCP1b (3D)	0.020/ 0.020	-0.074	0.053	-0.011	0.366	16 / 16
GCP2 (3D)	0.020/ 0.020	0.048	0.075	-0.011	0.402	17 / 17
GCP3 (3D)	0.020/ 0.020	0.058	0.082	0.019	0.418	15 / 15
GCP4 (3D)	0.020/ 0.020	0.089	0.109	-0.115	0.570	10 / 10
GCP5 (3D)	0.020/ 0.020	-0.040	0.021	-0.028	0.446	13 / 13
GCP6 (3D)	0.020/ 0.020	0.015	0.025	-0.052	0.259	10 / 10
GCP7 (3D)	0.020/ 0.020	-0.025	0.033	-0.019	0.293	12 / 12
GCP8 (3D)	0.020/ 0.020	-0.054	0.005	0.009	0.218	3 / 3
GCP9 (3D)	0.020/ 0.020	-0.453	-0.635	1.271	1.233	6 / 6
GCP10 (3D)	0.020/ 0.020	-1.440	-1.566	3.483	0.306	15 / 15
GCP11 (3D)	0.020/ 0.020	-1.187	-0.977	2.923	0.339	17 / 17
GCP12 (3D)	0.020/ 0.020	-1.261	-1.082	2.909	0.423	11 / 11
GCP13 (3D)	0.020/ 0.020	-1.095	-1.761	1.470	0.381	12 / 12
GCP14 (3D)	0.020/ 0.020	-0.184	-0.437	0.429	1.258	12 / 12
GCP15 (3D)	0.020/ 0.020	-0.024	-0.077	-0.010	0.563	15 / 15
GCP16 (3D)	0.020/ 0.020	-0.217	-0.378	-0.023	1.316	9 / 9
GCP17 (3D)	0.020/ 0.020	-0.012	0.003	-0.004	0.376	16 / 16
GCP18 (3D)	0.020/ 0.020	-0.177	-0.202	0.177	1.741	12 / 12
GCP19 (3D)	0.020/ 0.020	-0.015	-0.011	-0.049	0.279	4 / 4
GCP20 (3D)	0.020/ 0.020	0.016	-0.067	0.012	1.228	12 / 12
GCP21 (3D)	0.020/ 0.020	-0.021	-0.051	-0.084	1.042	11 / 11
GCP23 (3D)	0.020/ 0.020	-0.012	-0.281	0.035	0.830	16 / 16
GCP24 (3D)	0.020/ 0.020	-0.112	-0.528	0.211	1.529	9 / 9
GCP26 (3D)	0.020/ 0.020	0.015	-0.290	-0.131	1.426	13 / 13
GCP27 (3D)	0.020/ 0.020	0.008	-0.003	-0.001	0.596	12 / 12
GCP28 (3D)	0.020/ 0.020	-0.024	-0.007	0.013	0.434	12 / 12
GCP29 (3D)	0.020/ 0.020	-2.694	-3.495	5.390	0.344	15 / 15
GCP30 (3D)	0.020/ 0.020	-2.296	-3.383	4.075	0.457	20 / 20
GCP31 (3D)	0.020/ 0.020	-2.227	-3.305	3.379	0.677	17 / 17
GCP32 (3D)	0.020/ 0.020	-0.106	-0.116	0.047	1.036	16 / 16
GCP33 (3D)	0.020/ 0.020	0.001	-0.109	0.024	0.500	12 / 12
GCP34 (3D)	0.020/ 0.020	-1.676	-3.617	1.333	0.385	14 / 14
GCP35 (3D)	0.020/ 0.020	-1.682	-3.344	1.433	0.550	13 / 13
GCP36 (3D)	0.020/ 0.020	-0.261	-0.017	-0.297	0.933	8 / 8
GCP37 (3D)	0.020/ 0.020	-0.883	-3.973	0.981	0.450	18 / 18
GCP38 (3D)	0.020/ 0.020	-0.680	-3.634	0.934	0.531	17 / 17
GCP39 (3D)	0.020/ 0.020	-0.049	-0.394	0.111	1.417	15 / 15
GCP40 (3D)	0.020/ 0.020	-0.122	-1.512	-0.008	1.237	15 / 15
GCP41 (3D)	0.020/ 0.020	-0.088	-1.446	0.173	0.583	12 / 12
GCP42 (3D)	0.020/ 0.020	-0.117	-1.529	0.215	0.339	15 / 15
GCP43 (3D)	0.020/ 0.020	0.053	-0.054	0.032	0.426	13 / 13
GCP44 (3D)	0.020/ 0.020	-0.080	-1.278	0.335	0.417	14 / 14
GCP45 (3D)	0.020/ 0.020	-0.068	-0.360	-0.023	0.505	13 / 13
GCP46 (3D)	0.020/ 0.020	-0.467	-2.253	0.617	0.493	12 / 12
GCP47 (3D)	0.020/ 0.020	-0.142	-1.209	0.158	0.621	8 / 8
GCP48 (3D)	0.020/ 0.020	-0.082	-1.215	0.203	0.414	8 / 8
GCP57 (3D)	0.020/ 0.020	-0.131	-0.346	-0.021	1.576	12 / 12
GCP58 (3D)	0.020/ 0.020	0.036	-0.044	-0.010	0.481	16 / 16
GCP59 (3D)	0.020/ 0.020	-0.023	0.008	0.027	0.271	9 / 9
GCP60b (3D)	0.020/ 0.020	-0.001	-0.015	0.019	0.331	12 / 12
GCP60v2 (3D)	0.020/ 0.020	0.003	-0.010	-0.025	0.359	12 / 12
GCP61 (3D)	0.020/ 0.020	0.011	-0.002	-0.015	0.361	12 / 12
GCP61v2 (3D)	0.020/ 0.020	-0.014	0.014	0.013	0.247	12 / 12
GCP62 (3D)	0.020/ 0.020	0.002	0.001	0.000	0.295	14 / 14
GCP63 (3D)	0.020/ 0.020	0.001	-0.006	-0.002	0.283	6 / 6

GCP64 (3D)	0.020/ 0.020	0.003	0.002	0.000	0.435	12 / 12
GCP65 (3D)	0.020/ 0.020	0.001	0.002	0.002	0.338	17 / 17
GCP66 (3D)	0.020/ 0.020	-0.006	-0.002	-0.009	0.316	13 / 13
GCP67 (3D)	0.020/ 0.020	0.004	-0.002	0.000	0.257	16 / 16
GCP68 (3D)	0.020/ 0.020	0.008	-0.000	0.001	0.349	17 / 17
GCP69 (3D)	0.020/ 0.020	0.009	0.016	0.005	0.352	16 / 16
GCP69b (3D)	0.020/ 0.020	-0.012	-0.008	-0.005	0.437	16 / 16
GCP70 (3D)	0.020/ 0.020	0.003	0.001	-0.002	0.407	15 / 15
GCP76 (3D)	0.020/ 0.020	0.006	0.002	-0.000	0.246	12 / 12
GCP77 (3D)	0.020/ 0.020	-0.002	-0.027	-0.003	0.415	12 / 12
GCP78 (3D)	0.020/ 0.020	-0.005	-0.008	0.001	0.306	15 / 15
GCP79 (3D)	0.020/ 0.020	-0.053	0.054	-0.065	0.984	9 / 9
GCP80 (3D)	0.020/ 0.020	-0.009	0.003	0.017	0.469	11 / 11
GCP81 (3D)	0.020/ 0.020	-0.014	0.141	0.013	0.524	14 / 14
GCP82 (3D)	0.020/ 0.020	0.006	0.016	-0.013	0.347	13 / 13
GCP83 (3D)	0.020/ 0.020	0.001	0.012	-0.010	0.267	13 / 13
GCP84 (3D)	0.020/ 0.020	-0.002	0.000	-0.004	0.321	13 / 13
GCP85 (3D)	0.020/ 0.020	0.025	0.006	-0.003	0.276	16 / 16
GCP86 (3D)	0.020/ 0.020	0.020	0.016	0.010	0.344	14 / 14
GCP87 (3D)	0.020/ 0.020	0.066	0.019	-0.013	0.351	16 / 16
GCP88 (3D)	0.020/ 0.020	-0.008	-0.045	0.006	0.655	11 / 11
GCP89 (3D)	0.020/ 0.020	-0.024	-0.153	0.003	0.644	18 / 18
GCP89b (3D)	0.020/ 0.020	-0.080	-0.109	0.015	0.798	18 / 18
GCP90 (3D)	0.020/ 0.020	0.049	0.004	-0.015	0.962	12 / 12
GCP91 (3D)	0.020/ 0.020	-0.234	-0.284	-0.055	1.486	15 / 15
GCP92 (3D)	0.020/ 0.020	-0.032	-0.195	0.026	1.099	15 / 15
GCP93 (3D)	0.020/ 0.020	-0.066	-0.245	0.141	1.248	17 / 17
GCP94 (3D)	0.020/ 0.020	-0.859	-2.311	1.994	1.674	11 / 11
GCP94v2 (3D)	0.020/ 0.020	0.260	0.225	0.454	1.150	11 / 11
GCP100 (3D)	0.020/ 0.020	0.023	0.036	0.026	0.603	14 / 14
GCP101 (3D)	0.020/ 0.020	-0.000	-0.034	0.003	0.509	18 / 18
GCP102 (3D)	0.020/ 0.020	-0.008	0.002	-0.006	0.522	16 / 16
GCP103 (3D)	0.020/ 0.020	0.000	0.022	-0.006	0.422	15 / 15
GCP104 (3D)	0.020/ 0.020	-0.006	-0.002	0.009	0.678	10 / 10
GCP105 (3D)	0.020/ 0.020	0.020	0.005	0.004	0.443	15 / 15
GCP106 (3D)	0.020/ 0.020	-0.001	-0.000	0.000	0.351	16 / 16
GCP107 (3D)	0.020/ 0.020	0.003	-0.004	-0.001	0.331	24 / 24
GCP108 (3D)	0.020/ 0.020	-0.000	0.007	-0.002	0.206	18 / 18
GCP109 (3D)	0.020/ 0.020	0.006	0.001	-0.004	0.161	9 / 9
GCP110 (3D)	0.020/ 0.020	0.000	0.002	0.002	0.191	16 / 16
GCP111 (3D)	0.020/ 0.020	0.008	0.012	0.003	0.254	15 / 15
GCP112 (3D)	0.020/ 0.020	0.011	-0.001	-0.014	0.195	12 / 12
GCP113 (3D)	0.020/ 0.020	0.051	-0.029	-0.015	0.279	16 / 16
GCP114 (3D)	0.020/ 0.020	-0.067	0.016	0.038	0.419	13 / 13
GCP115 (3D)	0.020/ 0.020	-0.004	0.008	-0.001	0.146	15 / 15
GCP116 (3D)	0.020/ 0.020	0.018	0.099	-0.012	0.348	15 / 15
GCP117 (3D)	0.020/ 0.020	0.041	0.093	-0.043	0.344	12 / 12
GCP118 (3D)	0.020/ 0.020	-0.054	0.031	0.003	0.255	8 / 8
GCP119 (3D)	0.020/ 0.020	-0.015	0.010	0.027	0.194	8 / 8
GCP120 (3D)	0.020/ 0.020	-0.001	0.001	-0.002	0.200	15 / 15
GCP121 (3D)	0.020/ 0.020	-0.002	0.001	0.002	0.168	8 / 8
GCP122 (3D)	0.020/ 0.020	0.001	0.002	-0.002	0.043	7 / 7
GCP123 (3D)	0.020/ 0.020	-0.001	0.008	-0.001	0.202	14 / 14
GCP124 (3D)	0.020/ 0.020	0.001	-0.033	-0.010	0.240	13 / 13
GCP124v2 (3D)	0.020/ 0.020	-0.008	0.032	0.017	0.176	12 / 12
GCP125 (3D)	0.020/ 0.020	0.003	0.010	0.013	0.236	13 / 13
GCP126 (3D)	0.020/ 0.020	0.007	0.036	0.011	0.231	17 / 17
GCP150 (3D)	0.020/ 0.020	0.000	0.000	0.002	0.171	13 / 13
GCP151 (3D)	0.020/ 0.020	-0.001	0.006	-0.003	0.201	12 / 12

GCP152 (3D)	0.020/ 0.020	-0.002	-0.002	-0.002	0.172	14 / 14
GCP153 (3D)	0.020/ 0.020	-0.001	0.005	0.002	0.172	11 / 11
GCP154 (3D)	0.020/ 0.020	-0.003	-0.004	-0.003	0.106	9 / 9
GCP155 (3D)	0.020/ 0.020	0.001	-0.003	-0.001	0.131	9 / 9
GCP156 (3D)	0.020/ 0.020	0.009	0.000	0.000	0.321	12 / 12
GCP157 (3D)	0.020/ 0.020	0.006	-0.000	0.000	0.125	15 / 15
GCP158 (3D)	0.020/ 0.020	0.007	0.007	-0.008	0.143	8 / 8
GCP159 (3D)	0.020/ 0.020	-0.000	-0.004	-0.005	0.144	6 / 6
GCP160 (3D)	0.020/ 0.020	-0.010	-0.012	-0.003	0.159	6 / 6
GCP161 (3D)	0.020/ 0.020	-0.003	-0.001	-0.001	0.106	7 / 7
GCP162 (3D)	0.020/ 0.020	-0.001	0.001	-0.000	0.319	9 / 9
GCP163 (3D)	0.020/ 0.020	-0.013	-0.006	0.011	0.547	12 / 12
GCP164 (3D)	0.020/ 0.020	0.013	-0.001	-0.000	0.431	13 / 13
GCP165 (3D)	0.020/ 0.020	0.008	-0.005	-0.009	0.469	12 / 12
GCP166 (3D)	0.020/ 0.020	0.014	0.013	-0.002	0.501	13 / 13
GCP167 (3D)	0.020/ 0.020	-0.000	0.007	-0.009	0.689	10 / 10
GCP168 (3D)	0.020/ 0.020	0.000	-0.001	0.006	0.568	13 / 13
GCP169 (3D)	0.020/ 0.020	0.001	-0.002	-0.005	0.410	14 / 14
GCP170 (3D)	0.020/ 0.020	-0.004	0.004	0.016	0.441	10 / 10
GCP171 (3D)	0.020/ 0.020	0.007	-0.006	0.006	0.531	11 / 11
GCP172 (3D)	0.020/ 0.020	-0.005	-0.008	-0.016	0.349	7 / 7
GCP173 (3D)	0.020/ 0.020	0.108	0.087	0.087	0.991	13 / 13
GCP173b (3D)	0.020/ 0.020	0.087	0.101	0.097	0.943	13 / 13
GCP173v2 (3D)	0.020/ 0.020	-1.195	-1.716	2.369	1.081	13 / 13
GCP174 (3D)	0.020/ 0.020	0.142	0.154	0.059	1.273	13 / 13
GCP174v2 (3D)	0.020/ 0.020	-1.047	-1.691	2.054	1.608	13 / 13
GCP175 (3D)	0.020/ 0.020	0.005	-0.027	-0.019	0.412	7 / 7
GCP200 (3D)	0.020/ 0.020	-0.518	-0.151	0.750	1.114	3 / 3
GCP201 (3D)	0.020/ 0.020	-0.312	-1.188	1.952	0.352	3 / 3
GCP202 (3D)	0.020/ 0.020	0.113	-0.071	0.214	0.593	6 / 6
GCP203 (3D)	0.020/ 0.020	-0.047	-1.778	4.089	4.468	7 / 9
GCPa29 (3D)	0.020/ 0.020	0.025	-0.026	-0.018	0.590	14 / 14
GCPa30 (3D)	0.020/ 0.020	0.146	0.019	-0.023	0.720	20 / 20
GCPa31 (3D)	0.020/ 0.020	-0.089	0.250	0.082	0.938	18 / 18
GCPa32 (3D)	0.020/ 0.020	1.971	3.578	-2.629	1.097	16 / 16
GCPa33 (3D)	0.020/ 0.020	2.058	3.481	-2.218	0.794	12 / 12
GCPa34 (3D)	0.020/ 0.020	0.153	0.152	-0.032	0.455	14 / 14
GCPa35 (3D)	0.020/ 0.020	-0.033	0.506	0.031	1.027	13 / 13
GCPa36 (3D)	0.020/ 0.020	1.048	3.883	-1.733	1.294	8 / 8
GCPa37 (3D)	0.020/ 0.020	0.070	-0.076	0.067	0.542	18 / 18
GCPa38 (3D)	0.020/ 0.020	1.362	3.235	-4.048	0.896	12 / 12
GCPa39 (3D)	0.020/ 0.020	1.288	2.999	-3.297	1.661	13 / 13
GCPa47 (3D)	0.020/ 0.020	0.174	1.935	-0.436	0.584	8 / 8
GCPa48 (3D)	0.020/ 0.020	0.187	1.938	-0.460	0.801	8 / 8
GCPa49 (3D)	0.020/ 0.020	0.104	0.746	-0.197	0.749	12 / 12
GCPa50 (3D)	0.020/ 0.020	0.076	0.379	-0.016	1.163	13 / 13
GCPa51 (3D)	0.020/ 0.020	0.708	2.403	-3.499	1.723	12 / 12
GCPa52 (3D)	0.020/ 0.020	0.498	0.940	-2.183	4.558	7 / 9
GCPa53 (3D)	0.020/ 0.020	0.866	2.706	-3.878	0.674	16 / 16
GCPa54 (3D)	0.020/ 0.020	0.716	2.672	-4.190	0.609	9 / 9
GCPa55 (3D)	0.020/ 0.020	0.208	2.697	-3.585	1.795	3 / 3
GCPa56 (3D)	0.020/ 0.020	0.455	1.581	-2.642	0.661	3 / 3
GCPa58 (3D)	0.020/ 0.020	-3.169	-2.368	1.087	0.829	13 / 13
GCPa59 (3D)	0.020/ 0.020	0.187	2.010	-0.588	0.865	14 / 14
GCPa60 (3D)	0.020/ 0.020	0.192	2.416	-0.403	0.958	14 / 14
GCPa61 (3D)	0.020/ 0.020	0.176	2.187	-0.447	0.796	15 / 15
GCPa62 (3D)	0.020/ 0.020	0.070	2.454	-0.455	0.957	12 / 12
GCPa63 (3D)	0.020/ 0.020	0.093	0.226	-0.135	0.993	17 / 17
GCPa64 (3D)	0.020/ 0.020	0.243	3.476	-0.106	1.653	13 / 13

GCPa65 (3D)	0.020/0.020	0.543	2.746	-4.247	1.536	9 / 9
rI02 (3D)	0.020/0.020	1.758	3.337	-4.440	0.531	12 / 12
rI05 (3D)	0.020/0.020	0.893	2.395	-3.766	1.311	11 / 11
rI06 (3D)	0.020/0.020	1.082	2.141	-3.328	1.099	12 / 12
rI07 (3D)	0.020/0.020	1.219	2.112	-3.035	0.350	4 / 4
rI08 (3D)	0.020/0.020	0.985	1.497	-3.233	2.115	11 / 11
rI09 (3D)	0.020/0.020	1.056	1.722	-3.120	0.574	16 / 16
rI10 (3D)	0.020/0.020	1.031	1.565	-1.744	1.456	8 / 8
rI11 (3D)	0.020/0.020	0.133	0.119	0.041	1.327	13 / 13
rI12 (3D)	0.020/0.020	0.010	0.075	0.076	0.806	13 / 13
rI13 (3D)	0.020/0.020	0.024	0.042	0.024	0.486	17 / 17
rI14 (3D)	0.020/0.020	0.032	-0.005	0.032	0.671	13 / 13
rI15 (3D)	0.020/0.020	-0.005	-0.039	0.048	0.428	10 / 10
rI16 (3D)	0.020/0.020	0.021	-0.050	0.015	0.412	12 / 12
rI17 (3D)	0.020/0.020	0.027	0.045	0.002	0.443	14 / 14
rI18 (3D)	0.020/0.020	1.308	1.179	-3.417	0.712	3 / 3
rI19 (3D)	0.020/0.020	0.906	0.923	-2.193	1.328	6 / 6
rI20 (3D)	0.020/0.020	-0.031	0.067	0.029	0.698	11 / 11
rI21 (3D)	0.020/0.020	0.081	-0.358	-0.986	0.636	12 / 12
rI22 (3D)	0.020/0.020	1.229	1.587	-1.550	0.728	14 / 14
rI23 (3D)	0.020/0.020	0.829	0.991	-1.850	1.535	11 / 11
rI24 (3D)	0.020/0.020	0.084	0.108	-0.065	0.377	10 / 10
rI25 (3D)	0.020/0.020	0.025	0.022	0.009	0.264	14 / 14
rI26 (3D)	0.020/0.020	0.020	0.044	0.004	0.425	14 / 14
rI27 (3D)	0.020/0.020	-0.095	0.023	0.006	0.333	14 / 14
Mean [m]		-0.003110	0.077094	-0.135395		
Sigma [m]		0.615341	1.253832	1.347122		
RMS Error [m]		0.615348	1.256199	1.353909		

Localisation accuracy per GCP and mean errors in the three coordinate directions. The last column counts the number of calibrated images where the GCP has been automatically verified vs. manually marked.

? Absolute Geolocation Variance



Min Error [m]	Max Error [m]	Geolocation Error X[%]	Geolocation Error Y[%]	Geolocation Error Z[%]
-	-15.00	0.05	0.07	0.02
-15.00	-12.00	0.14	0.20	0.11
-12.00	-9.00	0.84	1.04	0.00
-9.00	-6.00	5.32	7.68	1.30
-6.00	-3.00	16.65	18.62	9.89
-3.00	0.00	26.54	23.17	39.41
0.00	3.00	27.70	22.62	41.77
3.00	6.00	16.30	17.39	4.61
6.00	9.00	5.53	6.50	1.61
9.00	12.00	0.79	2.11	0.91
12.00	15.00	0.11	0.52	0.27
15.00	-	0.02	0.11	0.11
Mean [m]		-0.669796	-0.904245	2.236459
Sigma [m]		3.980622	4.550626	2.785915
RMS Error [m]		4.036580	4.639597	3.572544

Min Error and Max Error represent geolocation error intervals between -1.5 and 1.5 times the maximum accuracy of all the images. Columns X, Y, Z show the percentage of images with geolocation errors within the predefined error intervals. The geolocation error is the difference between the initial and computed image positions. Note that the image geolocation errors do not correspond to the accuracy of the observed 3D points.

Geolocation Bias	X	Y	Z
Translation [m]	-0.667207	-0.899449	2.267665

Relative Geolocation Variance

Relative Geolocation Error	Images X[%]	Images Y[%]	Images Z[%]
[-1.00, 1.00]	78.72	72.19	98.93
[-2.00, 2.00]	98.91	97.54	99.98
[-3.00, 3.00]	99.93	99.82	100.00
Mean of Geolocation Accuracy [m]	5.000000	5.000000	10.000000
Sigma of Geolocation Accuracy [m]	0.000000	0.000000	0.000000

Images X, Y, Z represent the percentage of images with a relative geolocation error in X, Y, Z.

Geolocation Orientational Variance	RMS [degree]
Omega	2.326
Phi	2.636
Kappa	87.279

Geolocation RMS error of the orientation angles given by the difference between the initial and computed image orientation angles.

Initial Processing Details

System Information

Hardware	CPU: Intel(R) Core(TM) i7-6900K CPU @ 3.20GHz RAM: 64GB GPU: NVIDIA GeForce GTX 1080 (Driver: 22.21.13.8253)
Operating System	Windows 10 Pro, 64-bit

Coordinate Systems

Image Coordinate System	WGS84 (egm96)
Ground Control Point (GCP) Coordinate System	WGS84 / UTM zone 33S (egm96)
Output Coordinate System	WGS84 / UTM zone 33S (egm96)

Processing Options

Detected Template	No Template Available
Keypoints Image Scale	Custom, Image Scale: 0.5
Advanced: Matching Image Pairs	Aerial Grid or Corridor
Advanced: Matching Strategy	Use Geometrically Verified Matching: no
Advanced: Keypoint Extraction	Targeted Number of Keypoints: Automatic
Advanced: Calibration	Calibration Method: Standard Internal Parameters Optimization: All External Parameters Optimization: All Rematch: Auto, no Bundle Adjustment: Classic

Point Cloud Densification details

Processing Options

Image Scale	multiscale, 1/2 (Half image size, Default)
Point Density	Optimal
Minimum Number of Matches	3

3D Textured Mesh Generation	yes
3D Textured Mesh Settings:	Resolution: Medium Resolution (default) Color Balancing: no
Advanced: 3D Textured Mesh Settings	Sample Density Divider: 1
Advanced: Matching Window Size	7x7 pixels
Advanced: Image Groups	group1
Advanced: Use Processing Area	yes
Advanced: Use Annotations	yes
Advanced: Limit Camera Depth Automatically	no

Results



Number of Generated Tiles	52
Number of 3D Densified Points	825666167
Average Density (per m ³)	3.09

DSM, Orthomosaic and Index Details



Processing Options



DSM and Orthomosaic Resolution	1 x GSD (10.4 [cm/pixel])
DSM Filters	Noise Filtering: yes Surface Smoothing: yes, Type: Sharp
Raster DSM	Generated: yes Method: Inverse Distance Weighting Merge Tiles: no
Orthomosaic	Generated: yes Merge Tiles: yes GeoTIFF Without Transparency: no Google Maps Tiles and KML: no
Grid DSM	Generated: yes, Spacing [cm]: 100

Quality Report



Generated with Pix4Dmapper Pro version 3.2.10 Preview



Important: Click on the different icons for:



Help to analyze the results in the Quality Report



Additional information about the sections



Click [here](#) for additional tips to analyze the Quality Report

Summary



Project	CSKN SOUTH BLOCK
Processed	2017-08-07 20:07:03
Camera Model Name(s)	ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(1), ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(2), ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(3), ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(4), ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(5), ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(6), ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(7), ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(8)
Average Ground Sampling Distance (GSD)	10.94 cm / 4.3 in
Area Covered	103.9 km ² / 10390 ha / 40.1368 sq. mi. / 25687.6 acres
Time for Initial Processing (without report)	03h:48m:13s

Quality Check



Images	median of 13751 keypoints per image	
Dataset	4964 out of 4991 images calibrated (99%), 1 images disabled, 2 blocks	
Camera Optimization	0.33% relative difference between initial and optimized internal camera parameters	
Matching	median of 4519.28 matches per calibrated image	
Georeferencing	yes, no 3D GCP	

Preview



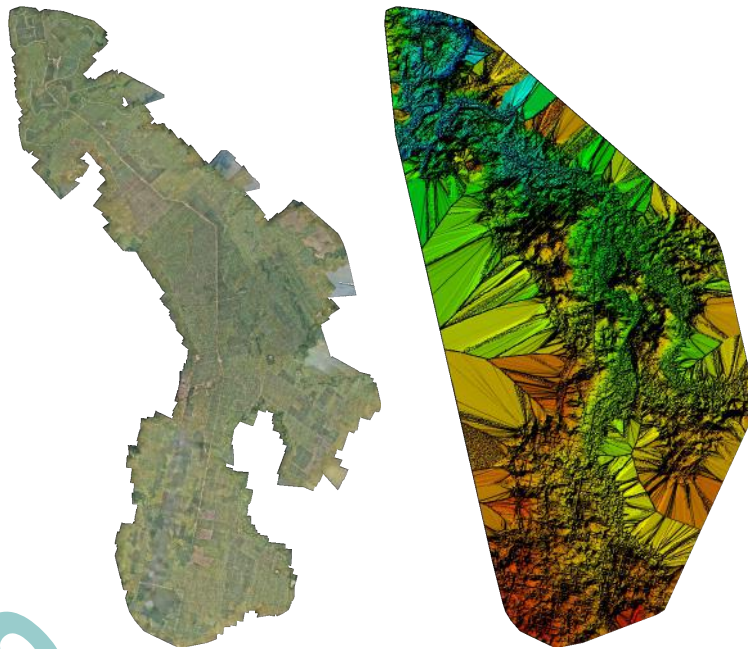


Figure 1: Orthomosaic and the corresponding sparse Digital Surface Model (DSM) before densification.

Calibration Details

Number of Calibrated Images	4964 out of 4992
Number of Geolocated Images	4983 out of 4992

? Initial Image Positions

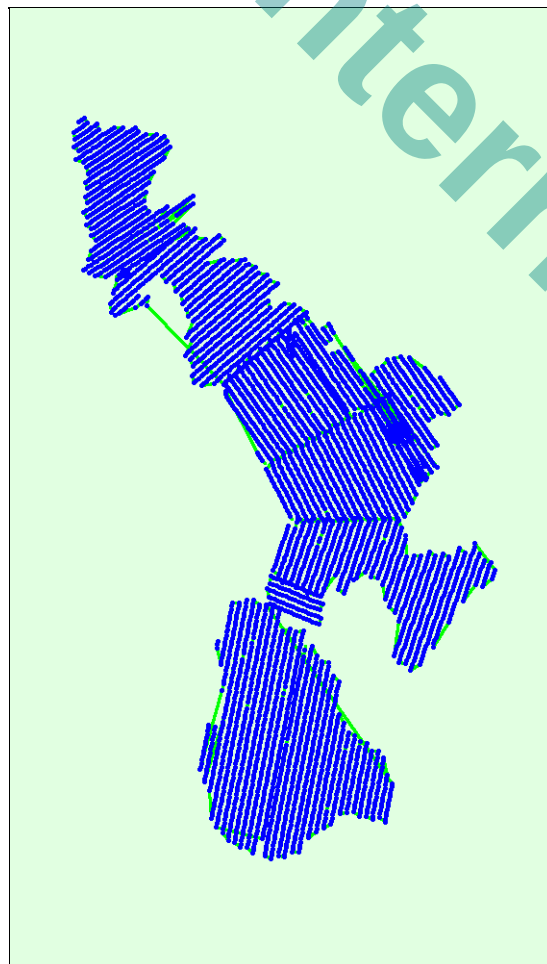


Figure 2: Top view of the initial image position. The green line follows the position of the images in time starting from the large blue dot.

🔍 Computed Image/GCPs/Manual Tie Points Positions

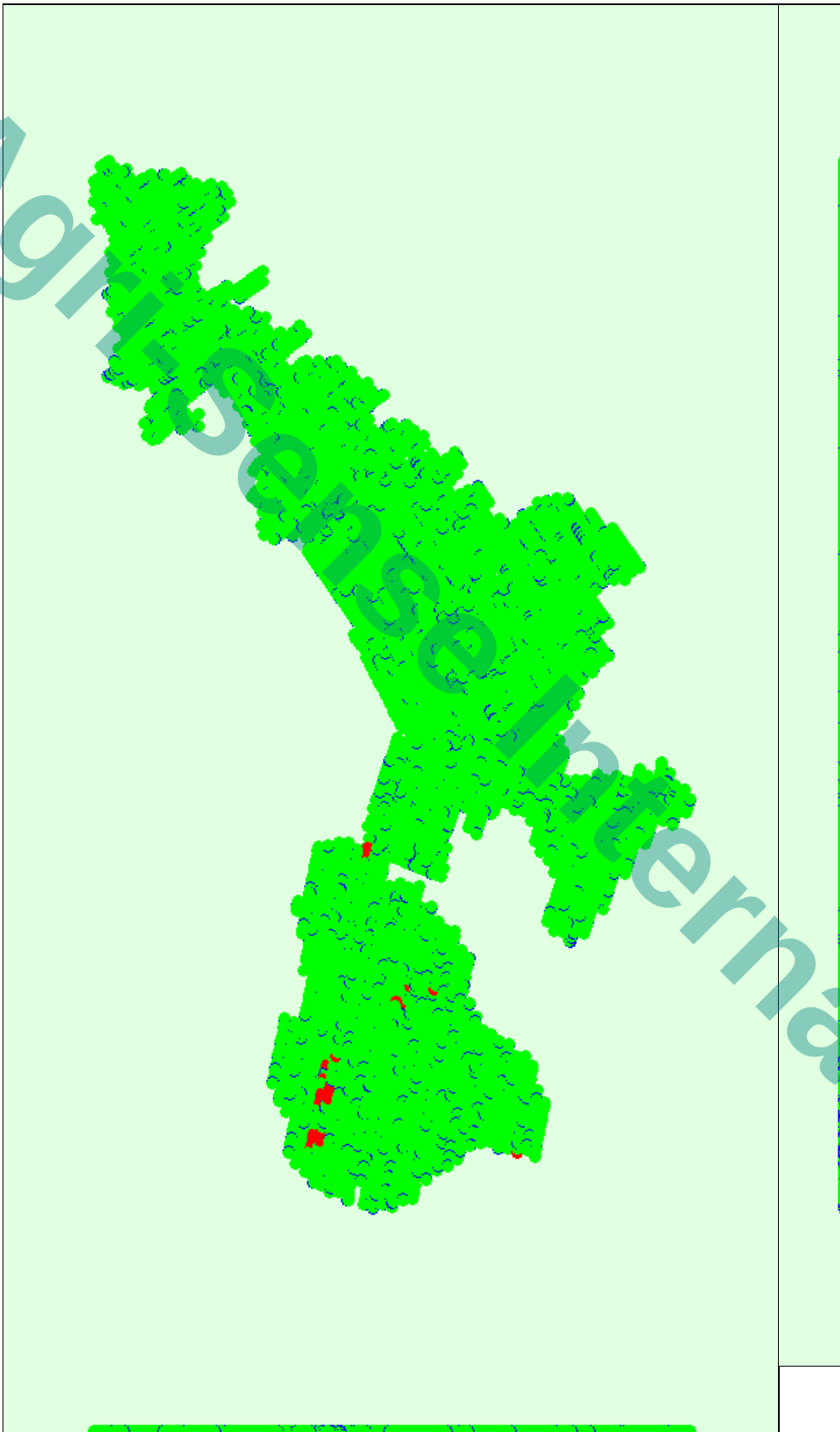


Figure 3: Offset between initial (blue dots) and computed (green dots) image positions as well as the offset between the GCPs initial positions (blue crosses) and their computed positions (green crosses) in the top-view (XY plane), front-view (XZ plane), and side-view (YZ plane). Red dots indicate disabled or uncalibrated images.

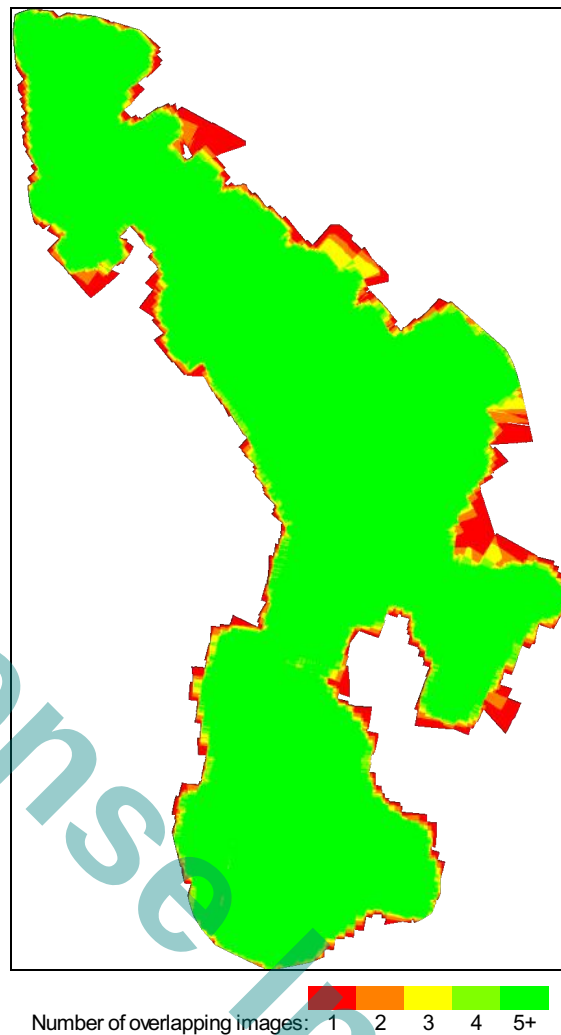


Figure 4: Number of overlapping images computed for each pixel of the orthomosaic. Red and yellow areas indicate low overlap for which poor results may be generated. Green areas indicate an overlap of over 5 images for every pixel. Good quality results will be generated as long as the number of keypoint matches is also sufficient for these areas (see Figure 5 for keypoint matches).

Bundle Block Adjustment Details

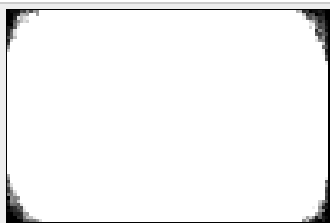
Number of 2D Keypoint Observations for Bundle Block Adjustment	27163484
Number of 3D Points for Bundle Block Adjustment	9278474
Mean Reprojection Error [pixels]	0.149

Internal Camera Parameters

ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(1). Sensor Dimensions: 23.333 [mm] x 15.533 [mm]

EXIF ID: ILCE-QX1_E16mmF2.8_16.0_5456x3632

	Focal Length	Principal Point x	Principal Point y	R1	R2	R3	T1	T2
Initial Values	3741.257 [pixel] 16.000 [mm]	2728.000 [pixel] 11.667 [mm]	1816.000 [pixel] 7.766 [mm]	0.000	0.000	0.000	0.000	0.000
Optimized Values	3748.885 [pixel] 16.033 [mm]	2682.735 [pixel] 11.473 [mm]	1801.041 [pixel] 7.702 [mm]	-0.069	0.107	-0.019	-0.002	-0.002



The number of Automatic Tie Points (ATPs) per pixel, averaged over all images of the camera model, is color coded between black and white. White indicates that, on average, more than 16 ATPs have been extracted at the pixel location. Black indicates that, on average, 0 ATPs have been extracted at the pixel location. Click on the image to see the average direction and magnitude of the re-projection error for each pixel. Note that the vectors are scaled for better visualization.

? Internal Camera Parameters

📷 ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(2). Sensor Dimensions: 23.333 [mm] x 15.533 [mm]



EXIF ID: ILCE-QX1_E16mmF2.8_16.0_5456x3632

	Focal Length	Principal Point x	Principal Point y	R1	R2	R3	T1	T2
Initial Values	3741.257 [pixel] 16.000 [mm]	2728.000 [pixel] 11.667 [mm]	1816.000 [pixel] 7.766 [mm]	0.000	0.000	0.000	0.000	0.000
Optimized Values	3738.673 [pixel] 15.989 [mm]	2697.375 [pixel] 11.536 [mm]	1795.664 [pixel] 7.679 [mm]	-0.069	0.110	-0.023	-0.002	-0.003



The number of Automatic Tie Points (ATPs) per pixel, averaged over all images of the camera model, is color coded between black and white. White indicates that, on average, more than 16 ATPs have been extracted at the pixel location. Black indicates that, on average, 0 ATPs have been extracted at the pixel location. Click on the image to see the average direction and magnitude of the re-projection error for each pixel. Note that the vectors are scaled for better visualization.

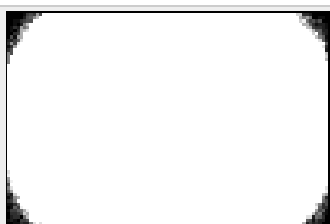
? Internal Camera Parameters

📷 ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(3). Sensor Dimensions: 23.333 [mm] x 15.533 [mm]



EXIF ID: ILCE-QX1_E16mmF2.8_16.0_5456x3632

	Focal Length	Principal Point x	Principal Point y	R1	R2	R3	T1	T2
Initial Values	3741.257 [pixel] 16.000 [mm]	2728.000 [pixel] 11.667 [mm]	1816.000 [pixel] 7.766 [mm]	0.000	0.000	0.000	0.000	0.000
Optimized Values	3745.182 [pixel] 16.017 [mm]	2696.841 [pixel] 11.533 [mm]	1790.719 [pixel] 7.658 [mm]	-0.072	0.114	-0.024	-0.002	-0.003



The number of Automatic Tie Points (ATPs) per pixel, averaged over all images of the camera model, is color coded between black and white. White indicates that, on average, more than 16 ATPs have been extracted at the pixel location. Black indicates that, on average, 0 ATPs have been extracted at the pixel location. Click on the image to see the average direction and magnitude of the re-projection error for each pixel. Note that the vectors are scaled for better visualization.

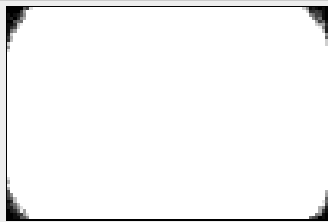
? Internal Camera Parameters

📷 ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(4). Sensor Dimensions: 23.333 [mm] x 15.533 [mm]



EXIF ID: ILCE-QX1_E16mmF2.8_16.0_5456x3632

	Focal Length	Principal Point x	Principal Point y	R1	R2	R3	T1	T2
Initial Values	3741.257 [pixel] 16.000 [mm]	2728.000 [pixel] 11.667 [mm]	1816.000 [pixel] 7.766 [mm]	0.000	0.000	0.000	0.000	0.000
Optimized Values	3746.279 [pixel] 16.021 [mm]	2685.726 [pixel] 11.486 [mm]	1774.865 [pixel] 7.590 [mm]	-0.074	0.122	-0.031	-0.002	-0.003



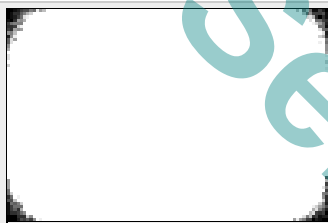
The number of Automatic Tie Points (ATPs) per pixel, averaged over all images of the camera model, is color coded between black and white. White indicates that, on average, more than 16 ATPs have been extracted at the pixel location. Black indicates that, on average, 0 ATPs have been extracted at the pixel location. Click on the image to see the average direction and magnitude of the re-projection error for each pixel. Note that the vectors are scaled for better visualization.

Internal Camera Parameters

ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(5). Sensor Dimensions: 23.333 [mm] x 15.533 [mm]

EXIF ID: ILCE-QX1_E16mmF2.8_16.0_5456x3632

	Focal Length	Principal Point x	Principal Point y	R1	R2	R3	T1	T2
Initial Values	3741.257 [pixel] 16.000 [mm]	2728.000 [pixel] 11.667 [mm]	1816.000 [pixel] 7.766 [mm]	0.000	0.000	0.000	0.000	0.000
Optimized Values	3730.816 [pixel] 15.955 [mm]	2693.771 [pixel] 11.520 [mm]	1789.252 [pixel] 7.652 [mm]	-0.065	0.097	-0.012	-0.002	-0.003



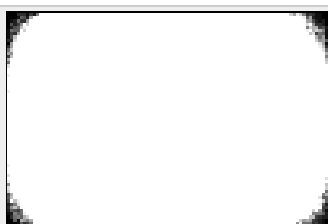
The number of Automatic Tie Points (ATPs) per pixel, averaged over all images of the camera model, is color coded between black and white. White indicates that, on average, more than 16 ATPs have been extracted at the pixel location. Black indicates that, on average, 0 ATPs have been extracted at the pixel location. Click on the image to see the average direction and magnitude of the re-projection error for each pixel. Note that the vectors are scaled for better visualization.

Internal Camera Parameters

ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(6). Sensor Dimensions: 23.333 [mm] x 15.533 [mm]

EXIF ID: ILCE-QX1_E16mmF2.8_16.0_5456x3632

	Focal Length	Principal Point x	Principal Point y	R1	R2	R3	T1	T2
Initial Values	3741.257 [pixel] 16.000 [mm]	2728.000 [pixel] 11.667 [mm]	1816.000 [pixel] 7.766 [mm]	0.000	0.000	0.000	0.000	0.000
Optimized Values	3718.987 [pixel] 15.905 [mm]	2696.331 [pixel] 11.531 [mm]	1795.245 [pixel] 7.678 [mm]	-0.066	0.098	-0.013	-0.002	-0.003



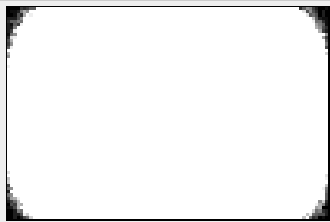
The number of Automatic Tie Points (ATPs) per pixel, averaged over all images of the camera model, is color coded between black and white. White indicates that, on average, more than 16 ATPs have been extracted at the pixel location. Black indicates that, on average, 0 ATPs have been extracted at the pixel location. Click on the image to see the average direction and magnitude of the re-projection error for each pixel. Note that the vectors are scaled for better visualization.

Internal Camera Parameters

ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(7). Sensor Dimensions: 23.333 [mm] x 15.533 [mm]

EXIF ID: ILCE-QX1_E16mmF2.8_16.0_5456x3632

	Focal Length	Principal Point x	Principal Point y	R1	R2	R3	T1	T2
Initial Values	3741.257 [pixel] 16.000 [mm]	2728.000 [pixel] 11.667 [mm]	1816.000 [pixel] 7.766 [mm]	0.000	0.000	0.000	0.000	0.000
Optimized Values	3752.262 [pixel] 16.047 [mm]	2695.852 [pixel] 11.529 [mm]	1794.679 [pixel] 7.675 [mm]	-0.070	0.110	-0.022	-0.002	-0.003



The number of Automatic Tie Points (ATPs) per pixel, averaged over all images of the camera model, is color coded between black and white. White indicates that, on average, more than 16 ATPs have been extracted at the pixel location. Black indicates that, on average, 0 ATPs have been extracted at the pixel location. Click on the image to see the average direction and magnitude of the re-projection error for each pixel. Note that the vectors are scaled for better visualization.

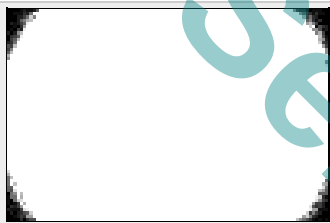
Internal Camera Parameters

 ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(8). Sensor Dimensions: 23.333 [mm] x 15.533 [mm]



EXIF ID: ILCE-QX1_E16mmF2.8_16.0_5456x3632

	Focal Length	Principal Point x	Principal Point y	R1	R2	R3	T1	T2
Initial Values	3741.257 [pixel] 16.000 [mm]	2728.000 [pixel] 11.667 [mm]	1816.000 [pixel] 7.766 [mm]	0.000	0.000	0.000	0.000	0.000
Optimized Values	3705.213 [pixel] 15.846 [mm]	2695.541 [pixel] 11.528 [mm]	1776.293 [pixel] 7.597 [mm]	-0.072	0.116	-0.031	-0.002	-0.002



The number of Automatic Tie Points (ATPs) per pixel, averaged over all images of the camera model, is color coded between black and white. White indicates that, on average, more than 16 ATPs have been extracted at the pixel location. Black indicates that, on average, 0 ATPs have been extracted at the pixel location. Click on the image to see the average direction and magnitude of the re-projection error for each pixel. Note that the vectors are scaled for better visualization.

2D Keypoints Table



	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	13751	4519
Min	7373	129
Max	35314	18516
Mean	15535	5472

2D Keypoints Table for Camera ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(1)

	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	13570	4619
Min	8003	942
Max	26301	9780
Mean	13663	4621

2D Keypoints Table for Camera ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(2)

	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	14469	5643
Min	8556	129
Max	29855	12641
Mean	15594	5668

2D Keypoints Table for Camera ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(3)

	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	15060	6589
Min	9582	936
Max	31197	16905
Mean	17247	7074

2D Keypoints Table for Camera ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(4)

	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	24782	10622
Min	11597	1109
Max	35314	18516
Mean	24265	10405

2D Keypoints Table for Camera ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(5)

	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	12749	3546
Min	8440	804
Max	23266	11051
Mean	12853	3586

2D Keypoints Table for Camera ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(6)

	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	12239	3207
Min	7656	196
Max	25507	5915
Mean	12327	3151

2D Keypoints Table for Camera ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(7)

	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	13964	5616
Min	7373	1216
Max	28309	12700
Mean	15834	5781

2D Keypoints Table for Camera ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(8)

	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	14075	4890
Min	10959	394
Max	22618	9914
Mean	14237	4857

Median / 75% / Maximal Number of Matches Between Camera Models

	ILCE-QX1_E16... (RGB)(1)	ILCE-QX1_E16... (RGB)(2)	ILCE-QX1_E16... (RGB)(3)	ILCE-QX1_E16... (RGB)(4)	ILCE-QX1_E16... (RGB)(5)	ILCE-QX1_E16... (RGB)(6)	ILCE-QX1_E16... (RGB)(7)	ILCE-QX1_E16... (RGB)(8)
ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(1)	77 / 316 / 4879	23 / 120 / 2160	23 / 94 / 1999					51 / 162 / 4437
ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(2)		102 / 454 / 7421	28 / 106 / 2273	69 / 276 / 4203				
ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(3)			155 / 602 / 9639	30 / 127 / 3911				
ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(4)				275 / 1006 / 12115			85 / 336 / 4622	
ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(5)					66 / 281 / 7689	14 / 56 / 967	33 / 137 / 2069	
ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(6)						62 / 253 / 3715		

ILCE-QX1 E16mmF2.8_16.0_5456x3632 (RGB)(7)							133 / 531 / 7475	
ILCE-QX1 E16mmF2.8_16.0_5456x3632 (RGB)(8)								96 / 334 / 4628

? 3D Points from 2D Keypoint Matches



	Number of 3D Points Observed
In 2 Images	5436463
In 3 Images	1884772
In 4 Images	865766
In 5 Images	437468
In 6 Images	248385
In 7 Images	151766
In 8 Images	95171
In 9 Images	59666
In 10 Images	38055
In 11 Images	24895
In 12 Images	15783
In 13 Images	8874
In 14 Images	4805
In 15 Images	2550
In 16 Images	1672
In 17 Images	1001
In 18 Images	665
In 19 Images	374
In 20 Images	143
In 21 Images	81
In 22 Images	62
In 23 Images	29
In 24 Images	16
In 25 Images	6
In 26 Images	3
In 27 Images	2
In 28 Images	1

? 2D Keypoint Matches



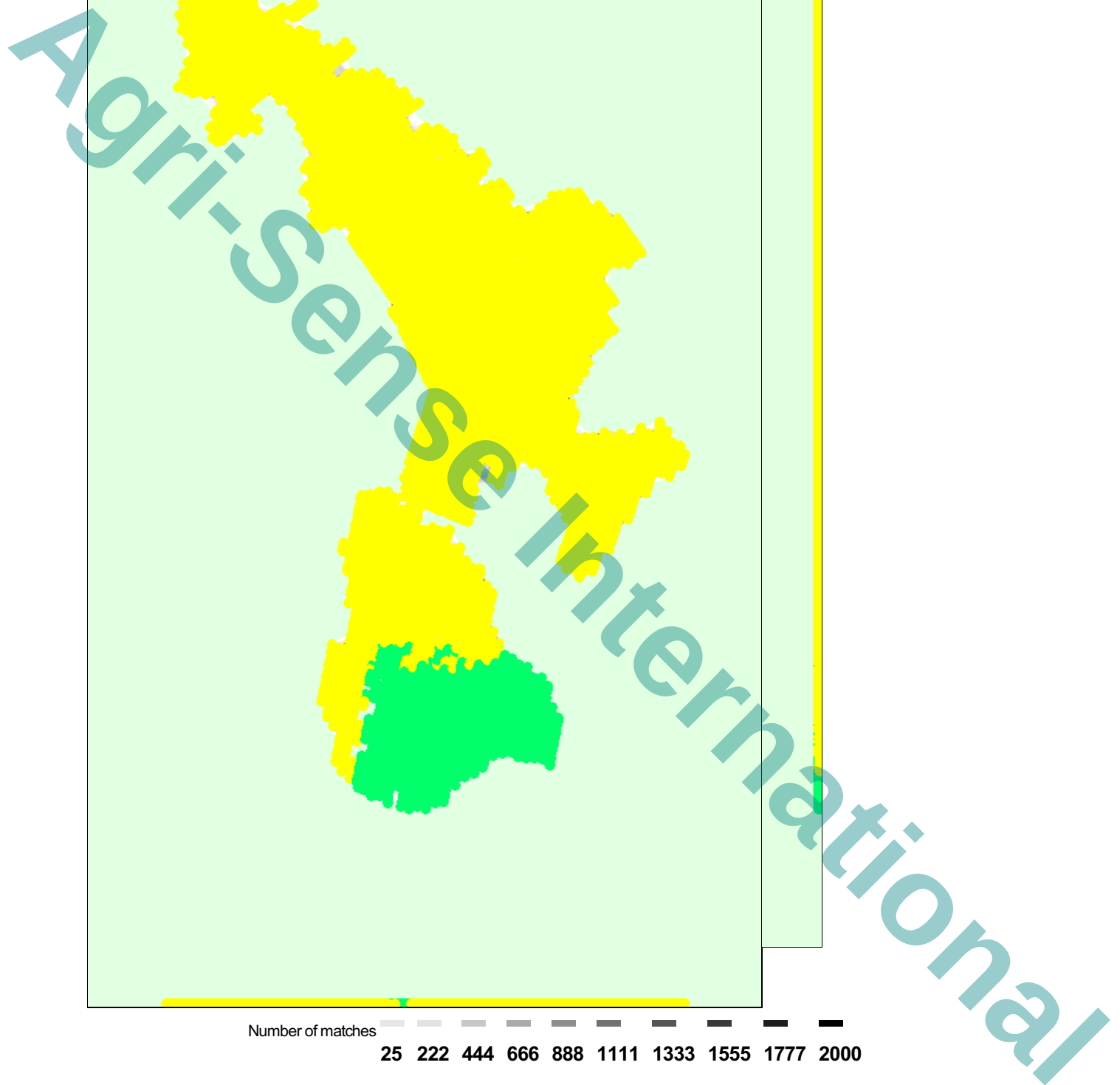


Figure 5: Computed image positions with links between matched images. The darkness of the links indicates the number of matched 2D keypoints between the images. Bright links indicate weak links and require manual tie points or more images.

? Absolute Geolocation Variance



Min Error [m]	Max Error [m]	Geolocation Error X [%]	Geolocation Error Y [%]	Geolocation Error Z [%]
-	-15.00	0.04	0.04	0.00
-15.00	-12.00	0.04	0.12	0.00
-12.00	-9.00	0.32	1.76	0.00
-9.00	-6.00	1.69	7.34	0.04
-6.00	-3.00	12.17	17.59	5.75
-3.00	0.00	36.00	24.31	46.19
0.00	3.00	36.30	21.35	41.26
3.00	6.00	10.39	17.66	5.49
6.00	9.00	2.66	8.07	0.83
9.00	12.00	0.20	1.47	0.20
12.00	15.00	0.14	0.22	0.18
15.00	-	0.04	0.06	0.06
Mean [m]		0.000000	0.000000	-0.000000
Sigma [m]		2.987897	4.554515	2.191311
RMS Error [m]		2.987897	4.554515	2.191311

Min Error and Max Error represent geolocation error intervals between -1.5 and 1.5 times the maximum accuracy of all the images. Columns X, Y, Z show the percentage of images with geolocation errors within the predefined error intervals. The geolocation error is the difference between the initial and computed image positions. Note that the image geolocation errors do not correspond to the accuracy of the observed 3D points.

? Relative Geolocation Variance



Relative Geolocation Error	Images X [%]	Images Y [%]	Images Z [%]
[-1.00, 1.00]	90.44	71.19	99.66
[-2.00, 2.00]	99.52	98.20	100.00
[-3.00, 3.00]	99.92	99.90	100.00
Mean of Geolocation Accuracy [m]	5.000000	5.000000	10.000000
Sigma of Geolocation Accuracy [m]	0.000000	0.000000	0.000000

Images X, Y, Z represent the percentage of images with a relative geolocation error in X, Y, Z.

Geolocation Orientational Variance	RMS [degree]
Omega	2.645
Phi	3.322
Kappa	89.813

Geolocation RMS error of the orientation angles given by the difference between the initial and computed image orientation angles.

Initial Processing Details



System Information

Hardware	CPU: Intel(R) Core(TM) i7-6900K CPU @ 3.20GHz RAM: 128GB GPU: NVIDIA GeForce GTX 1080 (Driver: 22.21.13.8253)
Operating System	Windows 10 Pro, 64-bit

Coordinate Systems



Image Coordinate System	WGS84 (egm96)
Output Coordinate System	WGS84 / UTM zone 33S (egm96)

Processing Options



Detected Template	No Template Available
Keypoints Image Scale	Custom, Image Scale: 0.5
Advanced: Matching Image Pairs	Aerial Grid or Corridor
Advanced: Matching Strategy	Use Geometrically Verified Matching: yes
Advanced: Keypoint Extraction	Targeted Number of Keypoints: Automatic
Advanced: Calibration	Calibration Method: Alternative Internal Parameters Optimization: All External Parameters Optimization: All Rematch: Auto, no Bundle Adjustment: Classic

DSM, Orthomosaic and Index Details



Processing Options



DSM and Orthomosaic Resolution	1 x GSD (10.9 [cm/pixel])
DSM Filters	Noise Filtering: yes Surface Smoothing: yes, Type: Sharp
Grid DSM	Generated: yes, Spacing [cm]: 100
Time for DSM Generation	05m:41s

Quality Report



Generated with Pix4Dmapper Pro version 3.2.10 Preview



Important: Click on the different icons for:



Help to analyze the results in the Quality Report



Additional information about the sections



Click [here](#) for additional tips to analyze the Quality Report

Summary



Project	Flight 2021
Processed	2017-06-02 21:04:05
Camera Model Name(s)	ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(1), ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(2)
Average Ground Sampling Distance (GSD)	10.82 cm / 4.26 in
Area Covered	26.359 km ² / 2635.9 ha / 10.1825 sq. mi. / 6516.82 acres
Time for Initial Processing (without report)	57m:08s

Quality Check



Images	median of 13656 keypoints per image	
Dataset	1375 out of 1388 images calibrated (99%), all images enabled, 2 blocks	
Camera Optimization	0.38% relative difference between initial and optimized internal camera parameters	
Matching	median of 4037.14 matches per calibrated image	
Georeferencing	yes, no 3D GCP	

Preview

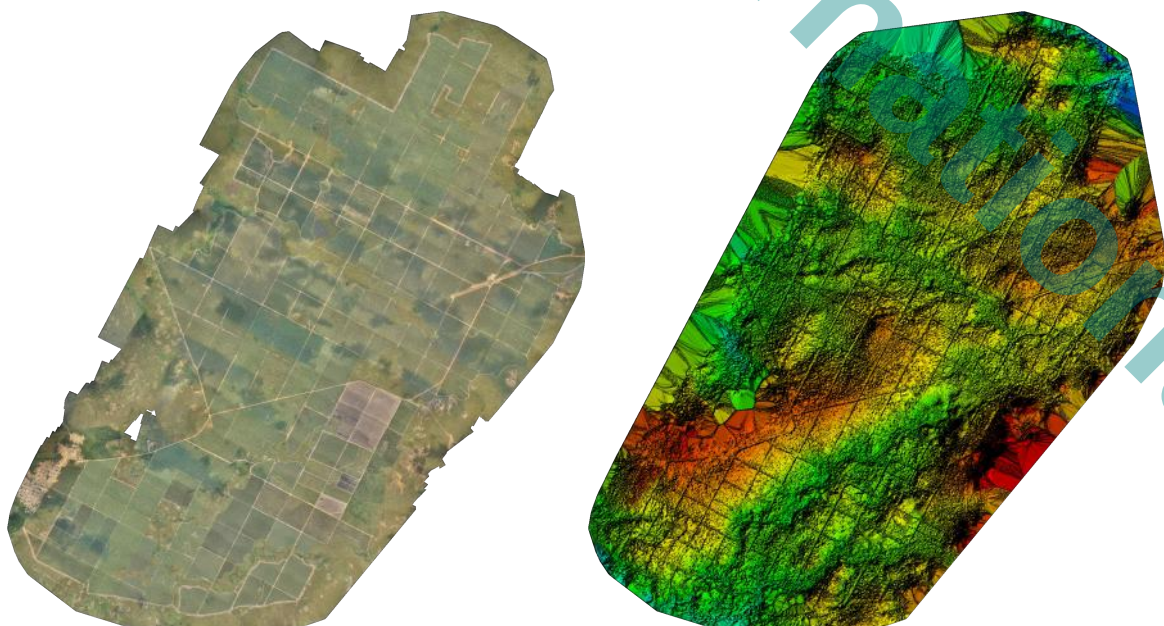


Figure 1: Orthomosaic and the corresponding sparse Digital Surface Model (DSM) before densification.

Calibration Details



Number of Calibrated Images	1375 out of 1388
Number of Geolocated Images	1386 out of 1388

? Initial Image Positions

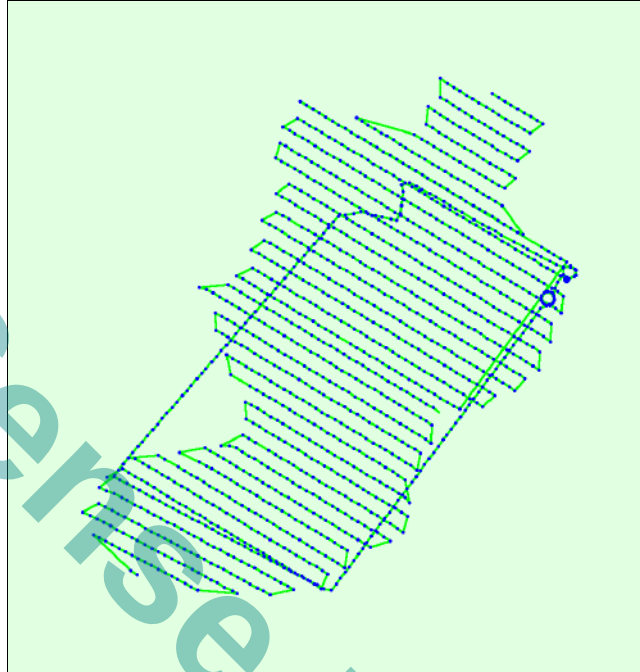


Figure 2: Top view of the initial image position. The green line follows the position of the images in time starting from the large blue dot.

? Computed Image/GCPs/Manual Tie Points Positions



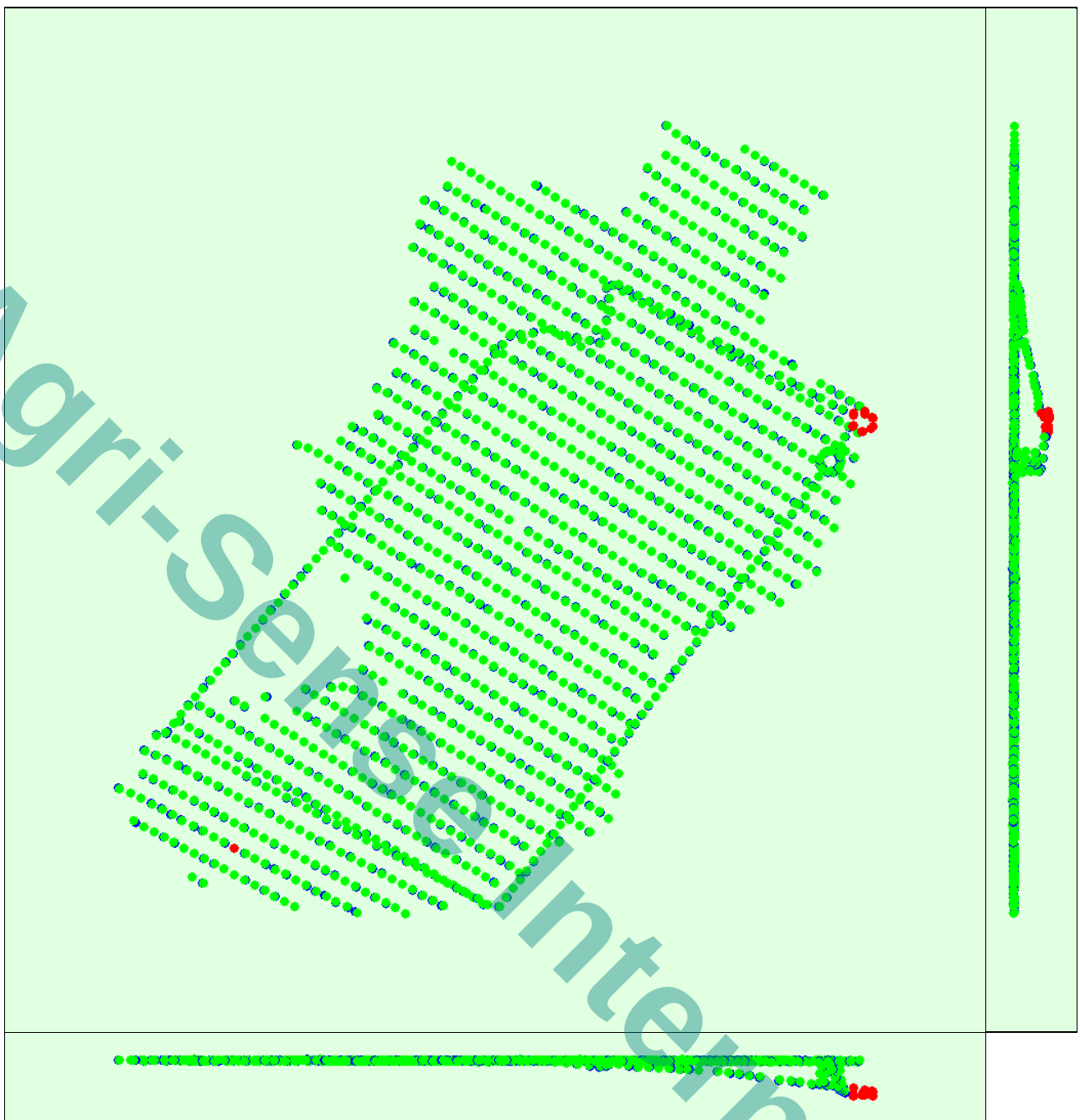
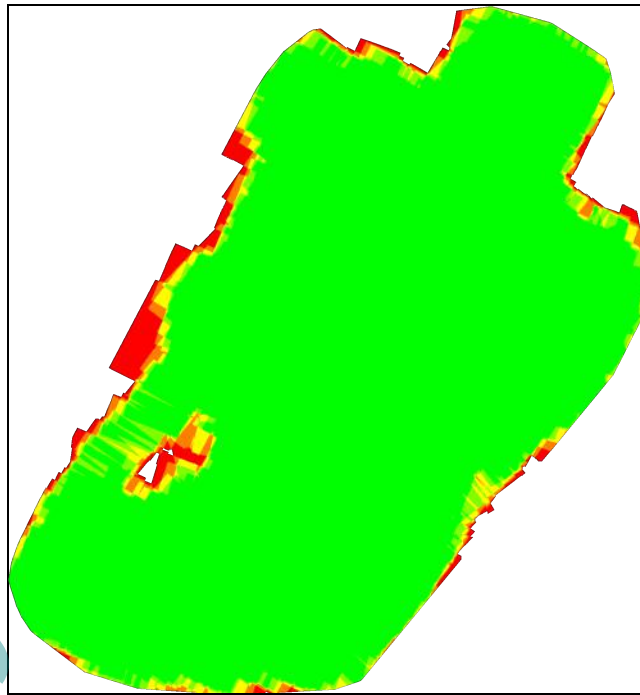


Figure 3: Offset between initial (blue dots) and computed (green dots) image positions as well as the offset between the GCPs initial positions (blue crosses) and their computed positions (green crosses) in the top-view (XY plane), front-view (XZ plane), and side-view (YZ plane). Red dots indicate disabled or uncalibrated images.

🔍 Overlap





Number of overlapping images: 1 2 3 4 5+

Figure 4: Number of overlapping images computed for each pixel of the orthomosaic. Red and yellow areas indicate low overlap for which poor results may be generated. Green areas indicate an overlap of over 5 images for every pixel. Good quality results will be generated as long as the number of keypoint matches is also sufficient for these areas (see Figure 5 for keypoint matches).

Bundle Block Adjustment Details

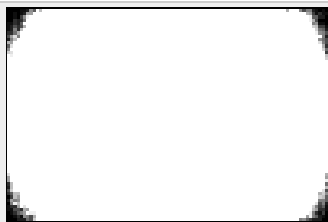
Number of 2D Keypoint Observations for Bundle Block Adjustment	5813332
Number of 3D Points for Bundle Block Adjustment	2064554
Mean Reprojection Error [pixels]	0.146

Internal Camera Parameters

ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(1). Sensor Dimensions: 23.333 [mm] x 15.533 [mm]

EXIF ID: ILCE-QX1_E16mmF2.8_16.0_5456x3632

	Focal Length	Principal Point x	Principal Point y	R1	R2	R3	T1	T2
Initial Values	3741.257 [pixel] 16.000 [mm]	2728.000 [pixel] 11.667 [mm]	1816.000 [pixel] 7.766 [mm]	0.000	0.000	0.000	0.000	0.000
Optimized Values	3714.163 [pixel] 15.884 [mm]	2699.343 [pixel] 11.544 [mm]	1791.882 [pixel] 7.663 [mm]	-0.067	0.100	-0.014	-0.002	-0.002



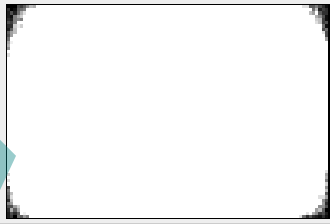
The number of Automatic Tie Points (ATPs) per pixel, averaged over all images of the camera model, is color coded between black and white. White indicates that, on average, more than 16 ATPs have been extracted at the pixel location. Black indicates that, on average, 0 ATPs have been extracted at the pixel location. Click on the image to see the average direction and magnitude of the re-projection error for each pixel. Note that the vectors are scaled for better visualization.

Internal Camera Parameters

ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(2). Sensor Dimensions: 23.333 [mm] x 15.533 [mm]

EXIF ID: ILCE-QX1_E16mmF2.8_16.0_5456x3632

	Focal Length	Principal Point x	Principal Point y	R1	R2	R3	T1	T2
Initial Values	3741.257 [pixel] 16.000 [mm]	2728.000 [pixel] 11.667 [mm]	1816.000 [pixel] 7.766 [mm]	0.000	0.000	0.000	0.000	0.000
Optimized Values	3742.826 [pixel] 16.007 [mm]	2694.268 [pixel] 11.522 [mm]	1791.279 [pixel] 7.661 [mm]	-0.066	0.098	-0.011	-0.002	-0.002



The number of Automatic Tie Points (ATPs) per pixel, averaged over all images of the camera model, is color coded between black and white. White indicates that, on average, more than 16 ATPs have been extracted at the pixel location. Black indicates that, on average, 0 ATPs have been extracted at the pixel location. Click on the image to see the average direction and magnitude of the re-projection error for each pixel. Note that the vectors are scaled for better visualization.

2D Keypoints Table

	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	13656	4037
Min	9676	89
Max	29061	14911
Mean	14331	4228

2D Keypoints Table for Camera ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(1)

	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	13340	4051
Min	9676	430
Max	23128	10903
Mean	13478	4138

2D Keypoints Table for Camera ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(2)

	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	14027	4078
Min	9887	89
Max	29061	14911
Mean	15084	4308

Median / 75% / Maximal Number of Matches Between Camera Models

	ILCE-QX1_E16...(RGB)(1)	ILCE-QX1_E16...(RGB)(2)
ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(1)	77 / 305 / 6225	41 / 150 / 1902
ILCE-QX1_E16mmF2.8_16.0_5456x3632 (RGB)(2)		93 / 382 / 8947

3D Points from 2D Keypoint Matches

	Number of 3D Points Observed
In 2 Images	1297402
In 3 Images	397522
In 4 Images	168586
In 5 Images	79741
In 6 Images	42751
In 7 Images	26169
In 8 Images	17172
In 9 Images	11537
In 10 Images	8102
In 11 Images	6020
In 12 Images	4371
In 13 Images	2708

In 14 Images	1259
In 15 Images	581
In 16 Images	324
In 17 Images	156
In 18 Images	67
In 19 Images	39
In 20 Images	23
In 21 Images	14
In 22 Images	1
In 23 Images	2
In 24 Images	4
In 25 Images	1
In 26 Images	2

2D Keypoint Matches



Figure 5: Computed image positions with links between matched images. The darkness of the links indicates the number of matched 2D keypoints between the images. Bright links indicate weak links and require manual tie points or more images.

Geolocation Details

Absolute Geolocation Variance

Min Error [m]	Max Error [m]	Geolocation Error X[%]	Geolocation Error Y[%]	Geolocation Error Z[%]
-	-15.00	0.15	0.00	0.00
-15.00	-12.00	0.15	0.07	0.07
-12.00	-9.00	1.97	0.44	0.22
-9.00	-6.00	6.77	1.82	0.36
-6.00	-3.00	18.28	13.69	1.46
-3.00	0.00	23.67	34.60	60.82
0.00	3.00	20.83	31.39	30.74
3.00	6.00	18.28	16.82	3.20
6.00	9.00	8.23	0.95	2.04
9.00	12.00	1.31	0.07	1.09
12.00	15.00	0.29	0.07	0.00
15.00	-	0.07	0.07	0.00
Mean [m]		-0.000000	-0.000000	-0.000000
Sigma [m]		4.613641	3.096438	2.207297
RMS Error [m]		4.613641	3.096438	2.207297

Min Error and Max Error represent geolocation error intervals between -1.5 and 1.5 times the maximum accuracy of all the images. Columns X, Y, Z show the percentage of images with geolocation errors within the predefined error intervals. The geolocation error is the difference between the initial and computed image positions. Note that the image geolocation errors do not correspond to the accuracy of the observed 3D points.

Relative Geolocation Variance

Relative Geolocation Error	Images X[%]	Images Y[%]	Images Z[%]
[-1.00, 1.00]	69.63	92.43	99.13
[-2.00, 2.00]	98.18	99.34	100.00
[-3.00, 3.00]	99.78	99.93	100.00
Mean of Geolocation Accuracy [m]	5.000000	5.000000	10.000000
Sigma of Geolocation Accuracy [m]	0.000000	0.000000	0.000000

Images X, Y, Z represent the percentage of images with a relative geolocation error in X, Y, Z.

Geolocation Orientational Variance	RMS [degree]
Omega	2.887
Phi	1.874
Kappa	86.264

Geolocation RMS error of the orientation angles given by the difference between the initial and computed image orientation angles.

Initial Processing Details

System Information

Hardware	CPU: Intel(R) Core(TM) i7-7700HQ CPU @ 2.80GHz RAM: 24GB GPU: Intel(R) HD Graphics 630 (Driver: 21.20.16.4534), NVIDIA GeForce GTX 1060 (Driver: 21.21.13.7654)
Operating System	Windows 10 Home, 64-bit

Coordinate Systems

Image Coordinate System	WGS84 (egm96)
Output Coordinate System	WGS84 / UTMzone 33S (egm96)

Processing Options



Detected Template	No Template Available
Keypoints Image Scale	Custom, Image Scale: 0.5
Advanced: Matching Image Pairs	Aerial Grid or Corridor
Advanced: Matching Strategy	Use Geometrically Verified Matching: yes
Advanced: Keypoint Extraction	Targeted Number of Keypoints: Automatic
Advanced: Calibration	Calibration Method: Alternative Internal Parameters Optimization: All External Parameters Optimization: All Rematch: Auto, no Bundle Adjustment: Classic

DSM, Orthomosaic and Index Details



Processing Options



DSM and Orthomosaic Resolution	1 x GSD (10.8 [cm/pixel])
DSM Filters	Noise Filtering: no Surface Smoothing: no
Raster DSM	Generated: yes Method: Triangulation Merge Tiles: yes
Grid DSM	Generated: yes, Spacing [cm]: 100
Time for DSM Generation	07m:30s

Appendix 2

Image Processing Report Description

Average Ground Sampling Distance; this parameter defines the average pixel size of the map to be produced, in this case the average pixel size of the final map was 8.13 cm.

Image Coordinate System, is a parameter which describes what coordinate system was used by the UAV while it was collecting images during survey. The UAV uses the standard and internationally accepted World Geodetic Standard 1984 geographic datum (WGS84) to position the photographs it takes.

Output Coordinate System, is the coordinate system in which the final map and Digital Surface Model (DSM) will be exported from the program. In this instance, the outputs were modelled on the Universal Transverse Mercator Coordinate system centred on 31N Zone, while being based on the WGS84 Datum.

Images – Keypoints per Image; this parameter describes the average number of definable keypoints in each image, that can be compared to keypoints in surrounding images. This process is done so that matching keypoints in images may be found and the program may generate the map to a high degree of accuracy. A value of 10000 or more is required.

Dataset – images Calibration; this parameter defines the percentage of images processed that are enabled. Above 90% indicates good calibration and that the images are all of good quality. Where the image matching is less than 90%, some of the images were too blurry to process and so have been disabled so that they will not affect the final orthomosaic image or DSM quality. The Matching Quality Parameter describes the quality of the remaining enabled image.

Camera Optimisation; For this parameter, any value over 5% suggests that there were problems with the camera while it was taking photos, as the focal length for each image is far from optimal. For values less than 5% the camera lens functions were within optimal levels.

Matching; this parameter describes how many keypoints could, on average, be matched for each of the enabled and calibrated images. Any value greater than 1000 shows that strong matching and that the images themselves are of sufficiently high quality to generate an accurate map.

Geo-referencing; This parameter defines whether the average error in the map is less than the Ground Sampling Distance, so the results show the average error in the X, Y and Z directions. The value displayed as the mean error is the difference between the images and the ground control points (GCP) that was corrected during processing. A lower value shows better matching between the Images and the GCP's. If there were an error or some inaccuracy with the images or GCP's then the processing report would show a red cross instead of a green tick with this parameter.

Appendix 3

List of Temporary GCP
Locations

Project file data		Coordinate System	
Name:	Z:\2_AgrisenseData\1_CurrentProjects \1_Projects\CSKN\Project\RAW\Trimble Survey Files\Processing \CSKN_Processing_Mc_20170608.vce	Name:	World wide/UTM
Size:	252 KB	Datum:	WGS 1984
Modified:	2017-06-08 01:53:54 PM (UTC:2)	Zone:	33 South
Time zone:	South Africa Standard Time	Geoid:	EGM96 (Global)
Reference number:		Vertical datum:	
Description:			
Comment 1:			
Comment 2:			
Comment 3:			

Point List

ID	Easting (Meter)	Northing (Meter)	Elevation (Meter)	Feature Code
	469794,953	9393982,004	404,660	
Base2	461970,899	9385480,798	359,943	
Base3	460879,616	9383276,276	357,807	
Base4	468080,306	9392041,593	371,475	
base5	466881,439	9391052,118	373,113	
BaseLow	457867,040	9379150,022	379,597	
DEFAULT	460001,568	9384499,026	361,597	
DEFAULT	469817,979	9390066,506	401,853	
DEFAULT	469794,297	9393982,243	408,320	
GCP1	468101,478	9392042,222	371,338	
GCP1b	468101,480	9392042,216	371,338	
GCP2	467542,654	9391767,364	372,661	
GCP3	466964,132	9391445,126	374,208	
GCP4	466723,800	9390901,433	373,831	
GCP5	464726,484	9387888,383	371,185	
GCP6	464364,960	9388273,408	371,352	
GCP7	464784,285	9389160,824	377,433	
GCP8	464033,254	9390051,239	389,321	
GCP9	464672,669	9390372,915	393,500	
GCP10	464894,755	9389818,989	384,138	
GCP11	465585,709	9388976,958	365,190	
GCP12	465633,059	9390182,131	381,348	
GCP13	465466,193	9390555,609	385,587	

GCP14	466305,013	9390652,473	377,886	
GCP15	466342,256	9390035,657	372,785	
GCP16	466487,634	9387789,290	371,519	
GCP17	467079,800	9387444,610	381,819	
GCP18	467252,730	9388664,620	374,426	
GCP19	468124,673	9388117,792	384,172	
GCP20	469375,520	9388979,274	397,445	
GCP21	468215,867	9389253,115	382,019	
GCP22	468674,180	9390067,328	385,361	
GCP23	467604,284	9390252,642	374,723	
GCP24	468349,308	9390852,611	375,904	
GCP25	469817,921	9390066,489	401,928	
GCP26	470893,730	9390335,265	383,080	
GCP27	470820,577	9391447,375	390,408	
GCP28	470041,806	9391158,663	381,857	
GCP29	466371,521	9391880,336	385,625	
GCP30	467086,616	9392467,419	380,670	
GCP31	466950,947	9393035,169	386,724	
GCP32	467333,250	9393274,001	374,995	
GCP33	467562,922	9393864,500	378,369	
GCP34	468276,108	9394067,219	380,110	
GCP35	468792,846	9394519,335	386,513	
GCP36	469022,339	9395174,493	384,572	
GCP37	467757,438	9392398,512	372,089	
GCP38	469045,508	9391171,106	373,094	
GCP39	468698,964	9391753,347	372,073	
GCP40	468617,236	9392691,741	375,948	
GCP41	469250,270	9392397,079	391,542	
GCP42	469114,700	9393159,004	381,786	
GCP43	468035,887	9393303,852	373,956	
GCP44	468750,596	9393610,054	376,281	
GCP45	469114,573	9394104,434	383,179	
GCP46	469680,979	9393399,020	395,857	
GCP47	470598,772	9393306,240	409,270	
GCP48	470723,110	9392700,700	410,448	
GCP49	471258,130	9392991,516	416,537	
GCP50	472145,720	9393695,613	420,776	
GCP51	472858,872	9393499,750	425,773	
GCP52	473445,881	9392902,354	423,911	

GCP53	472671,256	9392930,411	422,529	
GCP54	472017,805	9392806,675	423,865	
GCP55	471493,410	9392129,397	412,524	
GCP57	469509,320	9394527,167	383,151	
GCP58	469717,431	9395097,144	385,267	
GCP59	470344,288	9395513,084	394,809	
GCP60b	457857,126	9379158,245	379,574	
GCP60v2	457857,121	9379158,254	379,577	
GCP61	457333,197	9378590,890	381,802	
GCP61v2	457333,194	9378590,897	381,813	
GCP62	455597,203	9378086,359	393,326	
GCP63	455088,304	9378924,154	402,802	
GCP64	455956,043	9379211,631	394,162	
GCP65	456524,311	9379580,299	378,483	
GCP66	456218,792	9380115,936	370,991	
GCP67	455958,665	9380994,902	362,835	
GCP68	455046,783	9380914,909	372,506	
GCP69	455732,446	9381742,720	362,810	
GCP69b	455732,446	9381742,718	362,810	
GCP70	454840,641	9382112,402	357,671	
GCP71	452465,150	9381348,329	378,250	
GCP72	453769,034	9381803,015	376,549	
GCP73	453444,699	9380812,661	381,164	
GCP74	453472,302	9379981,782	400,159	
GCP75	454196,816	9381145,347	366,264	
GCP76	454867,857	9380146,367	378,956	
GCP77	455483,695	9379984,022	379,816	
GCP78	456178,844	9377962,820	394,096	
GCP79	458630,383	9377999,904	391,860	
GCP80	458089,039	9377498,470	399,088	
GCP81	458743,054	9377157,444	387,739	
GCP82	458504,746	9376282,830	381,871	
GCP83	458929,069	9375469,957	375,936	
GCP84	459255,870	9374598,754	367,634	
GCP85	459843,921	9375542,285	373,532	
GCP86	459599,952	9376039,985	371,905	
GCP87	459916,071	9376757,811	362,828	
GCP88	460599,637	9376115,395	363,714	
GCP89	459671,335	9377564,473	372,858	

GCP89b	459671,287	9377564,536	372,822
GCP90	460767,232	9377381,061	364,035
GCP91	460275,211	9378264,435	361,022
GCP92	459510,092	9378472,979	358,701
GCP93	458752,050	9378499,110	368,135
GCP94	458436,658	9379210,280	381,487
GCP94v2	458437,820	9379212,803	379,850
GCP100	458143,490	9379738,286	378,564
GCP101	457634,240	9380445,645	383,298
GCP102	457342,231	9379740,450	380,798
GCP103	456688,543	9380447,454	378,159
GCP104	456748,875	9381235,554	375,945
GCP105	457778,632	9381556,058	359,742
GCP106	457962,600	9382794,801	354,920
GCP107	458543,490	9382343,957	354,756
GCP108	459207,277	9382209,861	357,839
GCP109	458928,373	9382870,000	353,337
GCP110	458937,770	9381535,234	358,552
GCP111	458292,808	9380517,561	372,132
GCP112	459553,874	9380457,475	373,976
GCP113	459883,297	9381591,971	359,166
GCP114	459948,271	9381625,096	358,308
GCP115	460748,284	9381600,845	365,617
GCP116	460523,853	9378963,043	372,421
GCP117	459869,696	9378929,285	373,453
GCP118	461152,375	9378321,103	381,011
GCP119	461236,509	9379479,630	371,695
GCP120	460845,619	9380303,550	356,831
GCP121	461986,706	9381652,366	375,296
GCP122	461754,792	9382399,495	369,877
GCP123	460741,549	9382556,636	366,544
GCP124	461964,496	9385480,628	359,896
GCP124v2	461964,488	9385480,688	359,894
GCP125	460002,634	9380657,808	367,890
GCP126	459944,849	9379941,069	354,469
GCP150	462035,873	9383934,240	354,749
GCP151	461664,402	9384478,859	355,657
GCP152	461286,280	9383928,278	355,592
GCP153	460885,856	9383289,463	357,058

GCP154	459604,126	9383601,949	369,089	
GCP155	460001,568	9384499,028	361,598	
GCP156	460236,470	9383691,560	367,615	
GCP157	460129,689	9382295,359	355,115	
GCP158	461086,772	9386973,650	360,506	
GCP159	460633,984	9387065,169	373,459	
GCP160	460885,964	9386475,235	359,283	
GCP161	460468,694	9385798,129	366,474	
GCP162	460009,903	9384926,718	357,126	
GCP163	460741,120	9384331,511	363,802	
GCP164	460746,219	9385166,465	363,641	
GCP165	461414,752	9385304,074	357,164	
GCP166	461573,543	9386030,204	368,638	
GCP167	462576,612	9386060,299	358,489	
GCP168	463216,715	9386592,834	359,590	
GCP169	462991,824	9387422,631	358,636	
GCP170	463488,810	9387322,634	361,091	
GCP171	464160,393	9387565,961	363,095	
GCP172	464239,187	9386919,428	373,843	
GCP173	466427,945	9389356,218	366,405	
GCP173b	466427,933	9389356,213	366,399	
GCP173v2	466426,673	9389354,355	368,655	
GCP174	466164,274	9388352,482	365,227	
GCP174v2	466163,037	9388350,623	367,213	
GCP175	465359,161	9387793,217	362,698	
GCP200	471025,666	9396234,710	398,774	
GCP201	470914,284	9396407,580	394,716	
GCP202	470416,365	9396026,357	394,798	
GCP203	469979,385	9394221,311	393,873	
GCPa29	466374,222	9391883,778	380,190	
GCPa30	467089,073	9392470,835	376,560	
GCPa31	466953,087	9393038,713	383,362	
GCPa32	467335,296	9393277,691	372,364	
GCPa33	467565,007	9393868,088	376,060	
GCPa34	468277,932	9394070,937	378,697	
GCPa35	468794,486	9394523,185	385,101	
GCPa36	469023,661	9395178,433	383,088	
GCPa37	467758,371	9392402,401	371,128	
GCPa38	470821,989	9391450,604	386,398	

GCPa39	470894,989	9390338,508	379,945	
GCPa40	471494,234	9392131,960	411,659	
GCPa41	472018,590	9392809,279	422,281	
GCPa42	472672,051	9392933,000	421,673	
GCPa43	473446,568	9392905,149	422,919	
GCPa44	472859,293	9393502,529	425,409	
GCPa45	472146,086	9393698,680	419,859	
GCPa46	471258,459	9392994,575	415,863	
GCPa47	470599,104	9393309,325	408,538	
GCPa48	470723,390	9392703,850	409,688	
GCPa49	469681,525	9393402,064	395,081	
GCPa50	469795,785	9393984,919	402,306	
GCPa51	469510,209	9394529,932	379,575	
GCPa52	469979,940	9394224,017	387,521	
GCPa53	469718,294	9395099,904	381,358	
GCPa54	470345,033	9395515,765	390,581	
GCPa55	471026,483	9396237,517	394,373	
GCPa56	470915,113	9396410,412	389,960	
GCPa57	470417,016	9396029,305	389,287	
GCPa58	469111,476	9394102,438	384,318	
GCPa59	468750,842	9393613,352	375,349	
GCPa60	468617,562	9392695,716	375,395	
GCPa61	469114,947	9393162,745	381,172	
GCPa62	469250,483	9392401,000	390,900	
GCPa63	469046,272	9391174,927	372,019	
GCPa64	468699,281	9391757,242	371,708	
GCPa65	468350,019	9390855,917	371,429	
rl01	472146,083	9393698,688	419,845	
rl02	470043,616	9391162,037	377,470	
rl03	469818,628	9390069,808	397,651	
rl04	468674,933	9390070,484	380,993	
rl05	468216,799	9389255,544	378,376	
rl06	469376,594	9388981,474	394,138	
rl07	468125,952	9388119,876	381,063	
rl08	467253,890	9388666,348	371,014	
rl09	467080,889	9387446,349	378,665	
rl10	466488,865	9387791,223	369,714	
rl11	466164,224	9388352,440	365,200	
rl12	466427,868	9389356,149	366,391	

rl13	465586,914	9388977,965	362,312	
rl14	464726,528	9387888,376	371,264	
rl15	464364,947	9388273,358	371,429	
rl16	464784,324	9389160,745	377,417	
rl17	464896,211	9389820,600	380,636	
rl18	464034,637	9390052,431	386,007	
rl19	464674,087	9390374,503	390,014	
rl20	465634,284	9390183,305	378,409	
rl21	465467,359	9390556,989	383,219	
rl22	466343,491	9390037,313	371,309	
rl23	466305,979	9390653,905	375,640	
rl24	466723,774	9390901,425	373,833	
rl25	466964,107	9391445,074	374,209	
rl26	467542,631	9391767,331	372,667	
rl27	468101,461	9392042,199	371,337	
wl01	462085,406	9383915,528	353,463	
wl02	461012,243	9385279,135	352,900	
wl03	461024,042	9385268,246	352,261	

31/08/2017 14:16:31	Z:\2_AgrisenseData\1_CurrentProjects \1_Projects\CSKN\Project\RAW\Trimble Survey Files\Processing \CSKN_Processing_Mc_20170608.vce	Trimble Business Center
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Appendix 4
Trimble R4 GNSS GPS
Quality Report

Project file data		Coordinate System	
Name:	Z:\2_AgrisenseData\1_CurrentProjects\1_Projects\CSKN\Project\RAW\Trimble Survey Files\Processing\CSKN_Processing_Mc_20170608.vce	Name:	World wide/UTM
Size:	252 KB	Datum:	WGS 1984
Modified:	2017-06-08 01:53:54 PM (UTC:2)	Zone:	33 South
Time zone:	South Africa Standard Time	Geoid:	EGM96 (Global)
Reference number:		Vertical datum:	
Description:			
Comment 1:			
Comment 2:			
Comment 3:			

Baseline Processing Report

Processing Summary

Observation	From	To	Solution Type	H. Prec. (Meter)	V. Prec. (Meter)	Geodetic Az.	Ellipsoid Dist. (Meter)	ΔHeight (Meter)
rl27 (B166)	Base4	rl27	Fixed	0,008	0,012	88°23'15"	21,172	-0,139
rl26 (B165)	Base4	rl26	Fixed	0,010	0,016	243°00'07"	603,818	1,200
rl25 (B164)	Base4	rl25	Fixed	0,011	0,019	241°54'24"	1266,086	2,752
rl24 (B163)	Base4	rl24	Fixed	0,013	0,023	229°58'50"	1772,736	2,390
rl23 (B162)	Base4	rl23	Fixed	0,015	0,026	231°59'56"	2253,406	4,205
rl22 (B161)	Base4	rl22	Fixed	0,015	0,025	220°56'18"	2653,131	-0,110
rl21 (B160)	Base4	rl21	Fixed	0,014	0,023	240°25'25"	3006,414	11,788
rl20 (B159)	Base4	rl20	Fixed	0,014	0,024	232°48'11"	3073,037	6,988
rl19 (B158)	Base4	rl19	Fixed	0,015	0,025	243°56'58"	3793,761	18,590
rl18 (B157)	Base4	rl18	Fixed	0,015	0,026	243°50'43"	4509,977	14,593
rl17 (B156)	Base4	rl17	Fixed	0,015	0,025	235°07'51"	3883,673	9,226
rl16 (B155)	Base4	rl16	Fixed	0,015	0,026	228°52'22"	4379,222	6,024
rl15 (B154)	Base4	rl15	Fixed	0,014	0,029	224°37'22"	5293,875	0,060
rl14 (B153)	Base4	rl14	Fixed	0,013	0,033	218°56'57"	5340,323	-0,096
rl13 (B152)	Base4	rl13	Fixed	0,014	0,025	219°10'08"	3951,567	-9,078
rl12 (B151)	Base4	rl12	Fixed	0,013	0,023	211°37'59"	3154,339	-5,011
rl11 (B150)	Base4	rl11	Fixed	0,013	0,024	207°28'27"	4158,677	-6,176
rl10 (B149)	Base4	rl10	Fixed	0,014	0,026	200°33'17"	4540,295	-1,648
rl09 (B148)	Base4	rl09	Fixed	0,014	0,027	192°17'52"	4704,490	7,311
rl08 (B147)	Base4	rl08	Fixed	0,013	0,024	193°47'08"	3476,291	-0,372
rl07 (B146)	Base4	rl07	Fixed	0,013	0,025	179°21'39"	3923,502	9,689

rl06 (B145)	Base4	rl06	Fixed	0,011	0,022	157°04'11"	3324,645	22,738
rl05 (B144)	Base4	rl05	Fixed	0,011	0,021	177°13'23"	2790,472	6,972
rl04 (B143)	Base4	rl04	Fixed	0,011	0,020	163°14'26"	2059,646	9,567
rl03 (B142)	Base4	rl03	Fixed	0,012	0,020	138°37'42"	2629,652	26,222
rl02 (B141)	Base4	rl02	Fixed	0,011	0,019	114°09'36"	2152,162	6,012
rl01 (B140)	Base4	rl01	Fixed	0,010	0,016	67°51'11"	4392,210	48,316
Base4 (B139)	base5	Base4	Fixed	0,009	0,012	50°29'40"	1555,072	-1,643
GCPa65 (B138)	base5	GCPa65	Fixed	0,011	0,015	97°38'18"	1482,202	-1,683
GCPa64 (B137)	base5	GCPa64	Fixed	0,013	0,017	68°49'40"	1950,563	-1,428
GCPa63 (B136)	base5	GCPa63	Fixed	0,013	0,017	86°46'55"	2169,154	-1,103
GCPa62 (B135)	base5	GCPa62	Fixed	0,015	0,019	60°22'21"	2727,199	17,746
GCPa61 (B134)	base5	GCPa61	Fixed	0,016	0,019	46°38'56"	3074,187	7,999
GCPa60 (B133)	base5	GCPa60	Fixed	0,013	0,016	46°35'49"	2391,645	2,235
GCPa59 (B132)	base5	GCPa59	Fixed	0,012	0,014	36°09'13"	3172,125	2,166
GCPa58 (B131)	base5	GCPa58	Fixed	0,014	0,017	36°11'55"	3780,024	11,121
GCPa57 (B130)	base5	GCPa57	Fixed	0,017	0,021	35°25'01"	6107,505	16,037
GCPa56 (B129)	base5	GCPa56	Fixed	0,017	0,021	37°00'02"	6709,453	16,698
GCPa55 (B128)	base5	GCPa55	Fixed	0,017	0,021	38°39'59"	6641,082	21,116
GCPa54 (B127)	base5	GCPa54	Fixed	0,015	0,019	37°50'19"	5652,026	17,344
GCPa53 (B126)	base5	GCPa53	Fixed	0,014	0,017	35°03'11"	4944,823	8,134
GCPa52 (B125)	base5	GCPa52	Fixed	0,013	0,016	44°21'29"	4435,866	14,318
GCPa51 (B124)	base5	GCPa51	Fixed	0,012	0,016	37°06'47"	4361,234	6,366
GCPa50 (B123)	base5	GCPa50	Fixed	0,012	0,016	44°50'52"	4136,181	29,110
GCPa49 (B122)	base5	GCPa49	Fixed	0,011	0,014	50°01'26"	3656,924	21,901
GCPa48 (B121)	base5	GCPa48	Fixed	0,011	0,015	66°45'53"	4183,585	36,523
GCPa47 (B120)	base5	GCPa47	Fixed	0,011	0,015	58°45'52"	4350,943	35,357
GCPa46 (B119)	base5	GCPa46	Fixed	0,012	0,016	66°05'52"	4790,538	42,689
GCPa45 (B118)	base5	GCPa45	Fixed	0,013	0,018	63°20'23"	5894,726	46,664
GCPa44 (B117)	base5	GCPa44	Fixed	0,013	0,020	67°44'21"	6463,105	52,217
GCPa43 (B116)	base5	GCPa43	Fixed	0,013	0,020	74°16'00"	6824,285	49,741
GCPa42 (B115)	base5	GCPa42	Fixed	0,012	0,019	72°02'03"	6090,791	48,497
GCPa41 (B114)	base5	GCPa41	Fixed	0,011	0,018	71°08'44"	5431,468	49,110
GCPa40 (B113)	base5	GCPa40	Fixed	0,013	0,021	76°51'11"	4739,344	38,506
GCPa39 (B112)	base5	GCPa39	Fixed	0,012	0,020	100°06'38"	4078,079	6,840
GCPa38 (B111)	base5	GCPa38	Fixed	0,010	0,019	84°15'16"	3962,184	13,264
GCPa37 (B110)	base5	GCPa37	Fixed	0,008	0,016	33°01'48"	1610,677	-2,022
GCPa36 (B109)	base5	GCPa36	Fixed	0,015	0,031	27°27'55"	4651,058	9,863
GCPa35 (B108)	base5	GCPa35	Fixed	0,014	0,031	28°53'23"	3964,874	11,894

GCPa34 (B107)	base5	GCPa34	Fixed	0,013	0,029	24°51'13"	3327,466	5,503
GCPa33 (B106)	base5	GCPa33	Fixed	0,012	0,027	13°40'23"	2898,870	2,873
GCPa32 (B105)	base5	GCPa32	Fixed	0,011	0,024	11°33'17"	2272,257	-0,808
GCPa31 (B104)	base5	GCPa31	Fixed	0,009	0,021	2°05'39"	1988,655	10,198
GCPa30 (B103)	base5	GCPa30	Fixed	0,008	0,018	8°21'18"	1434,385	3,411
GCPa29 (B102)	base5	GCPa29	Fixed	0,008	0,016	328°39'01"	974,505	7,057
GCP7 (B101)	Base4	GCP7	Fixed	0,009	0,017	228°52'26"	4379,200	6,040
GCP6 (B100)	Base4	GCP6	Fixed	0,010	0,019	224°37'23"	5293,831	-0,017
GCP5 (B99)	Base4	GCP5	Fixed	0,010	0,020	218°56'58"	5340,345	-0,175
GCP4 (B98)	Base4	GCP4	Fixed	0,007	0,017	229°58'49"	1772,711	2,388
GCP3 (B97)	Base4	GCP3	Fixed	0,006	0,015	241°54'30"	1266,041	2,751
GCP2 (B96)	Base4	GCP2	Fixed	0,005	0,013	243°00'13"	603,783	1,194
GCP1b (B95)	Base4	GCP1b	Fixed	0,004	0,011	88°20'33"	21,191	-0,137
GCP1 (B94)	Base4	GCP1	Fixed	0,003	0,007	88°19'38"	21,190	-0,137
GCP175 (B93)	Base2	GCP175	Fixed	0,011	0,018	55°43'14"	4103,721	2,687
GCP174 (B92)	Base2	GCP174	Fixed	0,012	0,019	55°37'45"	5084,370	5,199
GCP173b (B91)	Base2	GCP173b	Fixed	0,012	0,019	49°01'34"	5908,537	6,345
GCP173 (B90)	Base2	GCP173	Fixed	0,011	0,017	49°01'34"	5908,550	6,350
GCP172 (B89)	Base2	GCP172	Fixed	0,014	0,023	57°38'56"	2687,066	13,858
GCP171 (B88)	Base2	GCP171	Fixed	0,012	0,020	46°25'53"	3024,698	3,093
GCP170 (B87)	Base2	GCP170	Fixed	0,011	0,019	39°31'34"	2387,631	1,097
GCP169 (B86)	Base2	GCP169	Fixed	0,010	0,018	27°45'59"	2194,695	-1,359
GCP168 (B85)	Base2	GCP168	Fixed	0,009	0,016	48°16'50"	1670,574	-0,385
GCP167 (B84)	Base2	GCP167	Fixed	0,007	0,013	46°18'01"	838,599	-1,470
GCP166 (B83)	Base2	GCP166	Fixed	0,007	0,013	324°09'25"	678,299	8,682
GCP165 (B82)	Base2	GCP165	Fixed	0,007	0,014	252°24'17"	583,773	-2,773
wl03 (B81)	Base2	wl03	Fixed	0,008	0,016	257°22'52"	970,791	-7,674
wl02 (B80)	Base2	wl02	Fixed	0,008	0,016	258°09'13"	980,011	-7,035
GCP164 (B79)	Base2	GCP164	Fixed	0,008	0,016	255°38'17"	1264,858	3,710
GCP163 (B78)	Base2	GCP163	Fixed	0,009	0,017	226°58'16"	1683,859	3,892
GCP162 (B77)	Base2	GCP162	Fixed	0,009	0,018	254°15'20"	2038,548	-2,797
GCP161 (B76)	Base2	GCP161	Fixed	0,008	0,015	281°57'40"	1535,942	6,527
GCP160 (B75)	Base2	GCP160	Fixed	0,007	0,014	312°32'28"	1472,291	-0,683
GCP159 (B74)	Base2	GCP159	Fixed	0,009	0,017	319°52'30"	2073,850	13,478
GCP158 (B73)	Base2	GCP158	Fixed	0,009	0,016	329°23'51"	1735,680	0,526
GCP157 (B72)	Base2	GCP157	Fixed	0,010	0,019	210°03'42"	3680,679	-4,740
GCP156 (B71)	Base2	GCP156	Fixed	0,008	0,015	224°08'32"	2492,861	7,723
GCP155 (B70)	Base2	GCP155	Fixed	0,007	0,012	243°32'08"	2201,324	1,685

DEFAULT (B69)	Base2	DEFAULT	Fixed	0,007	0,012	243°32'08"	2201,325	1,684
GCP154 (B68)	Base2	GCP154	Fixed	0,010	0,017	231°35'21"	3023,020	9,200
GCP153 (B67)	Base2	GCP153	Fixed	0,009	0,015	206°22'33"	2446,187	-2,825
Base3 (B66)	Base2	Base3	Fixed	0,009	0,015	206°22'11"	2460,779	-2,076
GCP152 (B65)	Base2	GCP152	Fixed	0,007	0,013	203°49'46"	1697,416	-4,309
GCP151 (B64)	Base2	GCP151	Fixed	0,006	0,011	197°02'32"	1048,170	-4,259
wl01 (B63)	Base2	wl01	Fixed	0,007	0,013	175°50'57"	1570,053	-6,439
GCP150 (B62)	Base2	GCP150	Fixed	0,007	0,012	177°37'39"	1548,514	-5,154
GCP124v2 (B61)	Base2	GCP124v2	Fixed	0,003	0,005	269°03'07"	6,414	-0,049
GCP126 (B60)	BaseLow	GCP126	Fixed	0,011	0,018	69°11'41"	2224,139	-25,153
GCP125 (B59)	BaseLow	GCP125	Fixed	0,009	0,015	54°48'51"	2615,218	-11,751
Base2 (B58)	BaseLow	Base2	Fixed	0,013	0,019	32°59'24"	7547,409	-19,820
GCP124 (B57)	BaseLow	GCP124	Fixed	0,014	0,020	32°56'59"	7543,804	-19,876
GCP123 (B56)	BaseLow	GCP123	Fixed	0,012	0,017	40°11'42"	4459,026	-13,149
GCP122 (B55)	BaseLow	GCP122	Fixed	0,013	0,017	50°08'51"	5068,847	-9,814
GCP121 (B54)	BaseLow	GCP121	Fixed	0,015	0,019	58°45'43"	4821,934	-4,376
GCP120 (B53)	BaseLow	GCP120	Fixed	0,011	0,016	68°52'02"	3195,358	-22,803
GCP119 (B52)	BaseLow	GCP119	Fixed	0,011	0,016	84°27'01"	3386,838	-7,917
GCP118 (B51)	BaseLow	GCP118	Fixed	0,010	0,016	104°11'53"	3389,581	1,429
GCP117 (B50)	BaseLow	GCP117	Fixed	0,009	0,014	96°19'38"	2015,549	-6,143
GCP116 (B49)	BaseLow	GCP116	Fixed	0,010	0,016	94°03'47"	2664,395	-7,176
GCP115 (B48)	BaseLow	GCP115	Fixed	0,013	0,022	49°39'08"	3784,041	-14,051
GCP114 (B47)	BaseLow	GCP114	Fixed	0,012	0,020	40°05'49"	3235,034	-21,358
GCP113 (B46)	BaseLow	GCP113	Fixed	0,011	0,019	39°34'58"	3167,967	-20,499
GCP112 (B45)	BaseLow	GCP112	Fixed	0,009	0,015	52°15'30"	2135,016	-5,659
GCP111 (B44)	BaseLow	GCP111	Fixed	0,008	0,012	17°19'50"	1432,827	-7,501
GCP110 (B43)	BaseLow	GCP110	Fixed	0,010	0,017	24°12'46"	2615,506	-21,110
GCP109 (B42)	BaseLow	GCP109	Fixed	0,012	0,022	15°57'39"	3869,883	-26,360
GCP108 (B41)	BaseLow	GCP108	Fixed	0,011	0,020	23°41'28"	3341,752	-21,841
GCP107 (B40)	BaseLow	GCP107	Fixed	0,011	0,021	11°59'43"	3266,018	-24,926
GCP106 (B39)	BaseLow	GCP106	Fixed	0,012	0,023	1°32'20"	3647,411	-24,773
GCP105 (B38)	BaseLow	GCP105	Fixed	0,009	0,020	357°55'58"	2408,570	-19,917
GCP104 (B37)	BaseLow	GCP104	Fixed	0,009	0,021	331°50'21"	2367,269	-3,704
GCP103 (B36)	BaseLow	GCP103	Fixed	0,007	0,018	317°47'15"	1753,426	-1,469
GCP102 (B35)	BaseLow	GCP102	Fixed	0,005	0,014	318°24'16"	790,254	1,187
GCP101 (B34)	BaseLow	GCP101	Fixed	0,006	0,016	349°51'03"	1316,869	3,668
GCP100 (B33)	BaseLow	GCP100	Fixed	0,005	0,013	25°12'29"	650,230	-1,049
GCP94v2 (B32)	BaseLow	GCP94v2	Fixed	0,006	0,014	83°45'38"	574,440	0,250

GCP61v2 (B31)	BaseLow	GCP61v2	Fixed	0,005	0,012	223°42'44"	773,346	2,233
GCP60v2 (B30)	BaseLow	GCP60v2	Fixed	0,003	0,006	309°43'37"	12,895	-0,020
GCP87 (B29)	BaseLow	GCP87	Fixed	0,008	0,015	139°27'21"	3150,989	-16,710
GCP86 (B28)	BaseLow	GCP86	Fixed	0,008	0,015	150°54'39"	3561,591	-7,614
GCP85 (B27)	BaseLow	GCP85	Fixed	0,009	0,016	151°19'00"	4115,418	-5,974
GCP84 (B26)	BaseLow	GCP84	Fixed	0,010	0,016	163°04'04"	4760,258	-11,845
GCP83 (B25)	BaseLow	GCP83	Fixed	0,011	0,018	163°56'23"	3831,697	-3,566
GCP82 (B24)	BaseLow	GCP82	Fixed	0,009	0,015	167°29'53"	2938,366	2,348
GCP81 (B23)	BaseLow	GCP81	Fixed	0,008	0,013	156°18'19"	2177,466	8,192
GCP80 (B22)	BaseLow	GCP80	Fixed	0,007	0,012	172°22'54"	1667,036	19,534
GCP79 (B21)	BaseLow	GCP79	Fixed	0,006	0,011	146°27'53"	1380,908	12,292
GCP78 (B20)	BaseLow	GCP78	Fixed	0,009	0,016	234°55'15"	2064,623	14,534
GCP77 (B19)	BaseLow	GCP77	Fixed	0,009	0,015	289°19'25"	2526,004	0,203
GCP76 (B18)	BaseLow	GCP76	Fixed	0,009	0,016	288°24'50"	3161,538	-0,661
GCP75 (B17)	BaseLow	GCP75	Fixed	0,008	0,016	298°34'05"	4179,115	-13,377
GCP74 (B16)	BaseLow	GCP74	Fixed	0,009	0,017	280°45'16"	4474,437	20,550
GCP73 (B15)	BaseLow	GCP73	Fixed	0,009	0,017	290°38'30"	4726,335	1,534
GCP72 (B14)	BaseLow	GCP72	Fixed	0,010	0,018	302°57'20"	4883,641	-3,108
GCP71 (B13)	BaseLow	GCP71	Fixed	0,010	0,018	292°10'52"	5834,252	-1,392
GCP70 (B12)	BaseLow	GCP70	Fixed	0,011	0,019	314°25'29"	4236,543	-21,997
GCP69b (B11)	BaseLow	GCP69b	Fixed	0,010	0,017	320°34'20"	3359,623	-16,850
GCP69 (B10)	BaseLow	GCP69	Fixed	0,009	0,015	320°34'20"	3359,625	-16,850
GCP68 (B9)	BaseLow	GCP68	Fixed	0,009	0,015	302°04'30"	3328,214	-7,131
GCP67 (B8)	BaseLow	GCP67	Fixed	0,011	0,016	314°04'05"	2655,332	-16,806
GCP66 (B7)	BaseLow	GCP66	Fixed	0,009	0,013	300°24'31"	1911,142	-8,627
GCP65 (B6)	BaseLow	GCP65	Fixed	0,008	0,011	287°48'19"	1410,518	-1,122
GCP64 (B5)	BaseLow	GCP64	Fixed	0,010	0,014	271°53'02"	1912,710	14,568
GCP63 (B4)	BaseLow	GCP63	Fixed	0,012	0,016	265°23'25"	2788,951	23,218
GCP62 (B3)	BaseLow	GCP62	Fixed	0,011	0,015	244°55'45"	2507,644	13,763
GCP61 (B2)	BaseLow	GCP61	Fixed	0,006	0,009	223°42'42"	773,349	2,221
GCP60b (B1)	BaseLow	GCP60b	Fixed	0,005	0,008	309°42'32"	12,885	-0,023

Acceptance Summary

Processed	Passed	Flag	Fail
166	166	0	0

Agri-Sense International

Appendix 5 Trimble R4 GNSS GPS Specifications

Trimble R4 GNSS system

Key Features

Trimble R-Track satellite tracking technology

Includes Trimble Maxwell 6 chip with 220 channels

Scalable from postprocessing to VRS to multi-constellation RTK configurations

Cable-free for convenience

Accurate, reliable and rugged system

Trimble Slate controller



Dependable When every point Counts

Designed for surveyors looking for easy-to-use GNSS technology, the Trimble® R4 GNSS System performs under even the most rigorous conditions. GNSS support upgrade options, integrated Trimble R-Track™ satellite tracking technology, and a straightforward system design result in a system that is flexible, reliable, and rugged.

a complete GNSS system

Lightweight, convenient and cable-free, the Trimble R4 GNSS system with Trimble Access™ field software provides the ease of use of an integrated receiver and everything you need to perform a basic survey campaign.

The dual-frequency antenna enhances tracking capacity and delivers sub-millimeter phase center stability for precise results in demanding conditions. Internally powered with removable batteries, this system provides a full working day of uninterrupted field operation.

advanced Trimble r-track technology

The Trimble R4, powered with a Trimble Maxwell™ 6 chip with 220 channels, delivers the accuracy and reliability required for precision surveying with superior tracking and RTK performance. With GPS L2C and the Japanese QZSS support included, you can track more satellites and measure more successfully in challenging environments. L2C provides more than just additional signals – the advanced signal structure provides better strength for more reliable satellite tracking.

Trimble R-Track satellite tracking technology delivers reliable, precise positioning performance. Trimble R-Track with Signal Prediction™ compensates for intermittent or marginal RTK correction signals, enabling extended precision operation after an RTK signal is interrupted.

The CMRx communications protocol provides correction compression for optimized bandwidth and full utilization all of the satellites in view, giving you reliable positioning performance.

Choose the level of GNSS support you require today

Choose the level of GNSS support you require today with the flexible upgrade options available on the Trimble R4. Founded on proven GNSS technology, the Trimble R4 comes standard with GPS L1, L2, L2C and QZSS. Beyond this standard GNSS support, the Trimble R4 offers upgrades to GLONASS, Galileo, and BeiDou (COMPASS)—just choose what you need.

Functions as a vrs rover, RTK rover, or Field base station

Use as a lightweight rover for static surveying or RTK. The Trimble R4 is also completely compatible with Trimble VRS™ solutions, creating a VRS rover for use inside real-time networks. With a built-in 450 MHz receive-only radio or a fully integrated GSM/GPRS radio, this system can be adapted to meet a variety of needs. As a base station, the Trimble R4 with the integrated UHF transmit option is rugged, weather-resistant and compatible with a range of radio solutions.

a dedicated, reliable GNSS Field solution

Pair the Trimble R4 with Trimble Access and the Trimble Slate Controller¹ for a dedicated GNSS solution that is effective for both real time and postprocessed GNSS surveys.

Powerful, connected, and compact, the Trimble Slate Controller combines the convenience and ease-of-use of a smartphone with the durability for which Trimble is known. Its slim, ergonomic design is easy to grasp and its screen provides superior sunlight readability enabling all-day use by hard-working survey professionals.

Trimble Access field software provides specialized and customized workflows to make surveying tasks quicker and easier while enabling teams to communicate vital information between field and office in real-time.

Survey companies can also implement their unique workflows by taking advantage of the customization capabilities available in the Trimble Access Software Development Kit (SDK).

Need to get data back to the office immediately? Benefit from real-time data sharing via Trimble Access Services, now available with any valid Trimble Access maintenance agreement.

Back in the office, users can seamlessly process data with Trimble BusinessCenter office software.

The Trimble R4 GNSS system – ready and reliable for your everyday surveying needs.

¹ The Trimble R4 can be used with a Trimble TSC3, Trimble CU, or Trimble Tablet Rugged PC with the purchase of an advanced data collector option.

Trimble r4 GNSS system

Datasheet

performance specifications

measurements

- Advanced Trimble Maxwell 6 Custom Survey GNSS chip with 220 channels
- Trimble R-Track technology
- High precision multiple correlator for GNSS pseudorange measurements
- Unfiltered, unsmoothed pseudorange measurements data for low noise, low multipath error, low time domain correlation and high dynamic response
- Very low noise GNSS carrier phase measurements with <1 mm precision in a 1 Hz bandwidth
- Signal-to-Noise ratios reported in dB-Hz
- Proven Trimble low elevation tracking technology
- Satellite signals tracked simultaneously:
 - GPS: L1C/A, L1C, L2C, L2E
 - GLONASS¹: L1C/A, L1P, L2C/A, L2P, L3
 - SBAS: L1C/A
 - Galileo¹: E1, E5A, E5B
 - BeiDou¹ (COMPASS): B1, B2
- SBAS: QZSS, WAAS, EGNOS, GAGAN
- Positioning rates: 1 Hz, 2 Hz, 5 Hz, and 10 Hz

positioning performance²

code differential GNSS

positioning

Horizontal	0.25 m + 1 ppm RMS
Vertical	0.50 m + 1 ppm RMS
SBAS differential positioning accuracy ³	typically <5 m 3DRMS

static GNSS

surveying

high-precision static

Horizontal	3 mm + 0.1 ppm RMS
Vertical	3.5 mm + 0.4 ppm RMS

static and Faststatic

Horizontal	3 mm + 0.5 ppm RMS
Vertical	5 mm + 0.5 ppm RMS

postprocessed Kinematic (PPK) GNSS

surveying

Horizontal	8 mm + 1 ppm RMS
Vertical	15 mm + 1 ppm RMS

real time Kinematic surveying⁴

single baseline <30 km

Horizontal	8 mm + 1 ppm RMS
Vertical	15 mm + 1 ppm RMS

network rtk

Horizontal	8 mm + 0.5 ppm RMS
Vertical	15 mm + 0.5 ppm RMS
Initialization time ⁵	typically <8 seconds
Initialization reliability ⁵	typically >99.9%

1 Optional upgrade.

2 Precision and reliability may be subject to anomalies due to multipath, obstructions, satellite geometry, and atmospheric conditions. The specifications stated recommend the use of stable mounts in an open sky view, EMI and multipath clean environment, optimal GNSS constellation configurations, along with the use of survey practices that are generally accepted for performing the highest-order surveys for the applicable application including occupation times appropriate for baseline length. Baselines longer than 30 km require precise ephemeris and occupations up to 24 hours may be required to achieve the high precision static specification.

3 Depends on SBAS system performance.

4 Network RTK PPM values are referenced to the closest physical reference station.

5 May be affected by atmospheric conditions, signal multipath, obstructions and satellite geometry. Initialization reliability is continuously monitored to ensure highest quality.

6 Receiver will operate normally to -40 °C, internal batteries are rated to -20 °C, optional internal GSM modem operates to -30 °C.

7 Tracking GPS, GLONASS and SBAS satellites. Optional upgrade required for GLONASS.

8 Varies with temperature and wireless data rate. When using a receiver and internal radio in the transmit mode, it is recommended that an external 6 Ah or higher battery is used.

9 Varies with terrain and operating conditions.

10 Bluetooth type approvals are country specific.

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PN 022543-490E (04/13)

hardware

physical

Dimensions (W×H)	19 cm × 10.2 cm (7.5 in x 4.0 in), including connectors
Weight	1.52 kg (3.35 lb) with internal battery, internal radio with UHF antenna 3.04 kg (6.70 lb) items above plus range pole, controller, and bracket

Temperature⁶

Operating	-40 °C to +65 °C (-40 °F to +149 °F)
Storage	-40 °C to +75 °C (-40 °F to +167 °F)
Humidity	100%, condensing
Water/dustproof	IP67 dustproof, protected from temporary immersion to depth of 1 m (3.28 ft)
Shock and vibration	Tested and meets the following environmental standards: Shock: Non-operating: Designed to survive a 2 m (6.6 ft) pole drop onto concrete. Operating: to 40 G, 10 msec, sawtooth Vibration: MIL-STD-810F, FIG.514.5C-1

electrical

- Power 11 V DC to 28 V DC external power input with over-voltage protection on Port 1 (7-pin Lemo)
- Rechargeable, removable 7.4 V, 2.6 Ah Lithium-Ion battery. Power consumption⁷ is 3.2 W in RTK rover mode with internal radio and Bluetooth in use.
- Operating times on internal battery⁸:
 - 450 MHz receive only option: 5.0 hours
 - 450 MHz receive/transmit option (0.5 W): 2.5 hours
 - Cellular receive option: 4.7 hours

communications and data storage

- Serial: 3-wire serial (7-pin Lemo) on Port 1; full RS-232 serial on Port 2 (Dsub 9 pin)
- Radio modem: fully integrated, fully sealed internal 450 MHz receiver/transmitter option:
 - Transmit power: 0.5 W
 - Range⁹: 3–5 km typical / 10 km optimal
- Cellular: fully integrated, sealed internal GSM/GPRS option
- Bluetooth: fully integrated, sealed 2.4 GHz communications port (Bluetooth[®])¹⁰
- External communication devices for corrections supported on Serial and Bluetooth ports
- Data storage: 11 MB internal memory, 188.6 hours of raw observables (approx. 1.4 MB/day), based on recording every 15 seconds from an average of 14 satellites

data formats

- CMR: CMR+, CMRx input and outputs
- RTCM: RTCM 2.1, RTCM 2.3, RTCM 3.0, RTCM 3.1 input and outputs
- Other outputs: 23 NMEA outputs, GSOE, RT17 and RT27 outputs, supports BINEX and smoothed carrier

supported trimble controllers

- Trimble Slate Controller
- Optional¹: Trimble TSC3 controller, Trimble CU controller, Trimble Tablet Rugged PC

certifications

FCC Part 15 (Class B device), 22, 24, 90; CE Mark; C-Tick; 850/1900 MHz; Class 10 GSM/GPRS module; Bluetooth EPL



Specifications subject to change without notice.

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TRIMBLE SLATE CONTROLLER

KEY FEATURES

Familiar, **easy-to-use**, smartphone form factor

All-in-one device that provides both smartphone and data collection capabilities

Durable Gorilla Glass and **4.3 inch capacitive touch display**

Communication technology enables **enhanced connectivity**

Optimized for Trimble Access field software for survey workflow support



A SMART MOBILE SURVEYING SOLUTION

Powerful, connected, and compact, the Trimble® Slate Controller combines the convenience and ease-of-use of a smartphone with the durability for which Trimble is known. Its slim, ergonomic design is easy to grasp and its screen provides superior sunlight readability enabling all-day use by hard-working survey professionals. Optimized for Trimble Access™ field software and the Trimble R4 GNSS receiver, the Trimble Slate Controller fully supports your everyday workflows and unique requirements.

ONE DEVICE FOR BOTH VOICE AND SURVEYING DATA COLLECTION

With the Trimble Slate Controller, you no longer need to juggle a smartphone and a rugged computer to stay connected to the office, your clients, and even your survey equipment. Offering voice, SMS text, and 3.75G cellular data transfer capabilities on GSM cellular networks worldwide, the Trimble Slate Controller is a rugged all-in-one device that enables enhanced communication and survey workflow support in the field.

- Transfer data to and from the cloud using Wi-Fi or WWAN connections
- Connect to a Trimble VRS™ network via high speed connection capabilities
- Connect directly to, and control, the Trimble R4 GNSS receiver using the controller's integrated Bluetooth® capability
- Enhance your job documentation and point attribution by capturing geotagged, high quality, digital photos with the integrated 8 MP camera
- Navigate directly to points using the internal GPS and Compass
- Maintain voice communication with company personnel

DESIGNED TO SUPPORT YOUR DAILY WORKFLOWS

Trimble Access field software, available on the Trimble Slate Controller, offers numerous features and capabilities to streamline the flow of everyday surveying work, such as topographic surveying, stakeout, control, and more. Streamlined workflows guide crews step-by-step through common project types and allow crews to get the job done faster with less distractions, while improving data consistency. Survey companies can also implement their unique workflows by taking advantage of the customization capabilities available in the Trimble Access Software Development Kit (SDK).

The Trimble Access Software Developer Kit provides software developers with the tools to customize and extend Trimble Access.

YOUR MOBILE OFFICE IN THE FIELD

A 1 GHz processor and 512 MB RAM provide powerful computing capabilities that allow you to run software applications quickly and reliably.

The Trimble Slate Controller runs the Windows® Embedded Handheld 6.5 Professional Operating System and Microsoft Office® Mobile® 2010, allowing you to take advantage of mobile office applications such as Word, Excel, PowerPoint, and Outlook, all without a trip to the office.

Once complete, simply transfer the job file back to your office using the Trimble Slate Controller's integrated communications technology. The Trimble Slate Controller is ready for the obstacles that may come your way. Did the client change the deliverables and the crews are already on site? No problem...simply use the communication capabilities to download the new job files without going back to the office.

SMARTPHONE CONVENIENCE. TRIMBLE DURABILITY

Whether on the job site, on the road, or in the office, the Trimble Slate Controller offers the convenient smartphone features you need to stay productive, informed, and in touch while its rugged design is built to withstand the most extreme environments your work requires. At 13.5 oz, its slim, ergonomic design means you can take the Trimble Slate controller anywhere.

Designed to hold up against the toughest of conditions, a 4.3 inch capacitive touch, Gorilla® glass display covers the entire front surface and provides superior sunlight readability without sacrificing durability.

The Trimble Slate Controller operates in extreme temperatures of -30 °C to +60 °C (-22 °F to +140 °F). It can also withstand a pole drop of 1.22 m (4.0 ft) onto a concrete surface.

DEPENDABLE WHEN EVERY POINT COUNTS

The Trimble Slate Controller, partnered with Trimble Access and the Trimble R4 GNSS receiver, provides a dedicated GNSS solution that is effective for both real time and post processed GNSS surveys. Providing everything you need to perform a basic survey campaign, this straightforward solution performs under the most rigorous conditions.

Work smart with the Trimble Slate Controller, an all-in-one device for voice and surveying data collection.

* Trimble Slate Controller is compatible with the Trimble R4 GNSS receiver only.

STANDARD SOFTWARE

Windows Embedded Handheld 6.5 Professional Operating System including:

- Trimble SatViewer (GPS interface application)
- Trimble CellStart (WWAN configuration application)
- Microsoft Office Mobile 2010 (Word Mobile, Excel Mobile, PowerPoint Mobile, Outlook Mobile)
- Internet Explorer Mobile 6
- Microsoft My Phone with SMS Text Messaging
- Camera control application
- Flashlight mode control application
- Calculator
- Calendar
- Microsoft Pictures & Videos
- Windows Media Player
- Windows Live Messenger
- Microsoft Task Manager & Notes
- Adobe Reader LE 2.5

Operating System Language Support: Chinese (Simplified), English, French, German, Italian, Japanese, Korean, Portuguese, Russian or Spanish

STANDARD ACCESSORIES

- International AC charging kit
- USB cable
- Wrist strap
- Capacitive stylus with tether
- Ultra clear screen protectors (qty 2) kit
- Quick Start Guide

OPTIONAL ACCESSORIES

- 9-pin serial adapter
- USB host adapter
- External battery pack
- Port cover
- Ultra clear screen protectors (qty 10) kit
- Anti-reflective screen protectors (qty 2) kit
- Vehicle charging kit
- Capacitive touchscreen gloves
- Trimble headset
- External GPS antenna

All standard accessories are also available to order separately.

PHYSICAL SPECIFICATIONS

Size: 15.5 cm x 8.2 cm x 2.5 cm (6.1 in x 3.2 in x .9 in)
Weight: 0.4 kg (13.5 oz), including battery

CERTIFICATIONS

FCC, CE, R&TTE, IC (Canada), C-tick, GCF compliant, RoHS compliant, Section 508 compliant, PTCRB, SAR, AT&T network compatible, Wi-Fi Alliance certified, CCX, USB 2.0 Full Speed, MIL-STD-810G, IP65/IP68, MIL-STD-461E.

ENVIRONMENTAL SPECIFICATIONS

Temperature:

- Operating: -30 °C to 60 °C (-22 °F to 144 °F)
- Storage: -40 °C to 70 °C (-40 °F to 158 °F)
- Temperature shock: Cycles between -30 °C and 60 °C (-22 °F and 144 °F), MIL-STD-810G, Method 503.5, Procedure I-C
- Water: Survives immersion at 1 m (3.3 ft) for two hours, IEC-60529 IPx8
- Dust: Protected against dust, IEC-60529 IP6x, dust chamber with under-pressure
- Drops: Survives multiple drops of 1.22 m (4 ft), MIL-STD-810G, Method 516.6, Procedure IV, Transit Drop
- Humidity: 90% relative humidity with temperatures between 30 °C and 60 °C (22 °F and 144 °F), MIL-STD-810G, Method 507.5, Procedure II
- Altitude: 4,572 m (15,000 ft) at 23 °C (73 °F) to 12,192 m (40,000 ft) at -30 °C (-22 °F), MIL-STD-810G, Method 500.5, Procedure I, II & III
- Vibration: General minimum integrity and loose cargo tests, MILSTD-810G, Method 514.6, Procedure I & II, Category 5
- Solar Exposure: Survives prolonged UVB exposure, MIL-STD-810G, Method 505.5, Procedure II
- Chemical Exposure: Resistant to mild alkaline and acid cleaning solutions, fuel hydrocarbons, alcohols and common vehicle and factory machine lubricants

ELECTRICAL SPECIFICATIONS

- Processor: 1 GHz, Texas Instruments DM3730
- Memory: 512 MB
- Storage: 16 GB SSD
- Expansion: MicroSD memory card slot (supports SDHC up to 32 GB, SIM card slot)
- Display:
 - 10.9 cm (4.3 in), 480 x 800 pixel, WVGA TFT
 - Sunlight-readable Gorilla Glass display
 - Light sensor to auto-adjust display brightness
 - Capacitive multi-touch interface
- Battery: 3.7 V, 3.3 Ah, 12.2 Wh, Lithium-ion polymer
- I/O: Custom Port that supports USB 2.0 Host, USB Client, 9-pin Serial and 5.6 V (5.0 V to 5.9 V) DC input power
- Audio: Integrated speaker and microphone with 3.5mm audio jack
- Wireless:
 - Integrated 3.75G cellular data, text and voice capability
 - Bluetooth 2.1 +EDR;
 - Wi-Fi 802.11 b/g/n
 - WWAN radios: UMTS / HSPA+, GSM / GPRS/ EDGE, UMTS Bands (WCDMA/FDD): 800 AWS, 850 AWS, 1900 AWS and 2100 MHz, GSM Bands: 850 MHz, 900 MHz, 1800 MHz, 1900 MHz
- Camera/GPS/compass/accelerometer:
 - 8 MP camera with geo-tagging and dual LED flash
 - GPS receiver: 2-4 m accuracy with WAAS/SBAS correction; MCX port for optional external antenna
 - Integrated electronic compass and accelerometer

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Appendix 6

Bench Mark locations

Agri-Sense International

CONTROL POINT MAP

Pt Name: BM1	Description: : 12mm Iron Peg in Concrete Pillar	Surveyor: AGRI-SENSE
Country: DRC	Site: CSKN	Date: Jun 2017
Survey Method: GPS	Datum: WGS 84	Projection: UTM
Northing: 9 379 150.02m	Easting: 457 867.04m	Height: 379.60m

Locality Sketch Map:



Directions: Along the main haulage road next to Vimbele 1 between the 2 sets of rail tracks

CONTROL POINT MAP

Pt Name: BM2	Description: : 12mm Iron Peg in Concrete Pillar	Surveyor: AGRI-SENSE
Country: DRC	Site: CSKN	Date: Jun 2017
Survey Method: GPS	Datum: WGS 84	Projection: UTM
Northing: 9 385 480.80m	Easting: 461 970.90m	Height: 359.94 m

Locality Sketch Map:



Directions: Along the main haulage road next to TRANSCO KM 8 between the 2 sets of rail tracks

CONTROL POINT MAP

Pt Name: BM3	Description: : 12mm Iron Peg in Concrete Pillar	Surveyor: AGRI-SENSE
Country: DRC	Site: CSKN	Date: Jun 2017
Survey Method: GPS	Datum: WGS 84	Projection: UTM
Northing: 9 392 041.59m	Easting: 468 080.31m	Height: 371.475m

Locality Sketch Map:



Directions: At the end of the Kwilu-Ngongo runway on approach 25