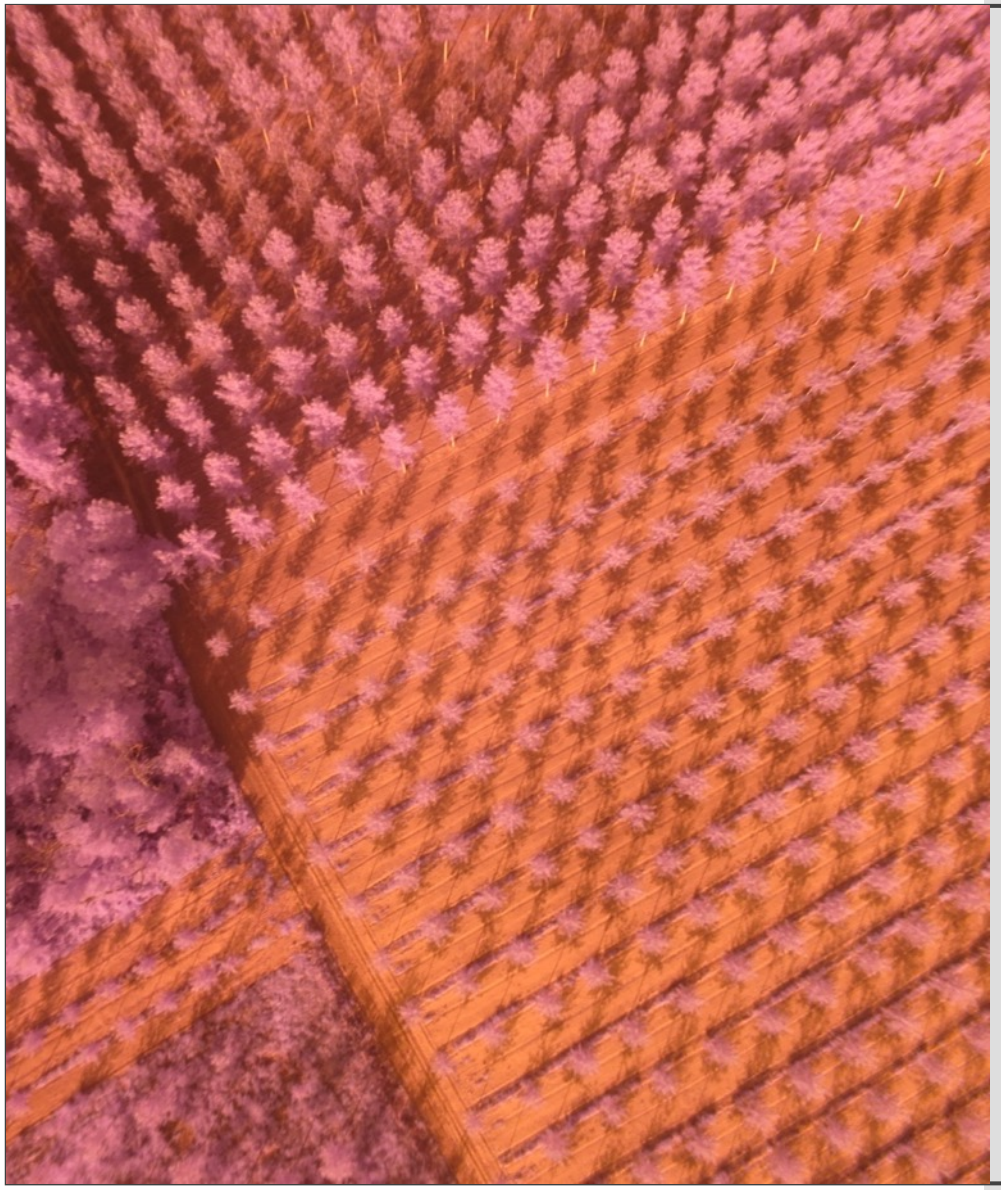
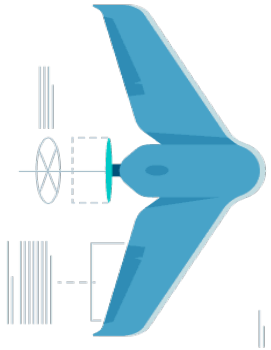


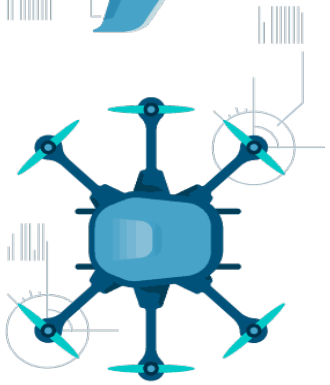
Elaborazione dei dati da Drone

Francesca GIANNETTI

UNIVERSITÀ DEGLI STUDI FIRENZE

geo LAB





REGOLAMENTAZIONE AERONAUTICA

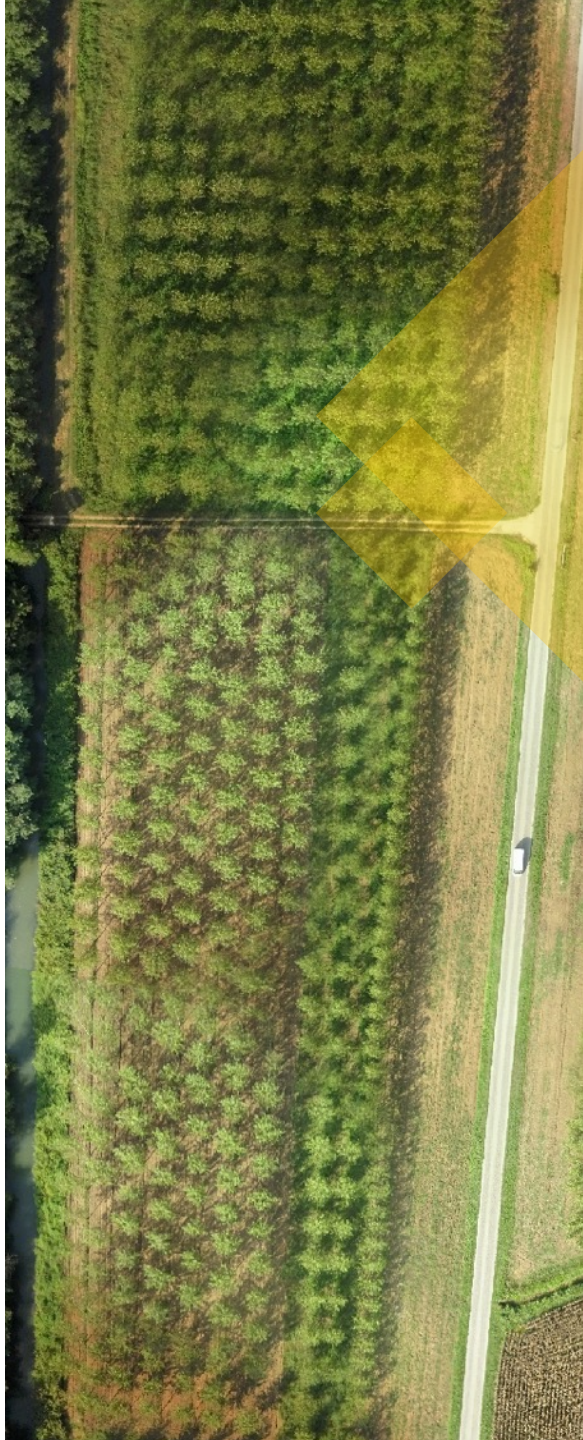
- Normativa EASA
- Normativa Italiana

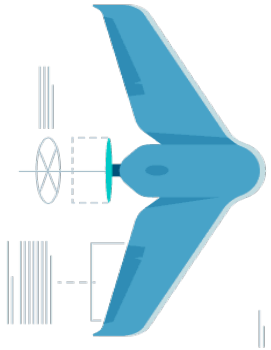
PER POTER UTILIZZARE I DRONI (UAV) PER SCOPI LAVORATIVI OCCORRE:

- Essere Operatore UAV registrato ENAC d-flight
- Essere Pilota UAV – possedere un attestato
- Assicurazione del drone – assicurazione

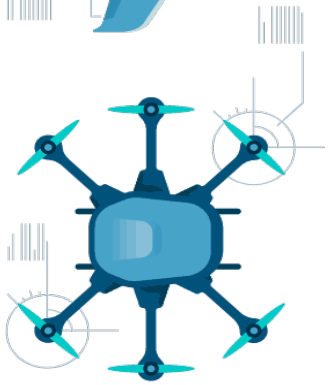
GLI UAV VENGONO CATEGORIZZATI IN BASE A:

- Peso
- Sensori
- Tempo di volo
- Tipologia di volo (rotori ed ali fisse)



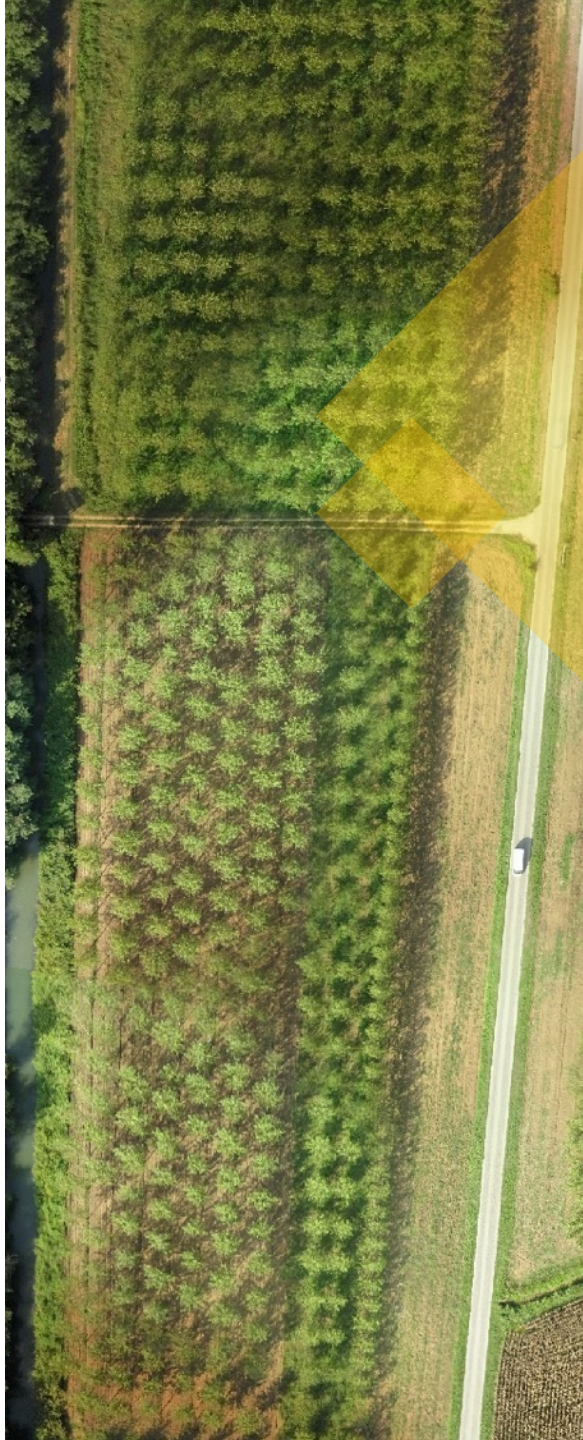


VINCOLI AL VOLO:
Aree vincolate – riferimento cartografia aeronautica
In alcune aree parco è necessario volare con autorizzazione
Può essere richiesta la Valutazione di Incidenza Ambientale



QUOTA DI VOLO:
120 m rispetto a terra
In alcuni casi come ATZ e CTR la quota di volo rispetto al
Terreno può scendere

DISTANZA DAL PILOTA
Modalità di volo VLOS – 500 m dal pilota
Può essere richiesta autorizzazione per volare in BVLOS
(solo in alcuni casi)



PROGETTAZIONE DEL PIANO DI VOLO – PRINCIPI DI FOTOGRAMMETRIA

La quota di volo
La risoluzione della fotocamera
La focale

DETERMINANO LA GROUND SAMPLING DISTANCE (GSD)
→ La risoluzione minima del pixel che potremmo avere una volta elaborato il rilievo

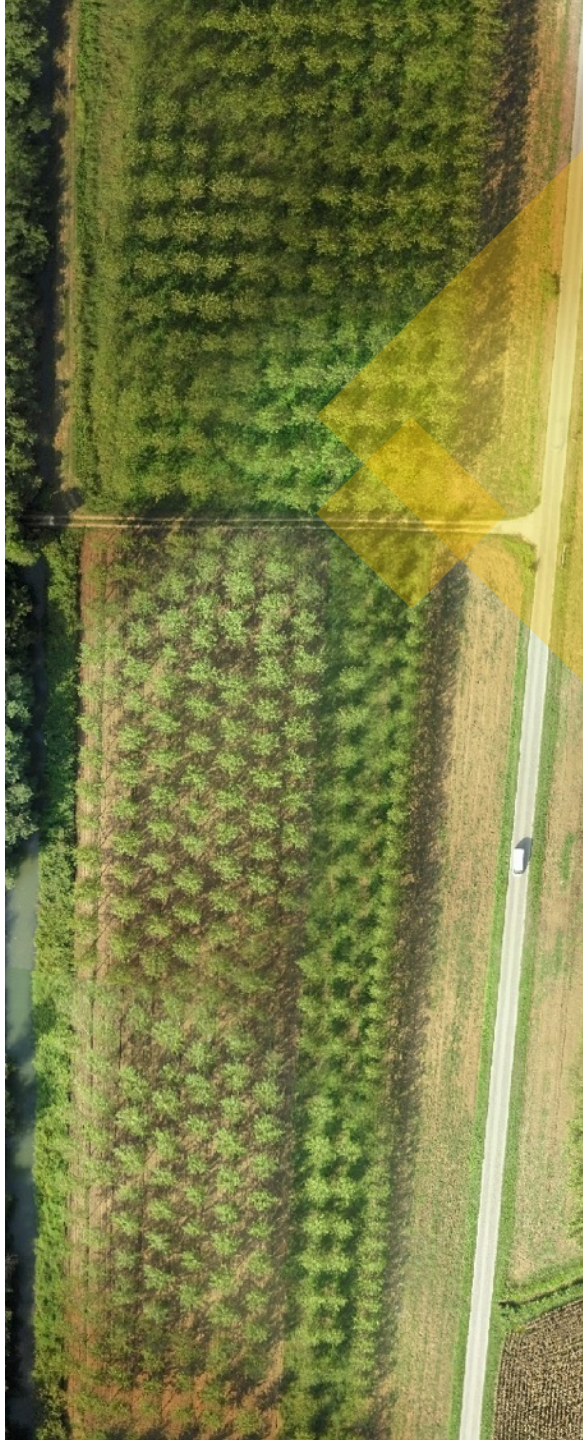
Il *GSD* corrisponde alla risoluzione di un'immagine a terra. Ti dice quanto è grande un suo pixel misurato a terra, nella scena reale.

GSD = (H x d) / p

H è la *distanza tra fotocamera e terreno* (in aerofotogrammeria nadirale è sempre l'altezza di volo);

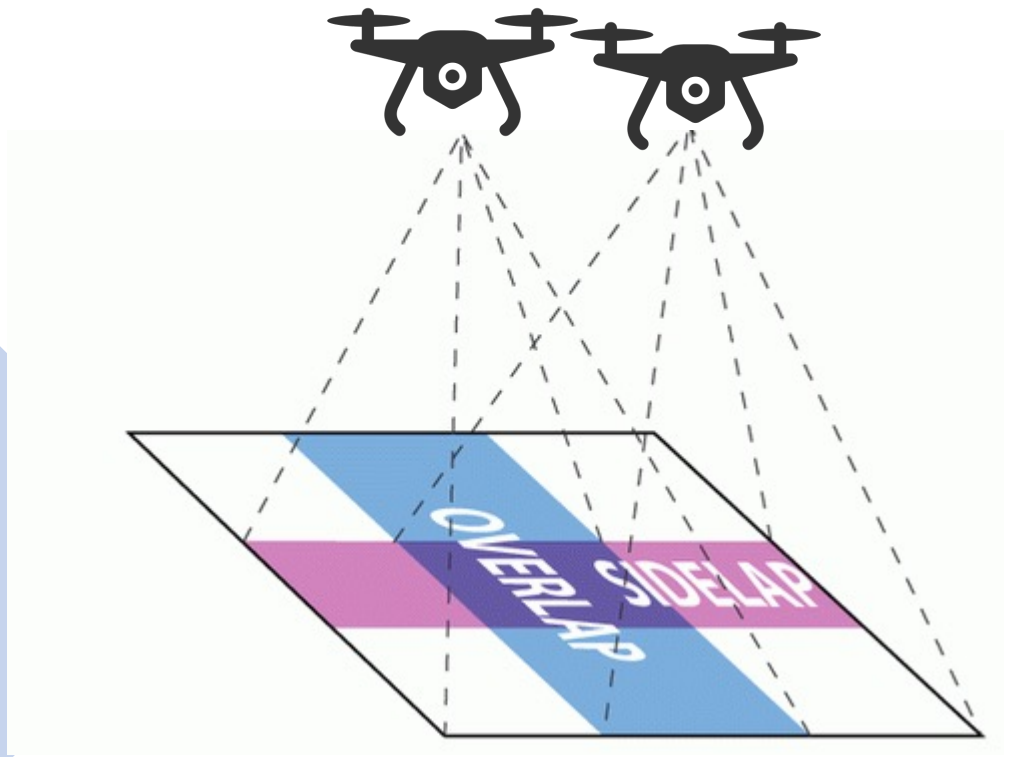
d è la *dimensione del lato di un pixel* (che ha forma quadrata) del *sensore fotografico* (dipende dalla dimensione del sensore e dalla sua risoluzione)*;*

p è la *lunghezza focale* dell'ottica (la distanza principale).



PROGETTAZIONE DEL PIANO DI VOLO – PRINCIPI DI FOTOGRAMMETRIA

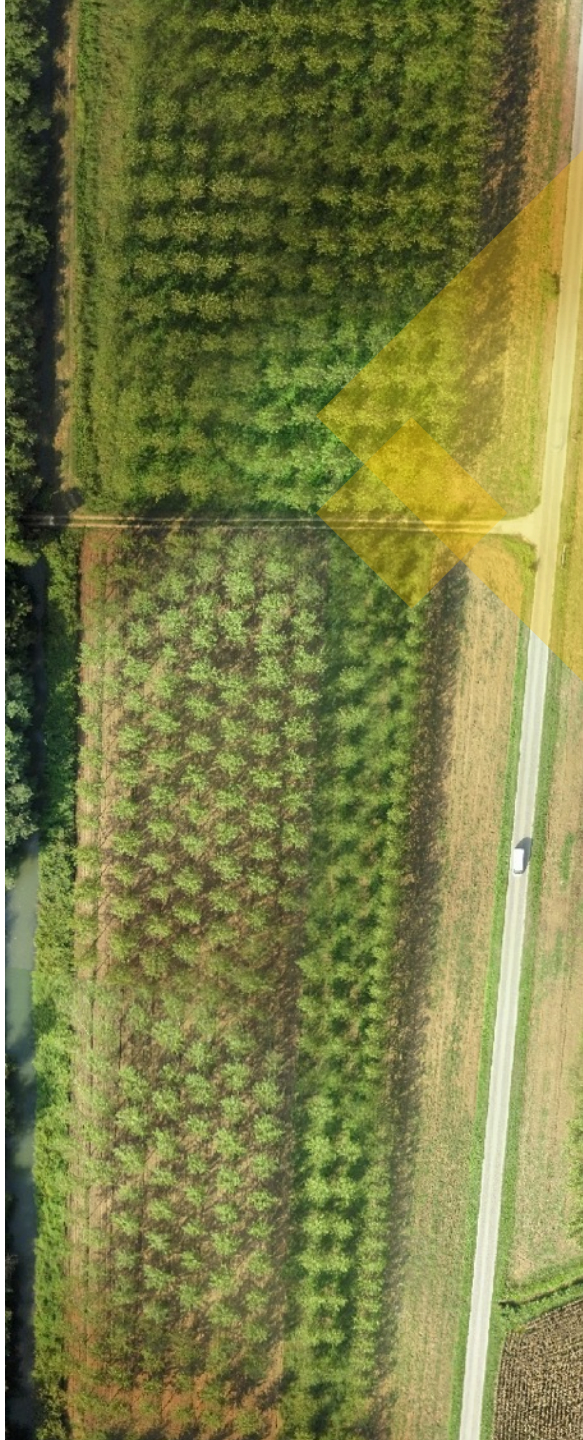
Overlap e Sidelap



Rispetto alla fotogrammetria classica
RICAMPIONAMENTO TRA LE STRISE
(Sidelap)
75-80%
RICAMPIONAMENTO LUNGO LA STRISCIA
(Overlap)
80-90%

PROBLEMATICHE IN PIOPPICOLTURA

- Feature molto simili tra loro, preferibile programmare un piano di volo con quota alta per evitare in fase di elaborazione problematiche di allineamento



PROGETTAZIONE DEL PIANO DI VOLO – PRINCIPI DI FOTOGRAMMETRIA

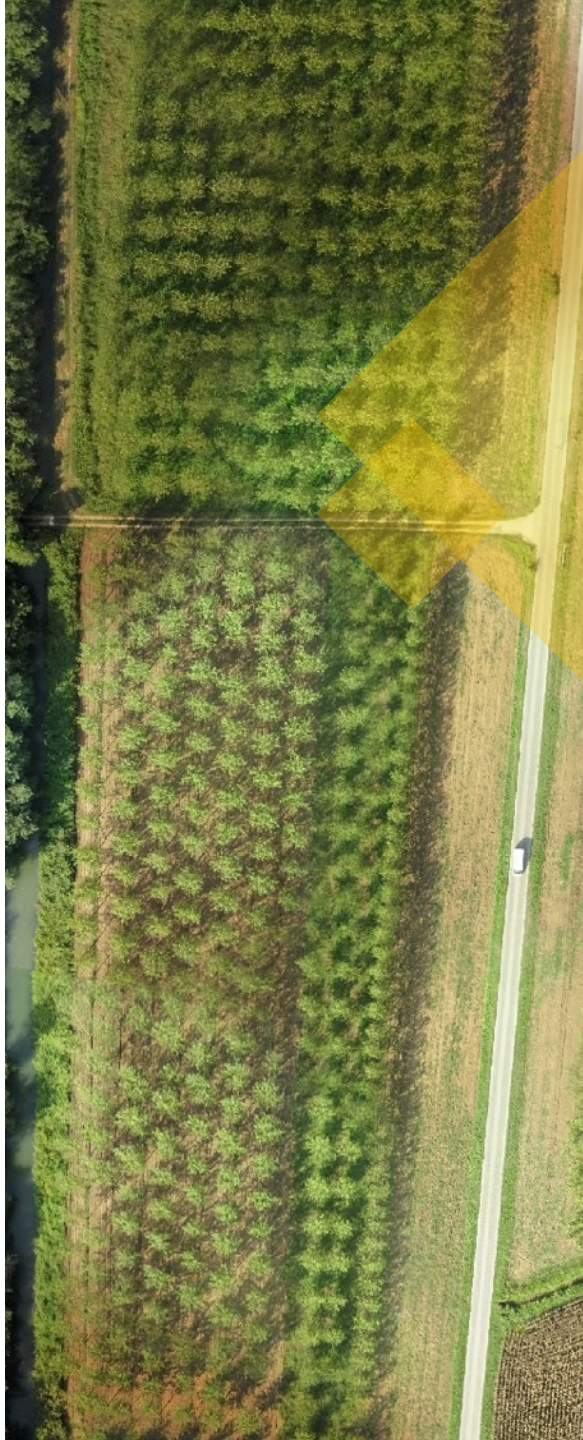
Software di programmazione del volo

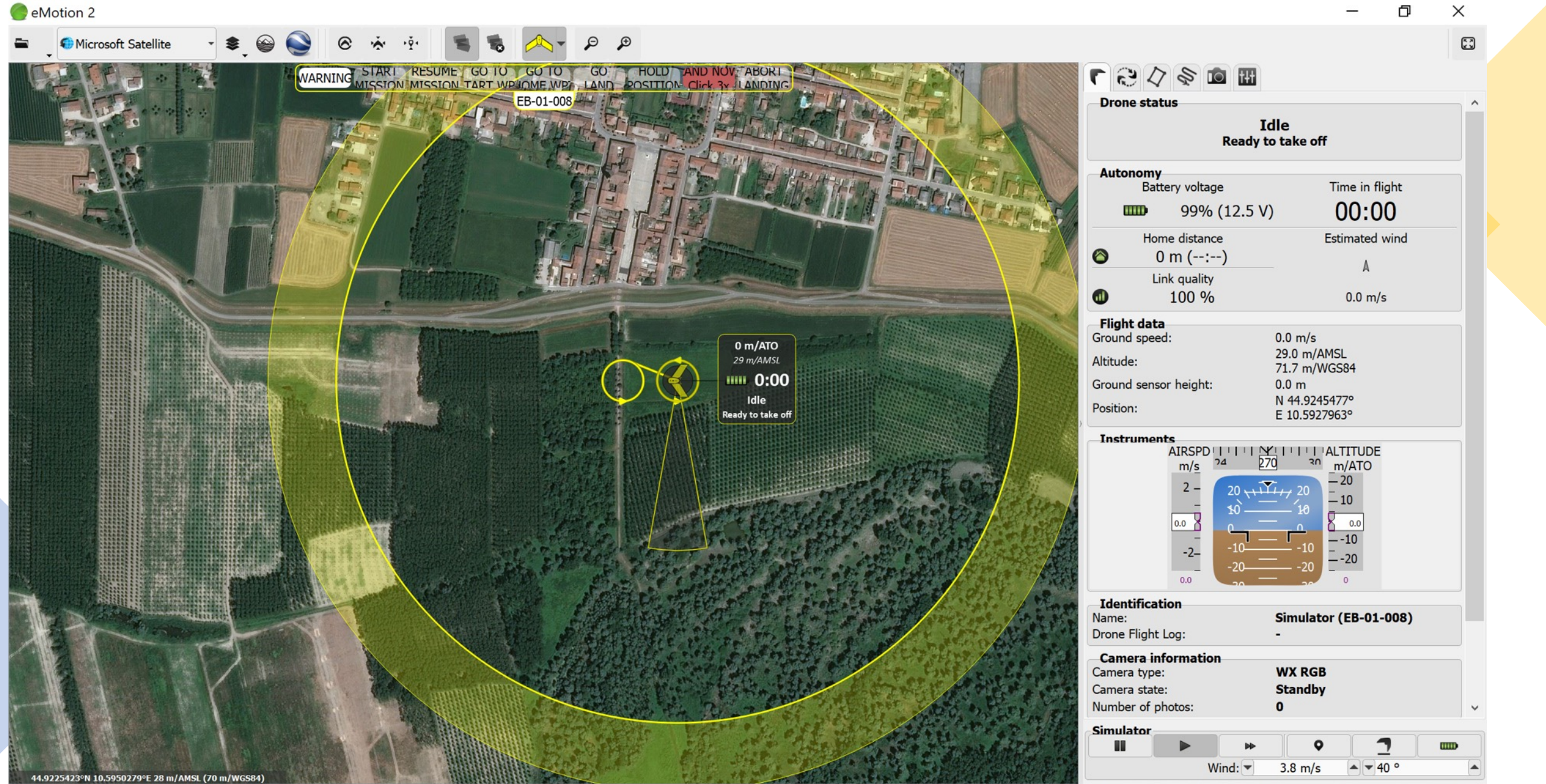
- Ogni drone è dotato di un proprio software, i voli fotogrammetrici solitamente si eseguono con volo automatico.

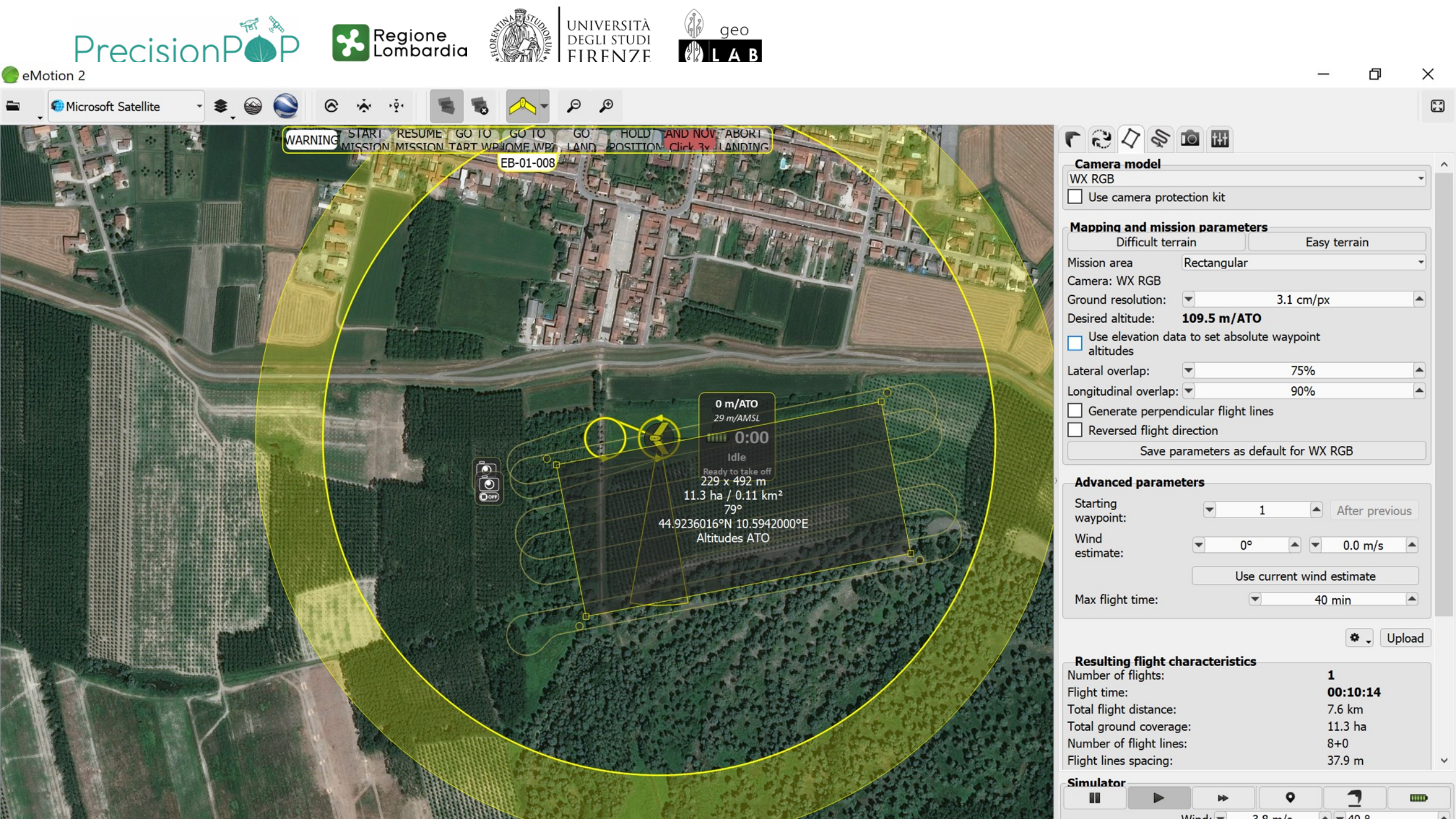
Esempi di sofware di pianificazione del volo

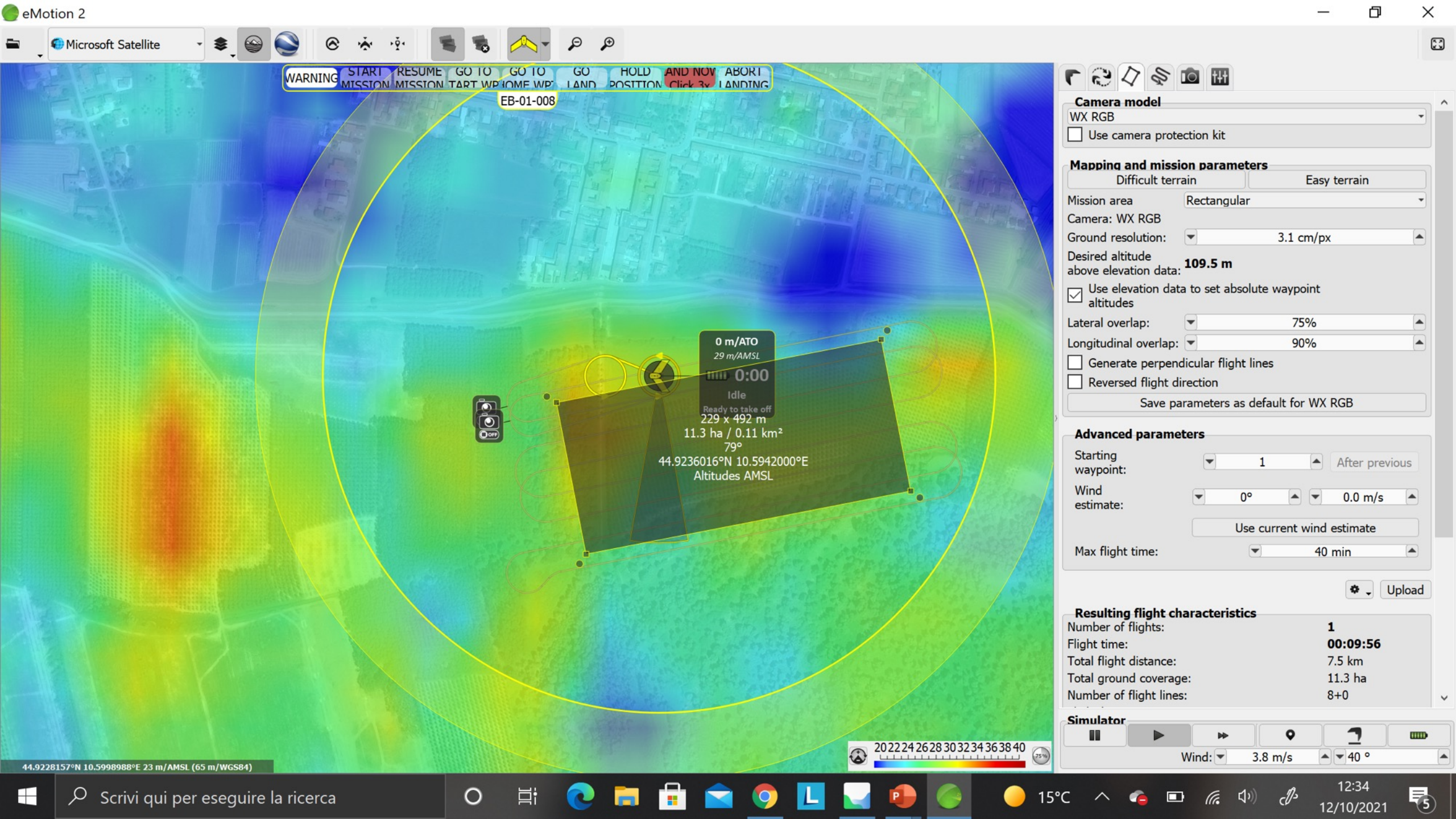
Pixar4D capture – DJI Phantom, DJI Mavic, Parrot ANAFI….
eMontion – Sensfly ebee
WINGRA HUB – Wingrtra

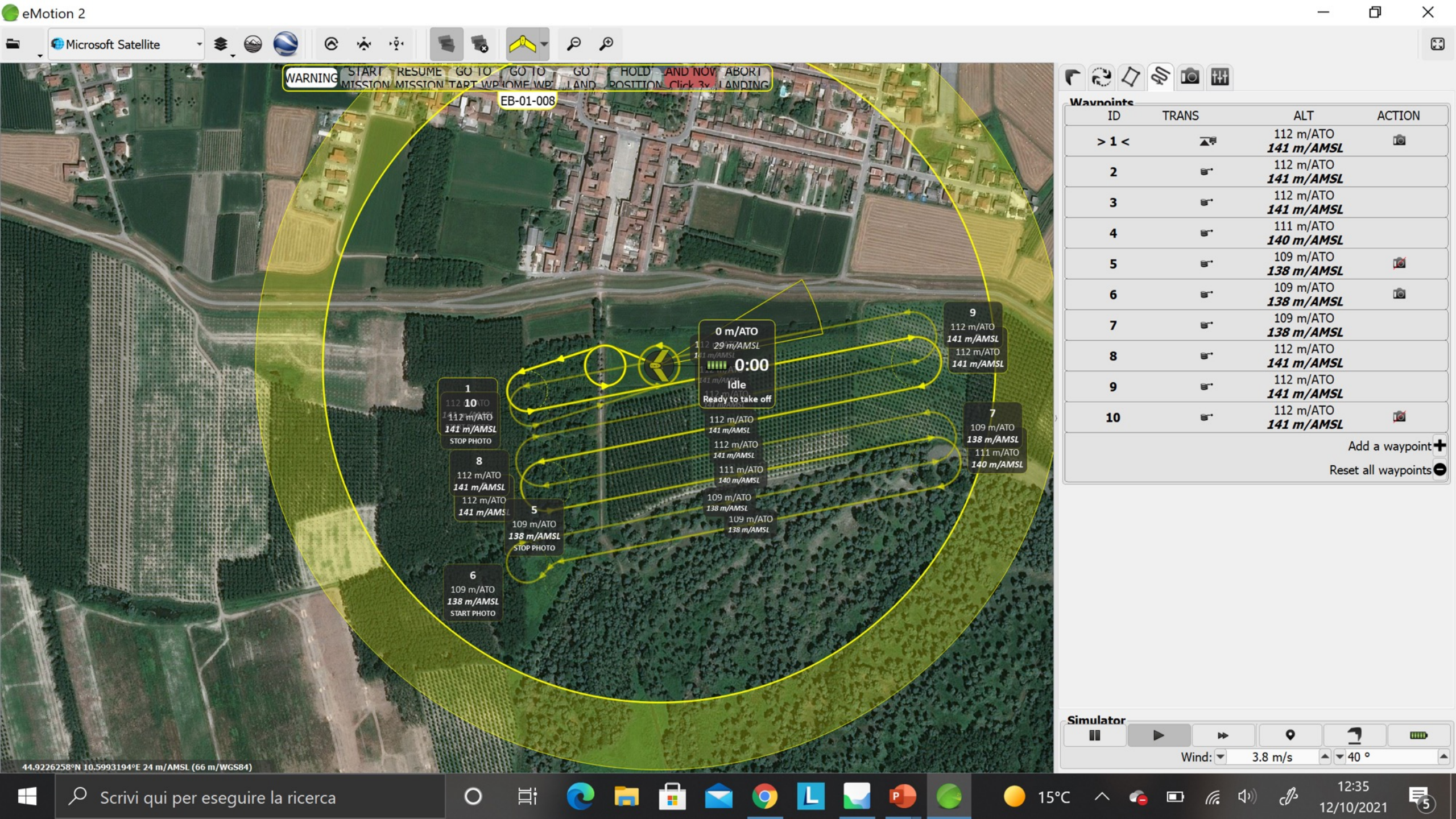
Sono tutti molto simili alcuni consentono di variare in automatico la quota di volo sulla base di DTM, altri necessitano di aggiustamento manuale dei punti di quota di volo

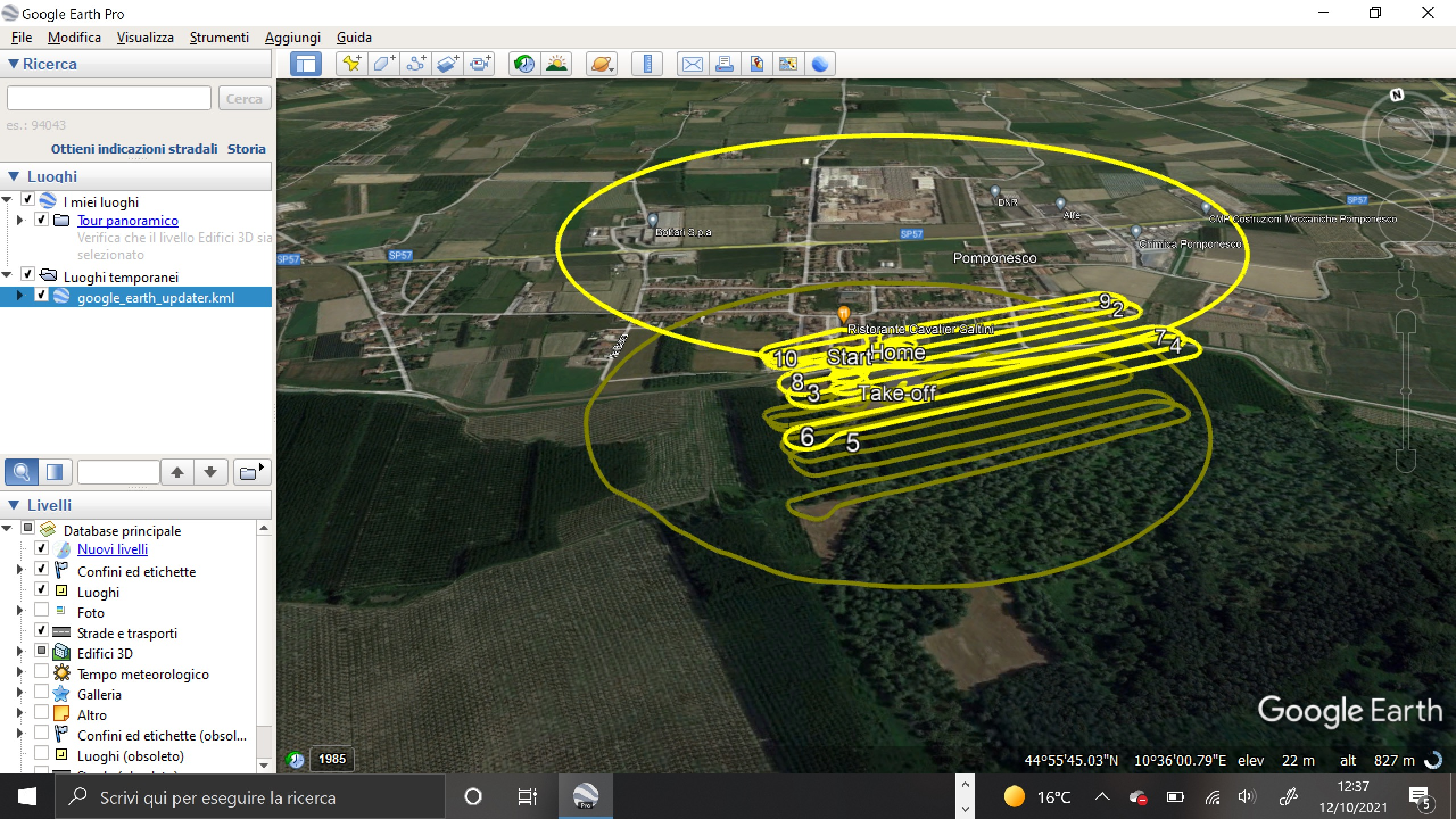



eMotion 2
Microsoft Satellite
WARNING
START MISSION
RESUME MISSION
GO TO TART WP
GO TO HOME WP
GO LAND
HOLD POSITION
AND NOV
Click 3x
ABORT LANDING
EB-01-008
0 m/ATO
29 m/AMSL
0:00
Idle
Ready to take off
44.9225423°N 10.5950279°E 28 m/AMSL (70 m/WGS84)
Drone status
Idle
Ready to take off
Autonomy
Battery voltage
99% (12.5 V)
Time in flight
00:00
Home distance
0 m (--:--)
Estimated wind
Link quality
100 %
0.0 m/s
Flight data
Ground speed:
0.0 m/s
Altitude:
29.0 m/AMSL
71.7 m/WGS84
Ground sensor height:
0.0 m
Position:
N 44.9245477°
E 10.5927963°
Instruments
AIRSPD
m/s
ALTITUDE
m/ATO
Identification
Name:
Simulator (EB-01-008)
Drone Flight Log:
-
Camera information
Camera type:
WX RGB
Camera state:
Standby
Number of photos:
0
Simulator
Wind:
3.8 m/s
40 °


PrecisionPOP
Regione Lombardia
UNIVERSITÀ DEGLI STUDI FIRENZE
geo LAB
eMotion 2
Microsoft Satellite
WARNING
START MISSION
RESUME MISSION
GO TO START WP
GO TO HOME WP
GO LAND
HOLD POSITION
ABORT AND NOW Click 3x LANDING
EB-01-008
0 m/ATO
29 m/AMSL
0:00
Idle
Ready to take off
229 x 492 m
11.3 ha / 0.11 km²
79°
44.9236016°N 10.5942000°E
Altitudes ATO
Camera model
WX RGB
Use camera protection kit
Mapping and mission parameters
Difficult terrain
Easy terrain
Mission area
Rectangular
Camera: WX RGB
Ground resolution:
3.1 cm/px
Desired altitude:
109.5 m/ATO
Use elevation data to set absolute waypoint altitudes
Lateral overlap:
75%
Longitudinal overlap:
90%
Generate perpendicular flight lines
Reversed flight direction
Save parameters as default for WX RGB
Advanced parameters
Starting waypoint:
1
After previous
Wind estimate:
0°
0.0 m/s
Use current wind estimate
Max flight time:
40 min
Upload
Resulting flight characteristics
Number of flights:
1
Flight time:
00:10:14
Total flight distance:
7.6 km
Total ground coverage:
11.3 ha
Number of flight lines:
8+0
Flight lines spacing:
37.9 m
Simulator


eMotion 2
Microsoft Satellite
WARNING
START MISSION
RESUME MISSION
GO TO TART WP
GO TO OME WP
GO LAND
HOLD POSITION
AND NOW Click 3x
ABORT LANDING
EB-01-008
0 m/ATO
29 m/AMSL
0:00
Idle
Ready to take off
229 x 492 m
11.3 ha / 0.11 km²
79°
44.9236016°N 10.5942000°E
Altitudes AMSL
Camera model
WX RGB
Use camera protection kit
Mapping and mission parameters
Difficult terrain
Easy terrain
Mission area
Rectangular
Camera: WX RGB
Ground resolution:
3.1 cm/px
Desired altitude above elevation data:
109.5 m
Use elevation data to set absolute waypoint altitudes
Lateral overlap:
75%
Longitudinal overlap:
90%
Generate perpendicular flight lines
Reversed flight direction
Save parameters as default for WX RGB
Advanced parameters
Starting waypoint:
1
After previous
Wind estimate:
0°
0.0 m/s
Use current wind estimate
Max flight time:
40 min
Upload
Resulting flight characteristics
Number of flights:
1
Flight time:
00:09:56
Total flight distance:
7.5 km
Total ground coverage:
11.3 ha
Number of flight lines:
8+0
Simulator
Wind:
3.8 m/s
40 °
20 22 24 26 28 30 32 34 36 38 40
44.9228157°N 10.5998988°E 23 m/AMSL (65 m/WGS84)
Scrivi qui per eseguire la ricerca
15°C
12:34
12/10/2021

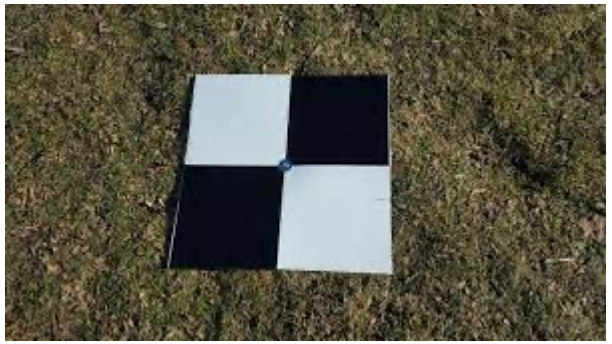

eMotion 2
Microsoft Satellite
WARNING
START MISSION
RESUME MISSION
GO TO START WP
GO TO HOME WP
GO LAND
HOLD POSITION
LAND NOW Click 3x
ABORT LANDING
EB-01-008
Waypoints
ID
TRANS
ALT
ACTION
> 1 <
112 m/ATO
141 m/AMSL
2
112 m/ATO
141 m/AMSL
3
112 m/ATO
141 m/AMSL
4
111 m/ATO
140 m/AMSL
5
109 m/ATO
138 m/AMSL
6
109 m/ATO
138 m/AMSL
7
109 m/ATO
138 m/AMSL
8
112 m/ATO
141 m/AMSL
9
112 m/ATO
141 m/AMSL
10
112 m/ATO
141 m/AMSL
Add a waypoint
Reset all waypoints
0 m/ATO
29 m/AMSL
0:00
Idle
Ready to take off
1
10
112 m/ATO
141 m/AMSL
STOP PHOTO
8
112 m/ATO
141 m/AMSL
5
109 m/ATO
138 m/AMSL
STOP PHOTO
6
109 m/ATO
138 m/AMSL
START PHOTO
9
112 m/ATO
141 m/AMSL
7
109 m/ATO
138 m/AMSL
111 m/ATO
140 m/AMSL
Simulator
Wind:
3.8 m/s
40 °
44.9226258°N 10.5993194°E 24 m/AMSL (66 m/WGS84)
Scrivi qui per eseguire la ricerca
15°C
12:35
12/10/2021


Google Earth Pro
File Modifica Visualizza Strumenti Aggiungi Guida
Ricerca
Cerca
es.: 94043
Ottieni indicazioni stradali Storia
Luoghi
I miei luoghi
Tour panoramico
Verifica che il livello Edifici 3D sia selezionato
Luoghi temporanei
google_earth_updater.kml
Livelli
Database principale
Nuovi livelli
Confini ed etichette
Luoghi
Foto
Strade e trasporti
Edifici 3D
Tempo meteorologico
Galleria
Altro
Confini ed etichette (obsol...
Luoghi (obsoleto)
Pomponesco
Ristorante Cavalier Saltini
Start Home
Take-off
10
9
2
7
4
8
3
6
5
SP57
DKR
Alfe
CMP Costruzioni Meccaniche Pomponesco
Chimica Pomponesco
Google Earth
1985
44°55'45.03"N 10°36'00.79"E elev 22 m alt 827 m
Scrivi qui per eseguire la ricerca
16°C
12:37
12/10/2021

GEOREFERENZIAZIONE DEL VOLO

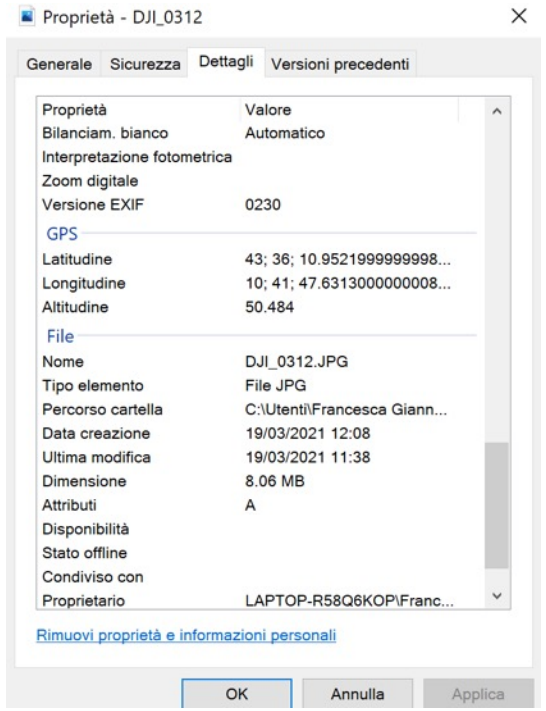
PRIMA DI EFFETTUARE IL VOLO

Acquisizione Ground Control Point con target – Con ricevitore GNSS topografico



UNA VOLTA ACQUISITE LE IMMAGINI

Geotag delle immagini – utilizzando il software di volo



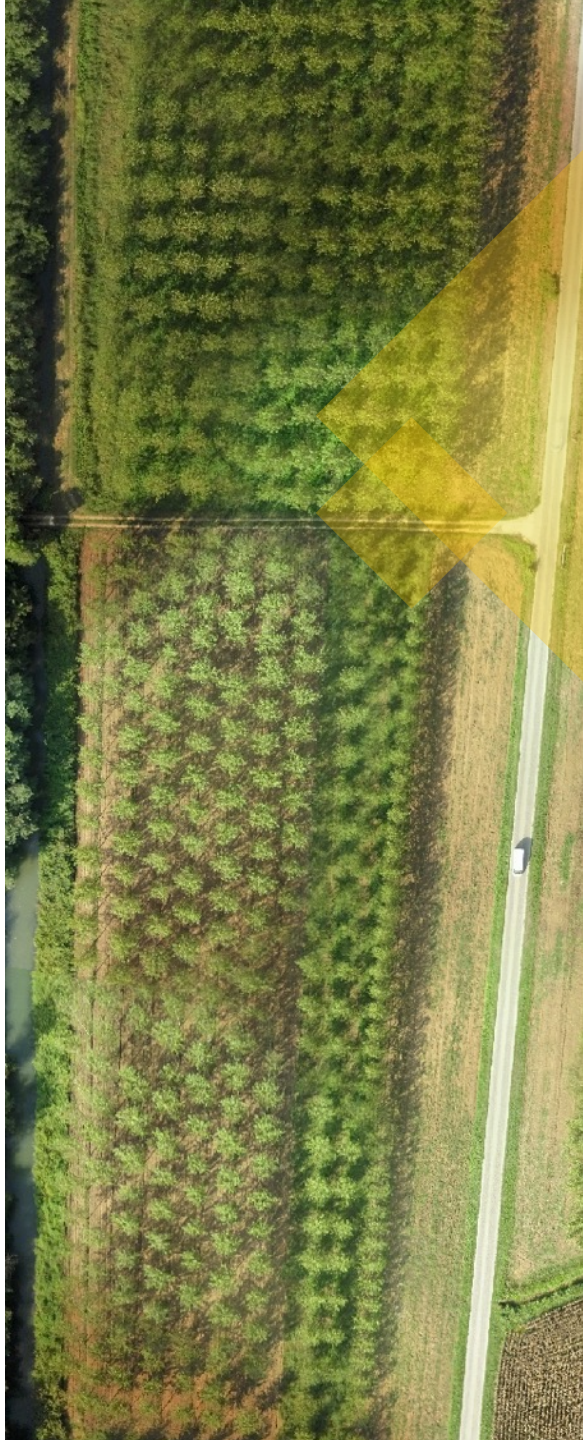


Image Based Modelling

Workflow Agisoft Photoscan / Metashape

Basic Workflow:

Align Photos
Build Dense Cloud
Build Mesh
Build Texture
Build Orthomosaic

Export Model
Generate Report

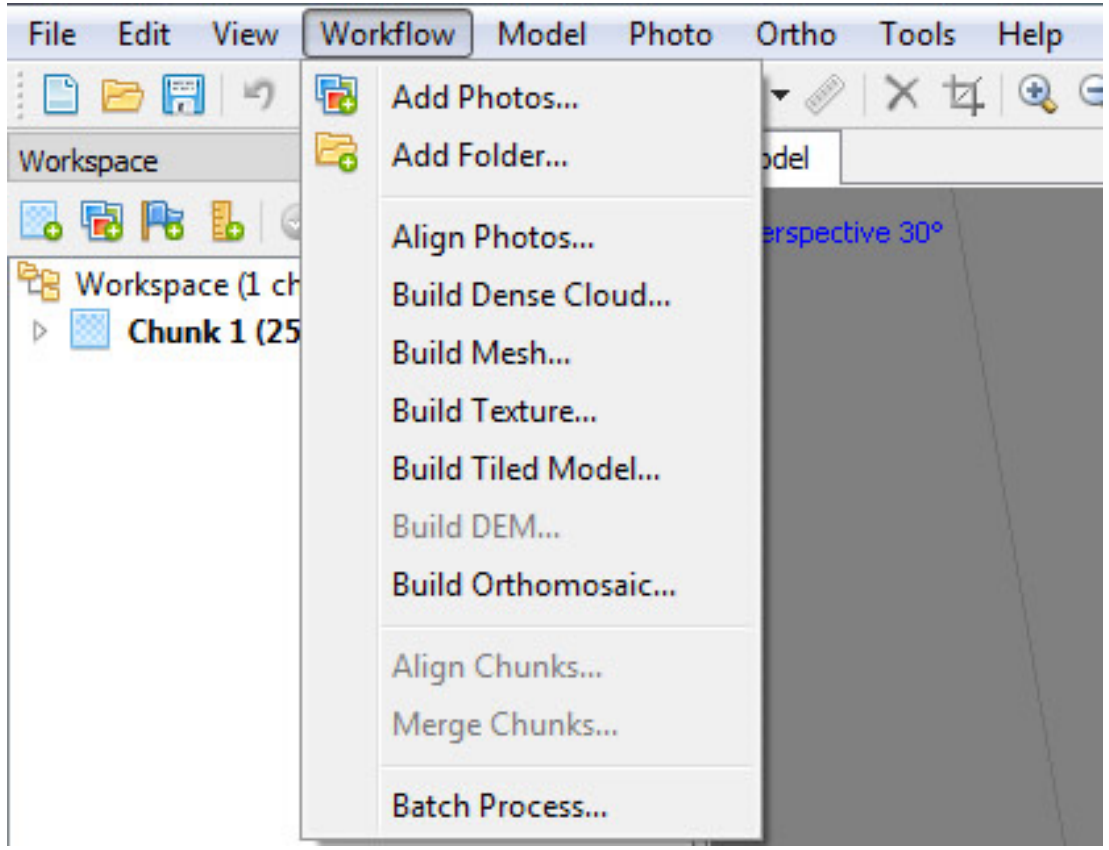
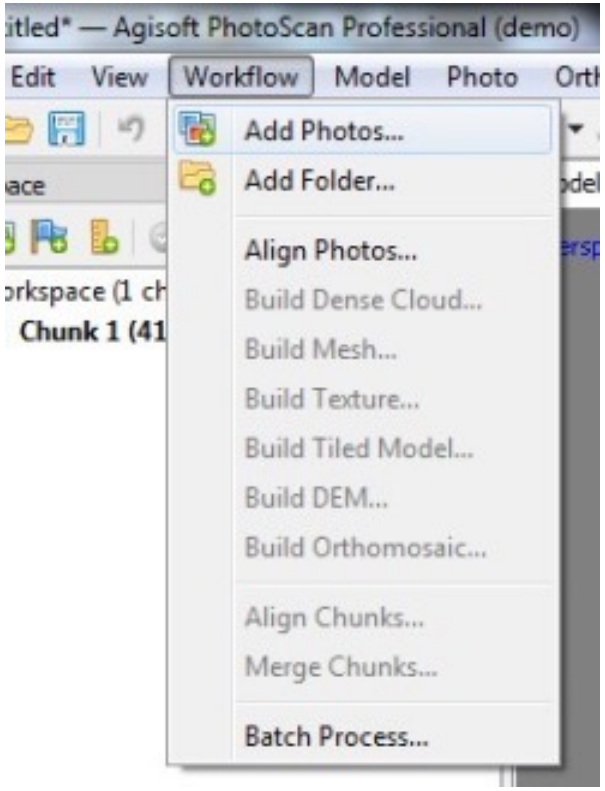
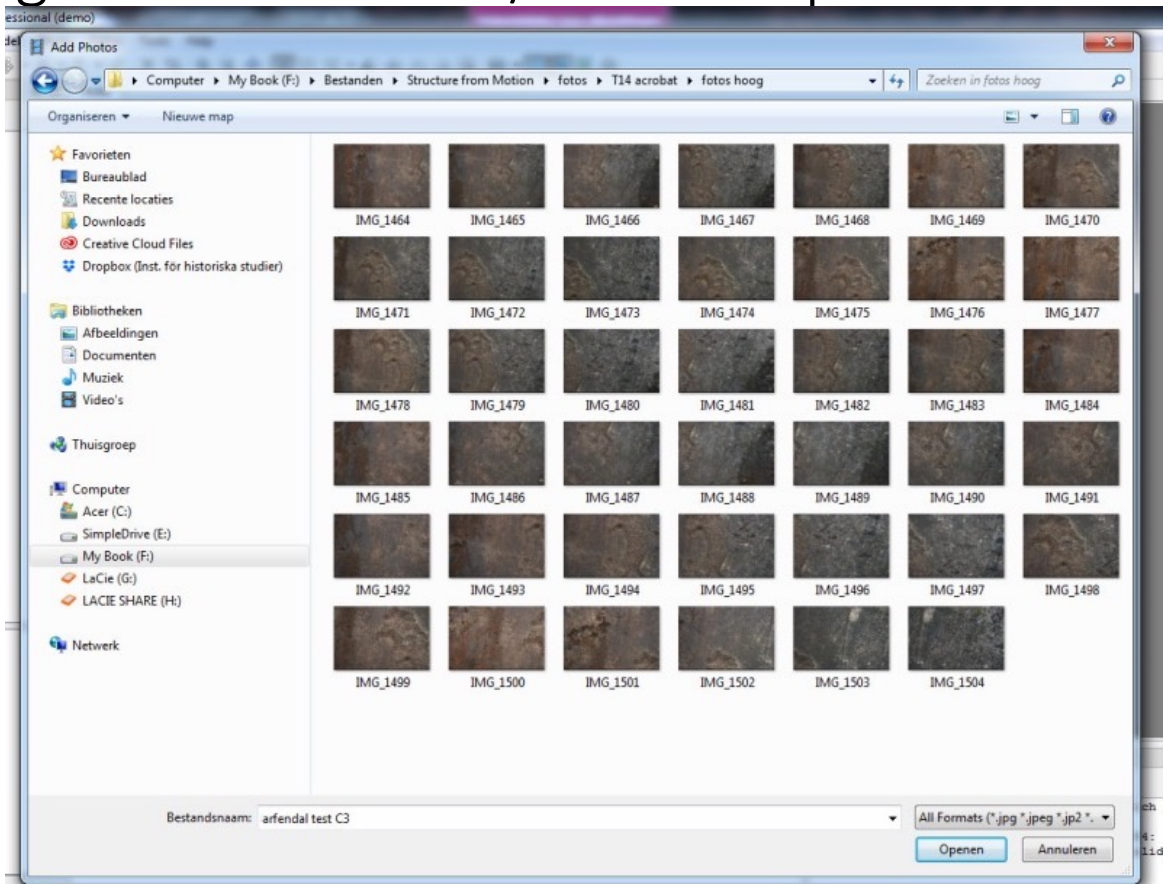


Image Based Modelling

Workflow Agisoft Photoscan / Metashape





“Workflow”- “Add photos”.

Image Based Modelling

Workflow Agisoft Photoscan / Metashape

Check quality of the photographs

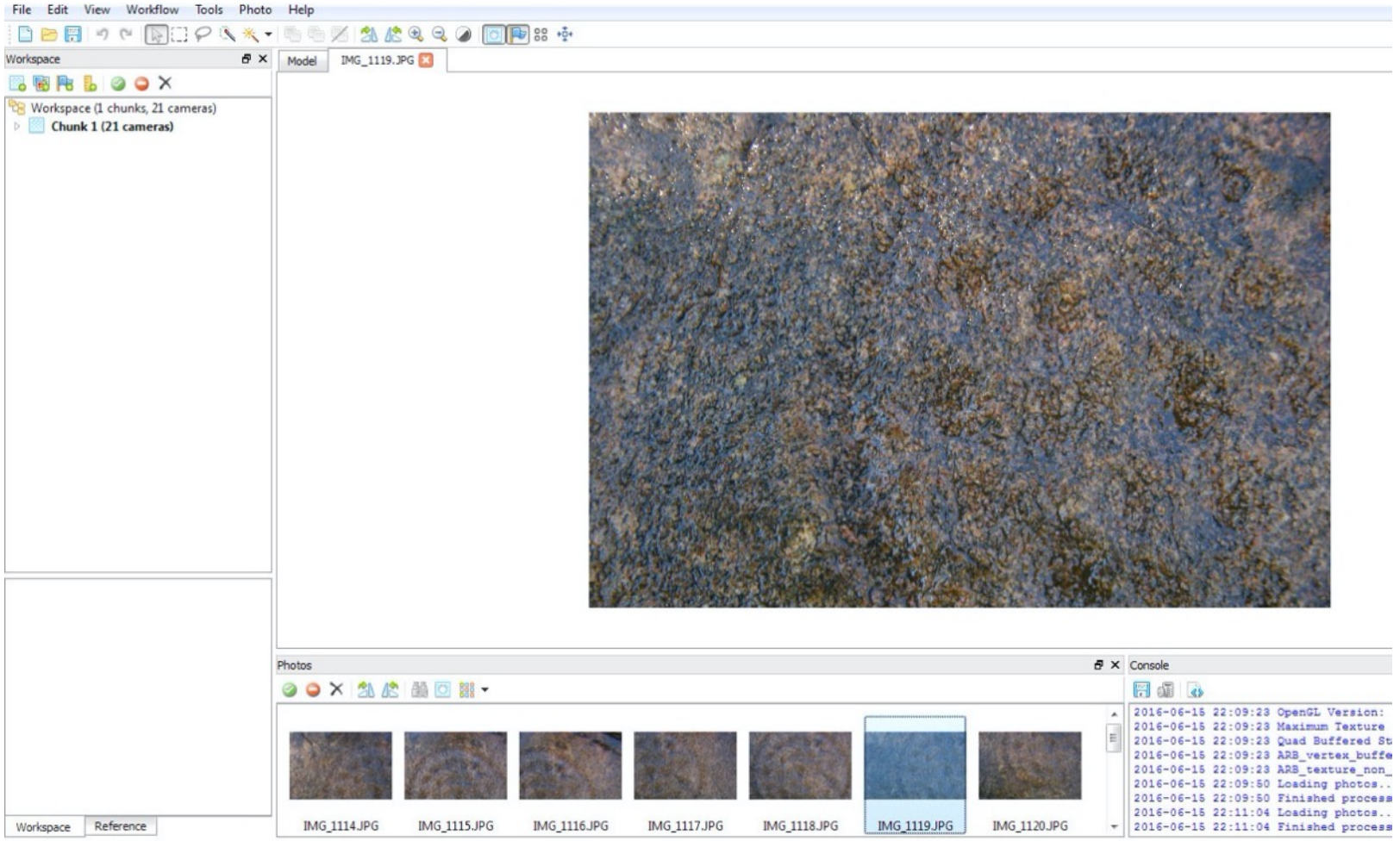


Image Based Modelling

Workflow Agisoft Photoscan / Metashape

Check quality of the photographs

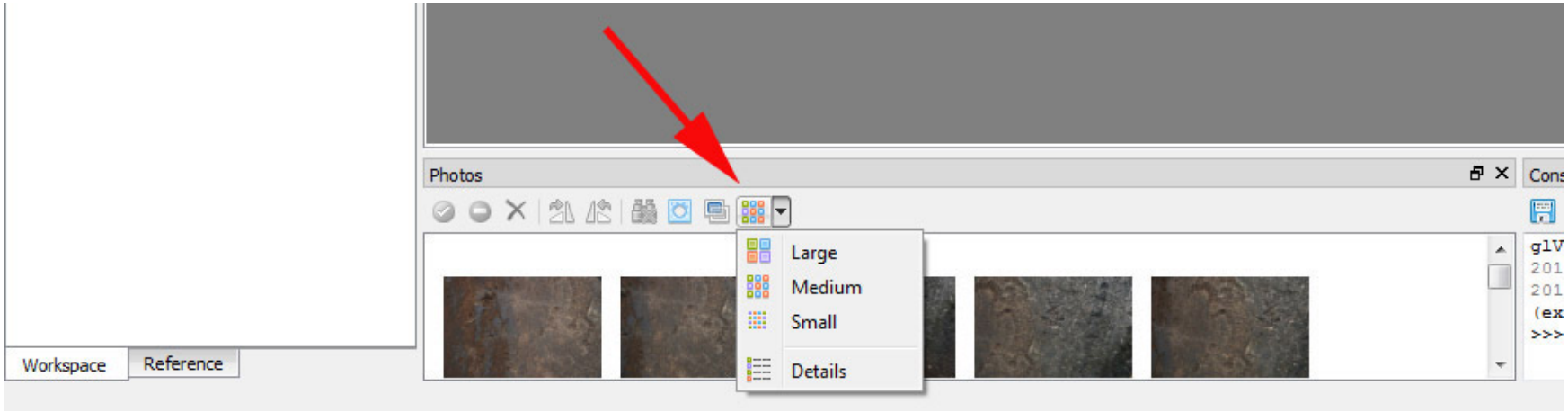
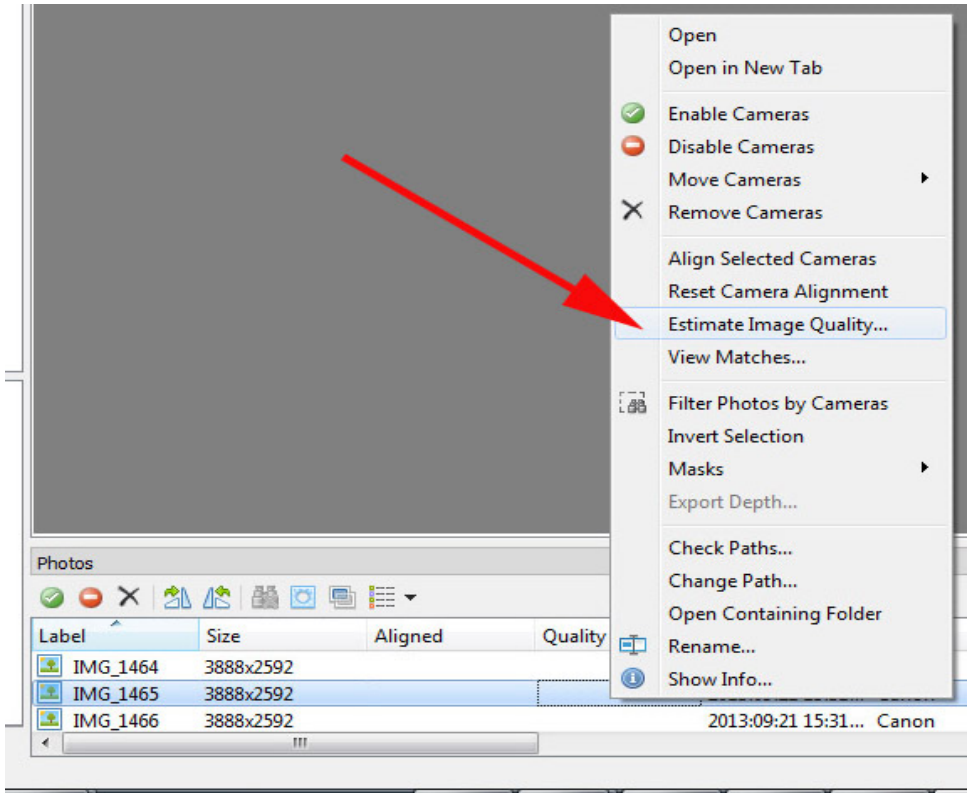


Image Based Modelling

Workflow Agisoft Photoscan / Metashape

Check quality of the photographs

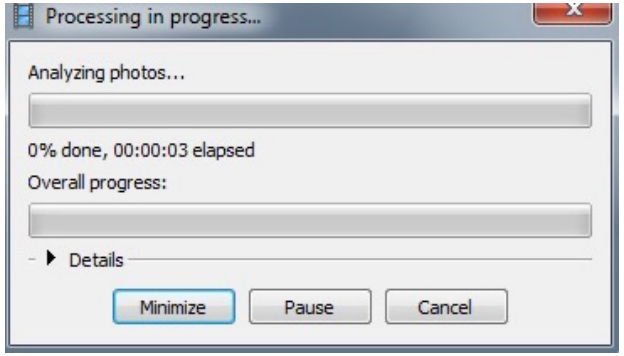


Estimate Image Quality. Set parameters to “Apply to “all cameras”, Click “OK”

Image Based Modelling

Workflow Agisoft Photoscan / Metashape

Check quality of the photographs



Agisoft stima la qualità delle immagini

Le foto qualificate sotto 0.5 or vengono rimosse o disabilitate.

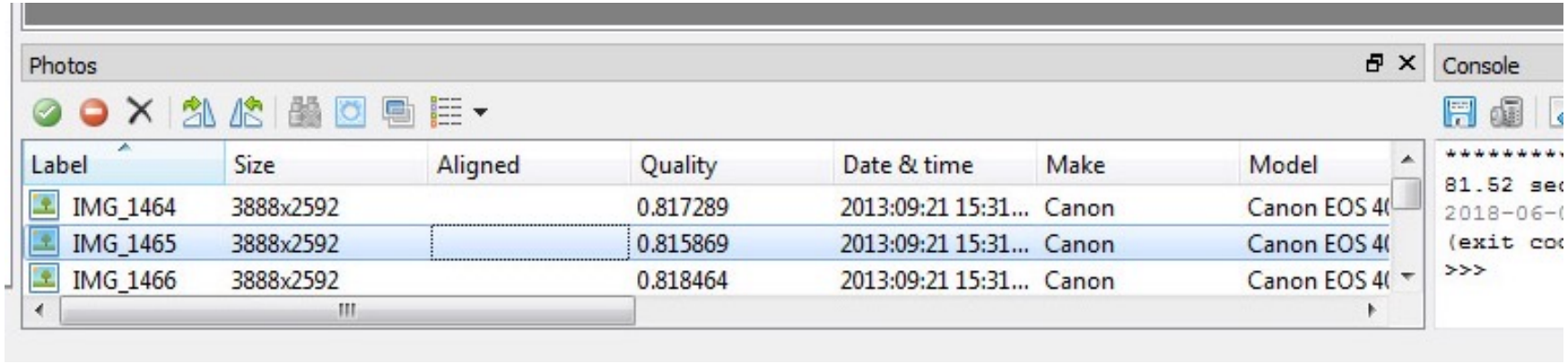
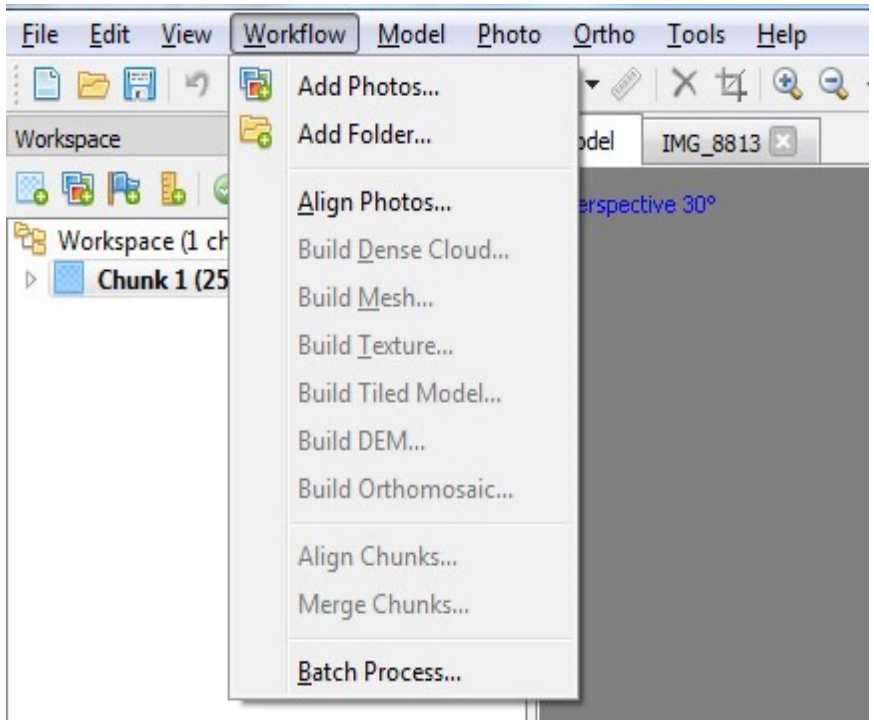
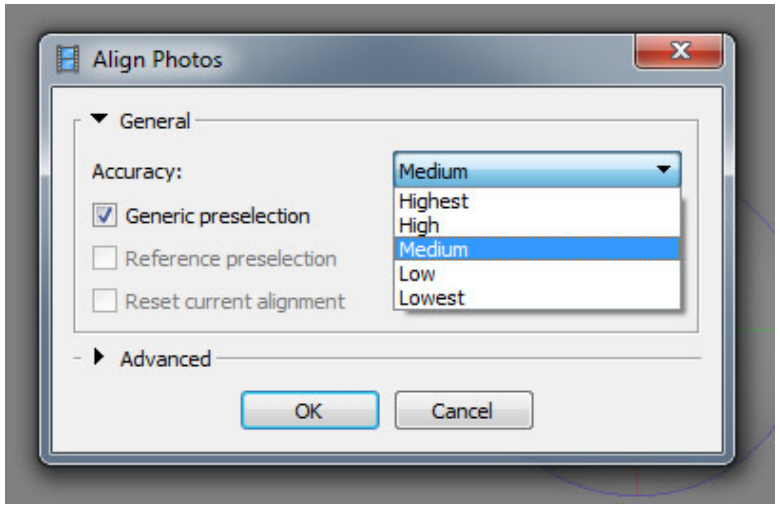


Image Based Modelling

Workflow Agisoft Photoscan / Metashape

Alignment and Point Cloud Creation





Choose “Align Photos” in the “Workflow” menu and set Accuracy on “High”.

L’allineamnto solitamente necessita di un po’ di tempo tra I 20 e le 2 ore dipende dalla numerosità delle foto.

Image Based Modelling

Workflow Agisoft Photoscan / Metashape

alignment and point cloud creation

Structure from Motion (SfM)

Matches the unique pixels from each photograph

Aligns images based on the unique pixels

Estimates camera positions

Creates a sparse point cloud

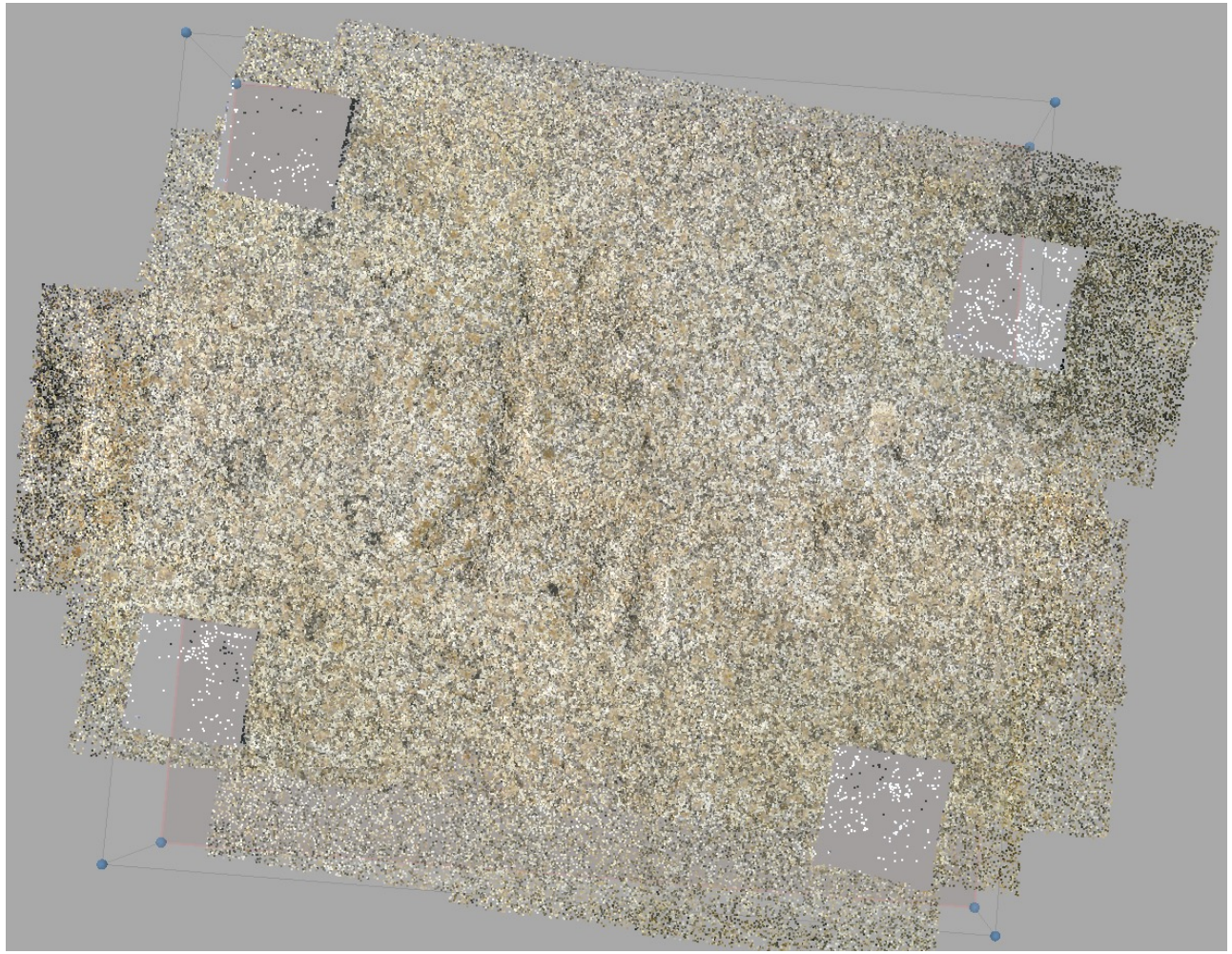
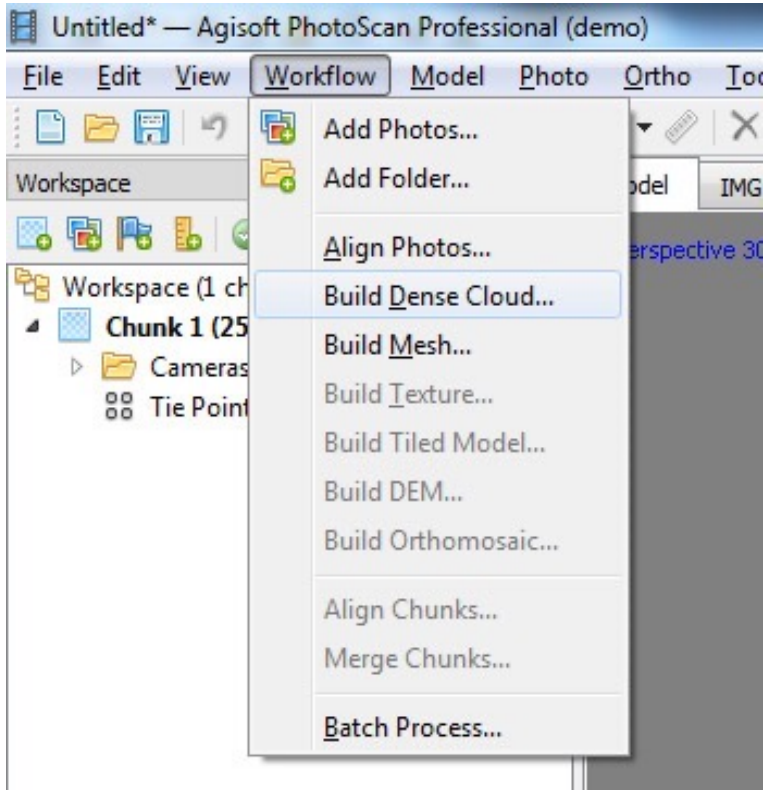
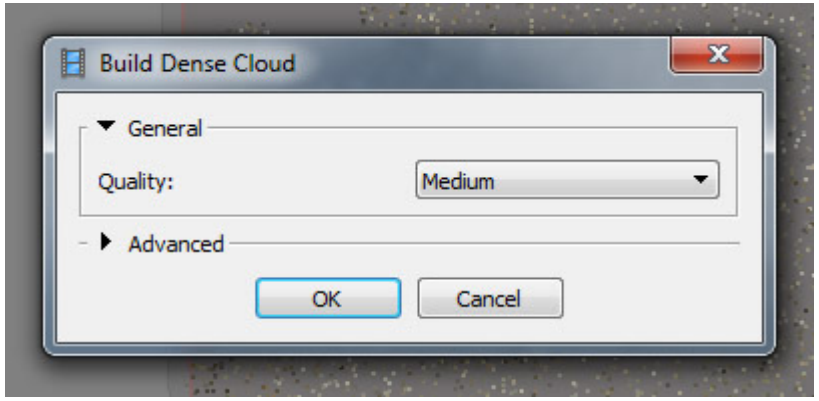


Image Based Modelling

Workflow Agisoft Photoscan / Metashape

Build Dense Cloud





Choose build dense cloud in the "Workflow" menu, set the Quality on Medium and press OK

Questa è la parte che richiede più tempo di tutte. Dipende molto dalla qualità delle foto e può durare diverse ore o giorni, a seconda delle potenze di calcolo del computer.

Image Based Modelling
Workflow Agisoft Photoscan / Metashape

Multi View Stereo (MVS)

Computes the depth for every pixel in an image

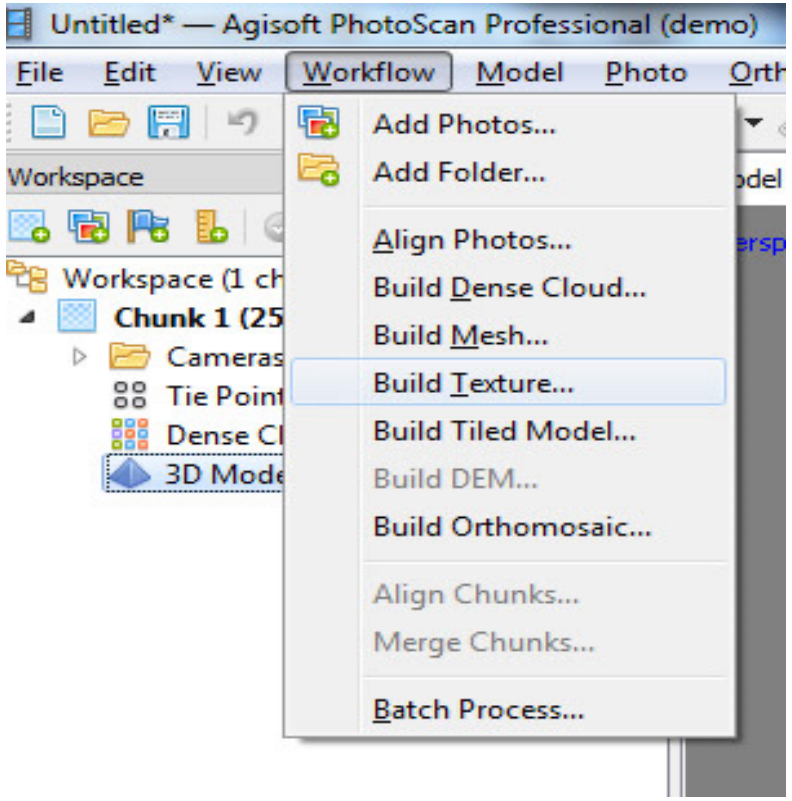
Merges the depth maps created for every image into one 3D model

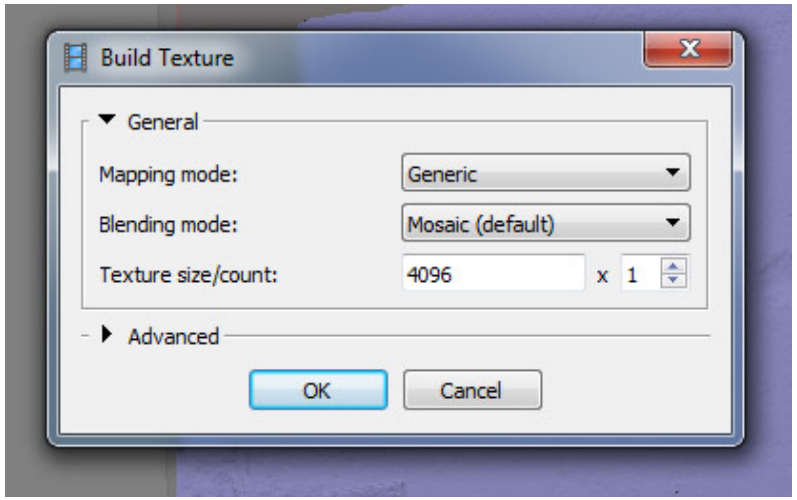
Creates a dense pointcloud which is meshed as a surface model

Image Based Modelling

Workflow Agisoft Photoscan / Metashape

Build Texture



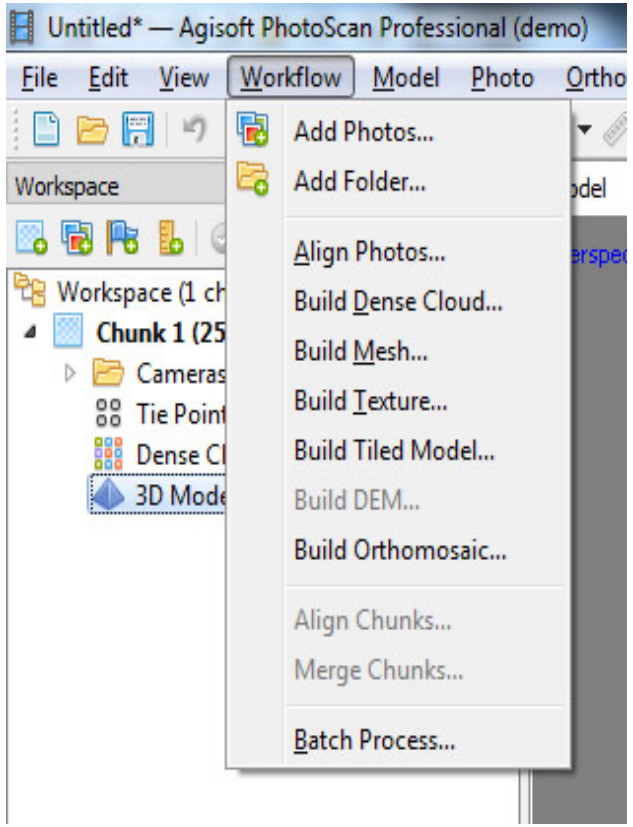


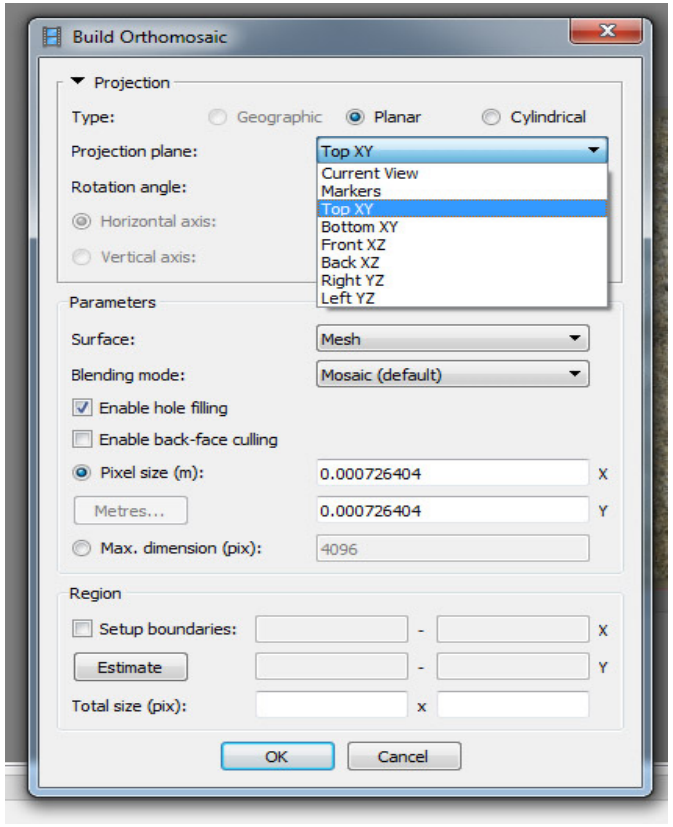
Choose build texture in the “Workflow” menu. Mapping mode should be Generic and the Blending mode should be Mosaic. Press OK

Image Based Modelling

Workflow Agisoft Photoscan / Metashape

Build Orthomosaic





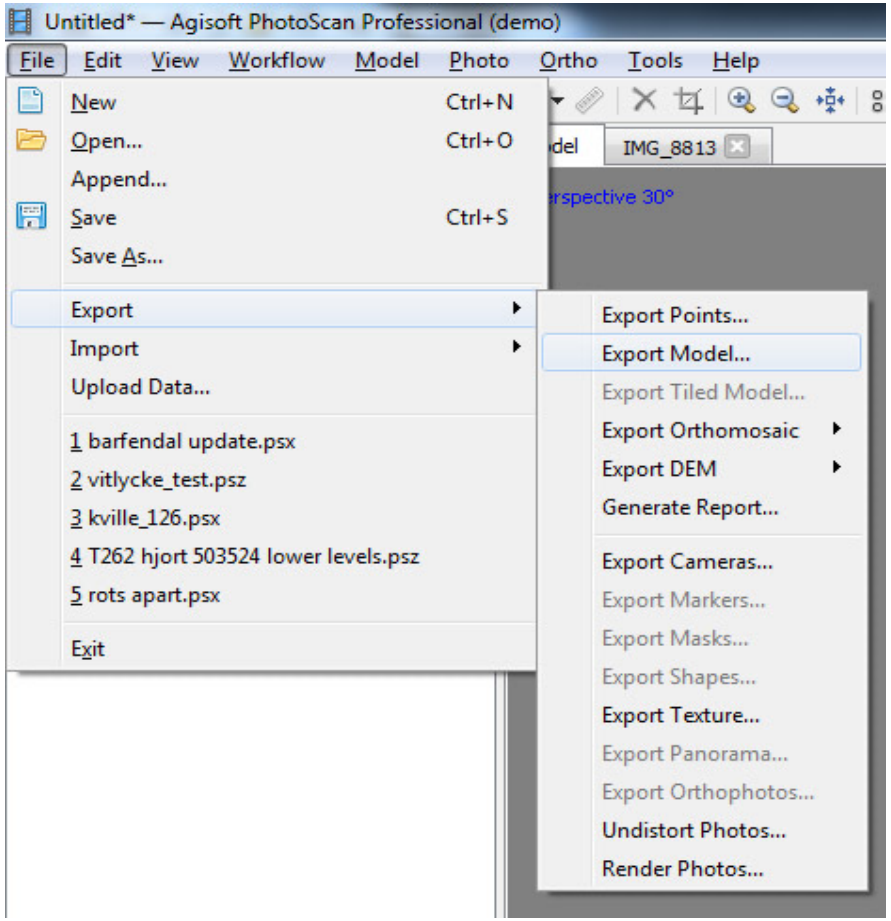
Under “Workflow” choose “Build Orthomosaic” and set projection plane on “Current View”. Press OK

The Orthomosaic is a highly detailed image based on all photographs used for the model

Image Based Modelling

Workflow Agisoft Photoscan / Metashape

Export Model

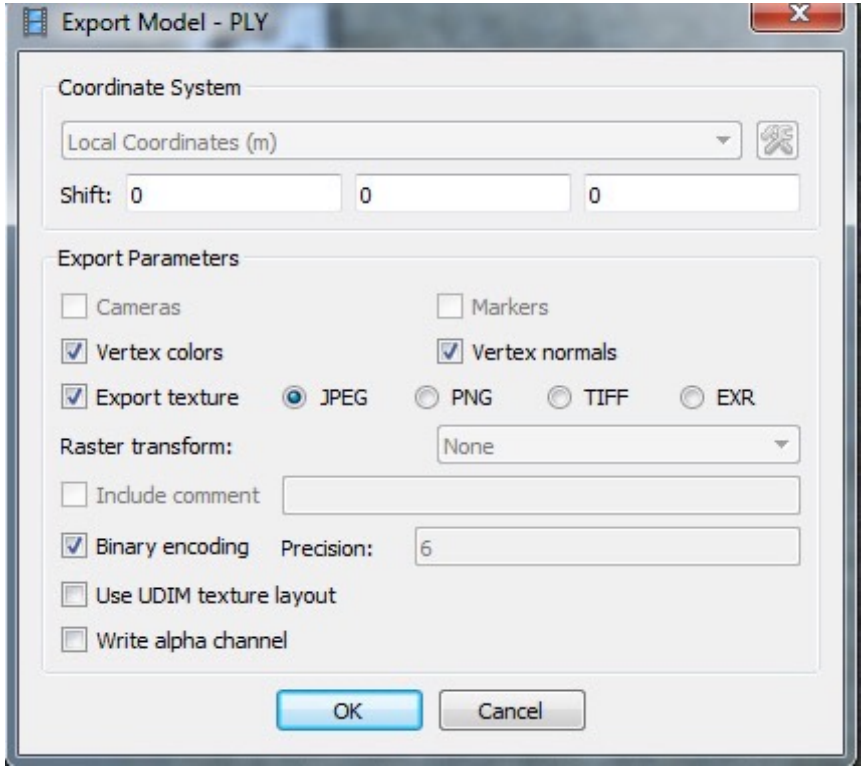


Choose “Export” in the “File” menu and then choose “Export model”.

Image Based Modelling

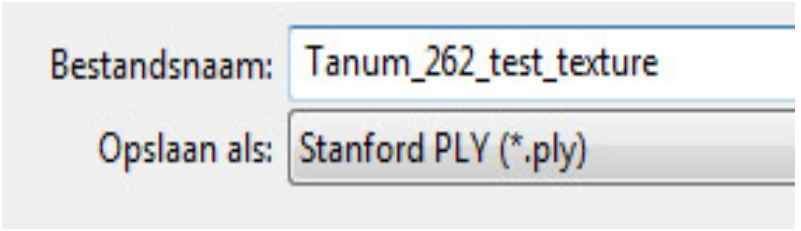
Workflow Agisoft Photoscan / Metashape

Export Model



Export of the model ***with*** texture

When exporting a textured version of the model, make sure that the saving is done without letters such as ä, å and ö and connect each word with "_".

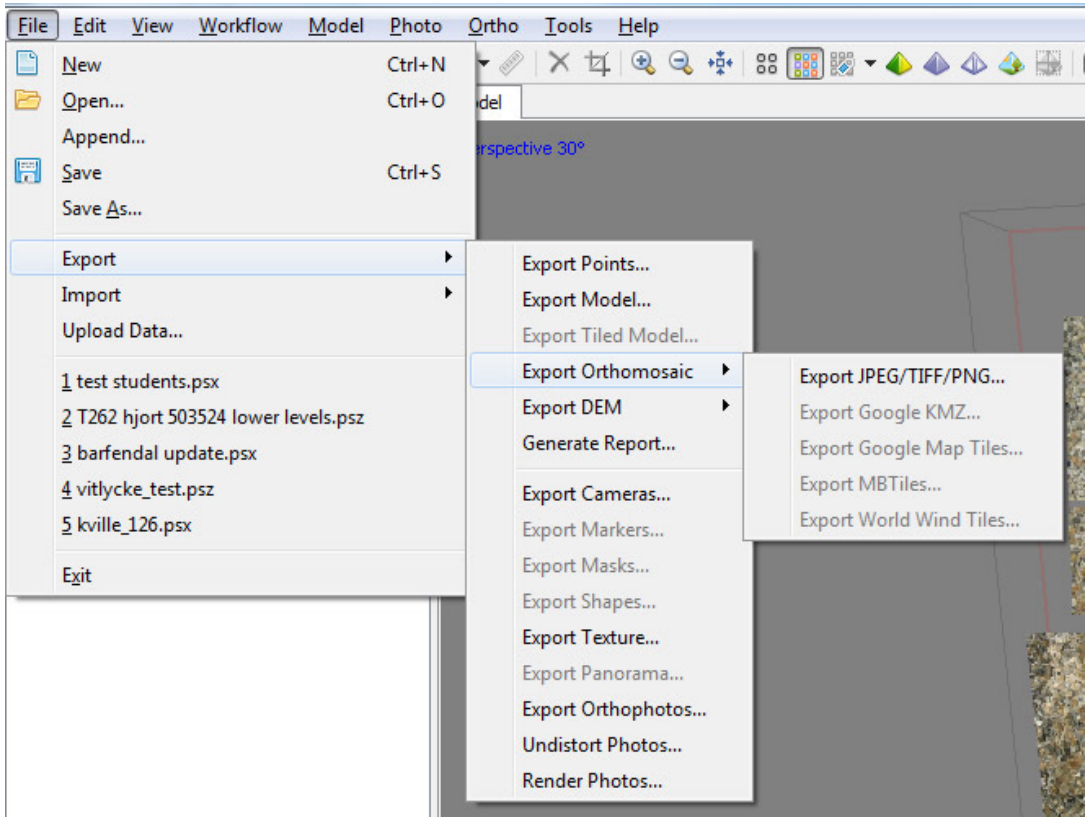


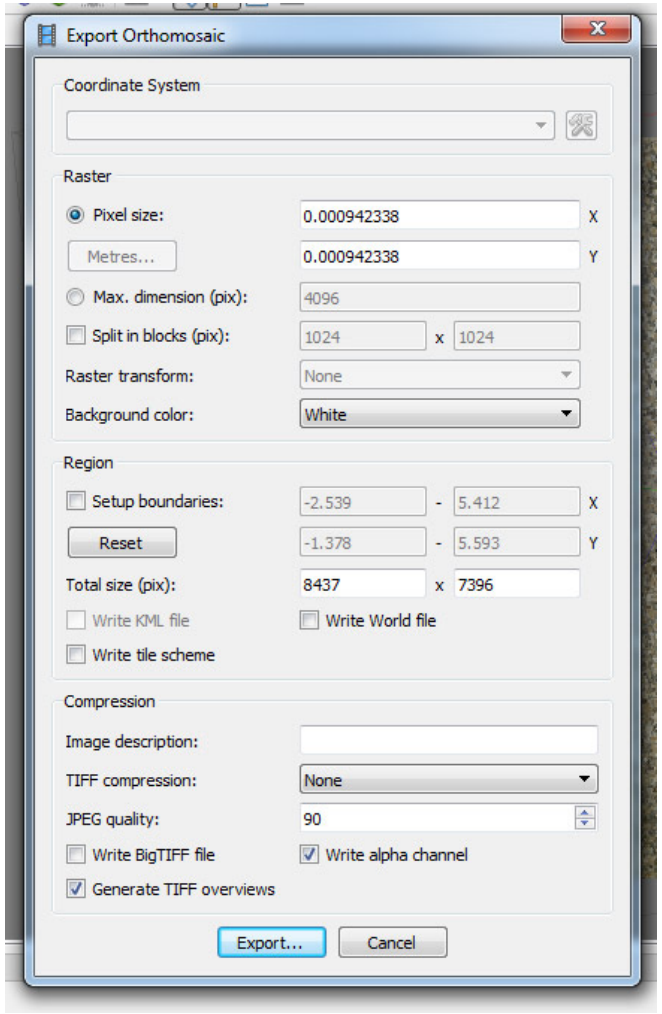
Note that the pane "Export texture"," Vertex colors" and "Vertex normals" are marked.

Image Based Modelling

Workflow Agisoft Photoscan / Metashape

Export Orthomosaic





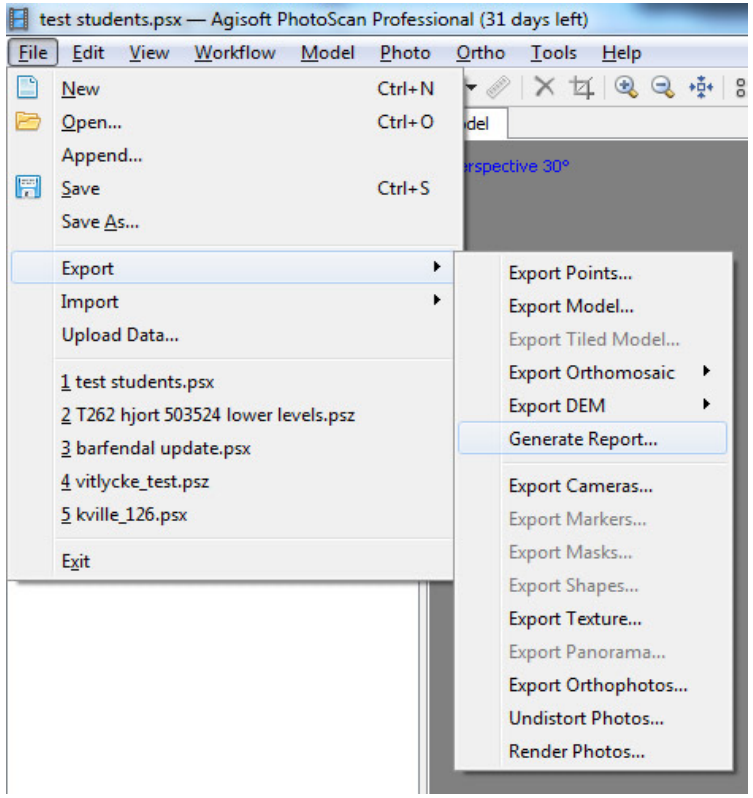
In the export menu choose export orthomosaic.
You can export the image as JPEG, TIFF and PNG.

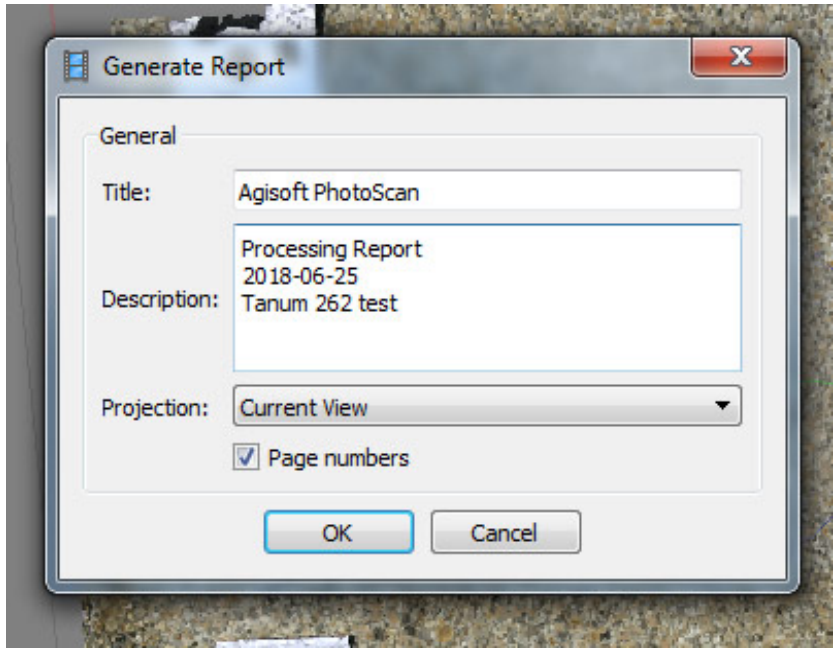
Image Based Modelling

Workflow Agisoft Photoscan / Metashape

Generate report

In the “Export” menu you can also generate a report, with all information regarding the processing, the calibration of the camera, the focal length, amount of photographs, etc.





Make sure you have the projection on “Current View”. The description is optional.

Image Based Modelling

Workflow Agisoft Photoscan / Metashape

Generate report

Agisoft PhotoScan

Processing Report
2018-06-25
Tanum 262 test
06 June 2018

Survey Data

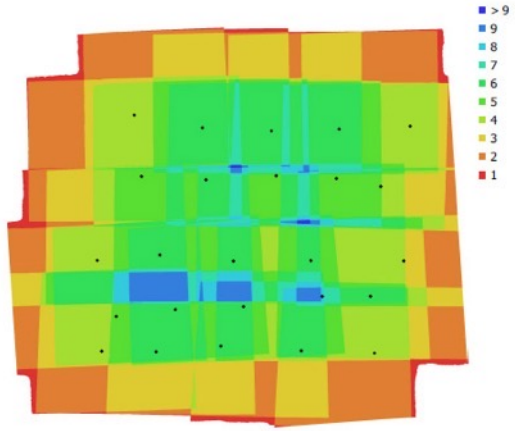


Fig. 1. Camera locations and image overlap.

Number of images:	25	Camera stations:	25
		Tie points:	5,871
		Projections:	23,839
		Reprojection error:	0.332 pix

Camera Model	Resolution	Focal Length	Pixel Size	Precalibrated
Canon EOS 400D DIGITAL (35mm)	3888 x 2592	35 mm	5.72 x 5.72 µm	No

Table 1. Cameras.

Image Based Modelling

Workflow Agisoft Photoscan / Metashape

Generate report

Camera Calibration

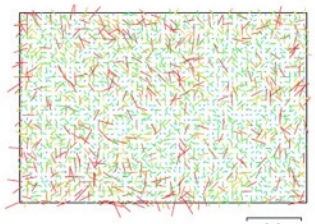


Fig. 2. Image residuals for Canon EOS 400D DIGITAL (35mm).

Canon EOS 400D DIGITAL (35mm)
25 images

Type	Resolution	Focal Length	Pixel Size
Frame	**3888 x 2592**	**35 mm**	**5.72 x 5.72 µm**

	Value	Error	K1	K2	P1	P2
F	6122.83					
K1	0.0161303	0.00045	1.00	-0.45	0.23	0.18
K2	0.434736	0.0019		1.00	0.03	0.03
P1	-0.000303994	6.6e-05			1.00	0.15
P2	-0.0038926	6.3e-05				1.00

Table 2. Calibration coefficients and correlation matrix.

Digital Elevation Model

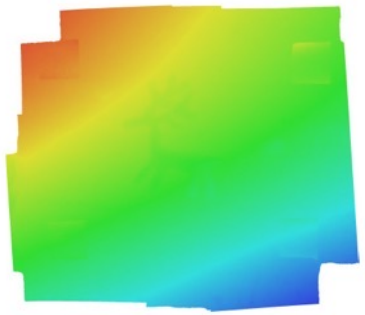
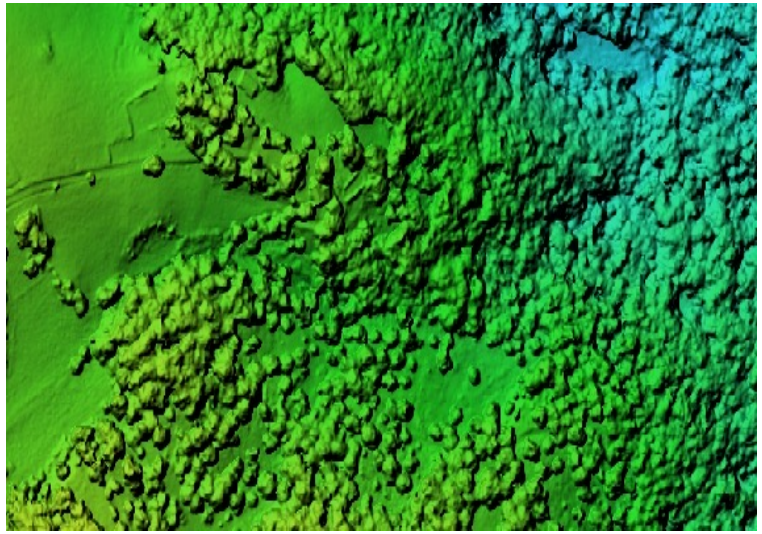


Fig. 3. Reconstructed digital elevation model.

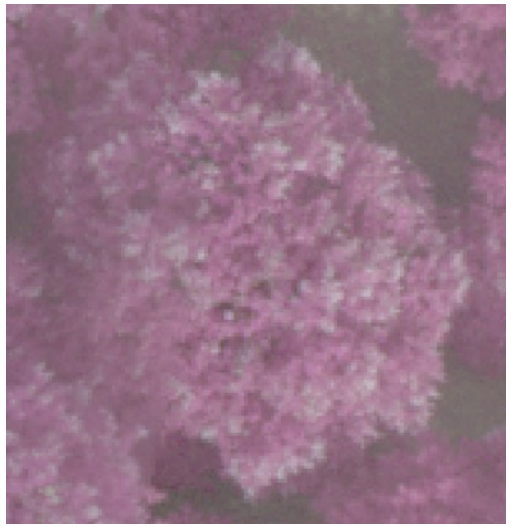
Processing Parameters

General	
Cameras	25
Aligned cameras	25
Coordinate system	Local Coordinates (m)
Rotation angles	Yaw, Pitch, Roll
Point Cloud	
Points	5,871 of 6,173
RMS reprojection error	0.0789383 (0.3322 pix)
Max reprojection error	0.237093 (5.38189 pix)
Mean key point size	4.06289 pix
Point colors	3 bands, uint8
Key points	No
Average tie point multiplicity	4.11809
Alignment parameters	
Accuracy	Medium
Generic preselection	Yes
Key point limit	40,000
Tie point limit	1,000
Adaptive camera model fitting	Yes
Matching time	8 minutes 58 seconds
Alignment time	1 minutes 0 seconds
Dense Point Cloud	
Points	3,576,389
Point colors	3 bands, uint8
Reconstruction parameters	
Quality	Medium
Depth filtering	Aggressive
Depth maps generation time	22 minutes 58 seconds
Dense cloud generation time	1 minutes 16 seconds
Model	
Faces	238,419
Vertices	120,003
Vertex colors	3 bands, uint8
Texture	4,096 x 4,096, 4 bands, uint8
Reconstruction parameters	
Surface type	Arbitrary
Source data	Dense
Interpolation	Enabled
Quality	Medium
Depth filtering	Aggressive
Face count	238,419
Processing time	12 minutes 48 seconds
Texturing parameters	
Mapping mode	Generic
Blending mode	Mosaic
Texture size	4,096 x 4,096
Enable hole filling	Yes
Enable ghosting filter	Yes
UV mapping time	1 minutes 16 seconds
Blending time	8 minutes 4 seconds
Orthomosaic	
Size	8,437 x 7,397
Coordinate system	Local Coordinates (m)
Colors	3 bands, uint8
Reconstruction parameters	

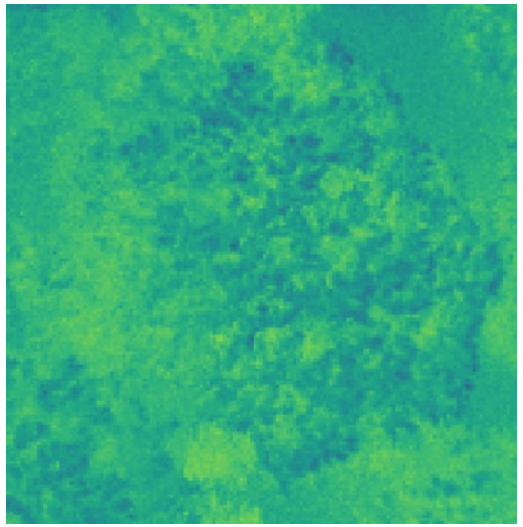
DSM

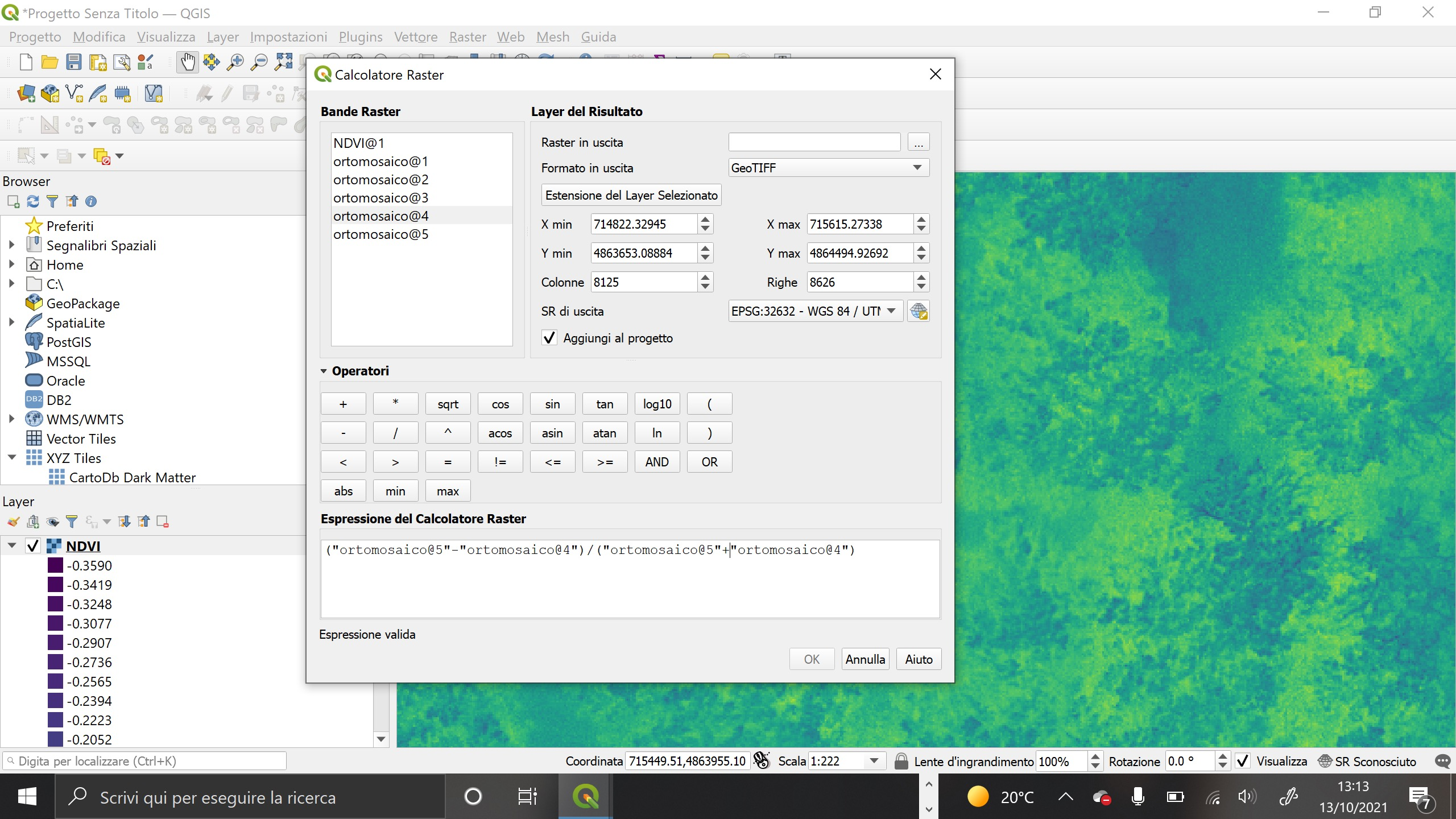


Ortofoto



NDVI derivato




*Progetto Senza Titolo — QGIS
Progetto Modifica Visualizza Layer Impostazioni Plugins Vettore Raster Web Mesh Guida
Calcolatore Raster
Bande Raster
NDVI@1
ortomosaico@1
ortomosaico@2
ortomosaico@3
ortomosaico@4
ortomosaico@5
Layer del Risultato
Raster in uscita
Formato in uscita
GeoTIFF
Estensione del Layer Selezionato
X min 714822.32945
X max 715615.27338
Y min 4863653.08884
Y max 4864494.92692
Colonne 8125
Righe 8626
SR di uscita
EPSG:32632 - WGS 84 / UTI
Aggiungi al progetto
Operatori
+ * sqrt cos sin tan log10 (
- / ^ acos asin atan ln)
< > = != <= >= AND OR
abs min max
Espressione del Calcolatore Raster
("ortomosaico@5"-"ortomosaico@4")/("ortomosaico@5"+"ortomosaico@4")
Espressione valida
OK Annulla Aiuto
Browser
Preferiti
Segnalibri Spaziali
Home
C:\
GeoPackage
SpatiaLite
PostGIS
MSSQL
Oracle
DB2
WMS/WMTS
Vector Tiles
XYZ Tiles
CartoDb Dark Matter
Layer
NDVI
-0.3590
-0.3419
-0.3248
-0.3077
-0.2907
-0.2736
-0.2565
-0.2394
-0.2223
-0.2052
Digita per localizzare (Ctrl+K)
Coordinata 715449.51,4863955.10
Scala 1:222
Lente d'ingrandimento 100%
Rotazione 0.0 °
Visualizza
SR Sconosciuto
Scrivi qui per eseguire la ricerca
20°C
13:13
13/10/2021

Grazie

Francesco Chianucci
Clara Tattoni
Massimiliano Brambilla
Elio Romano
Achille Giorcelli

Grazie dell'attenzione

www.precisionpop.net

Francesca Giannetti
Email – gherardo.chirici@unifi.it
www.geolab.unifi.it