Aerial

ACADEMY

GEOMAX

# TUTORIAL
# AERIAL IMAGE PROCESSING

# X-PHOTO Aerial

## DESCRIPTION

- Create Point Cloud from Images
- Create DSM, Orthophoto and 3D Surface from Point Cloud
- Stereo Drawing Tool

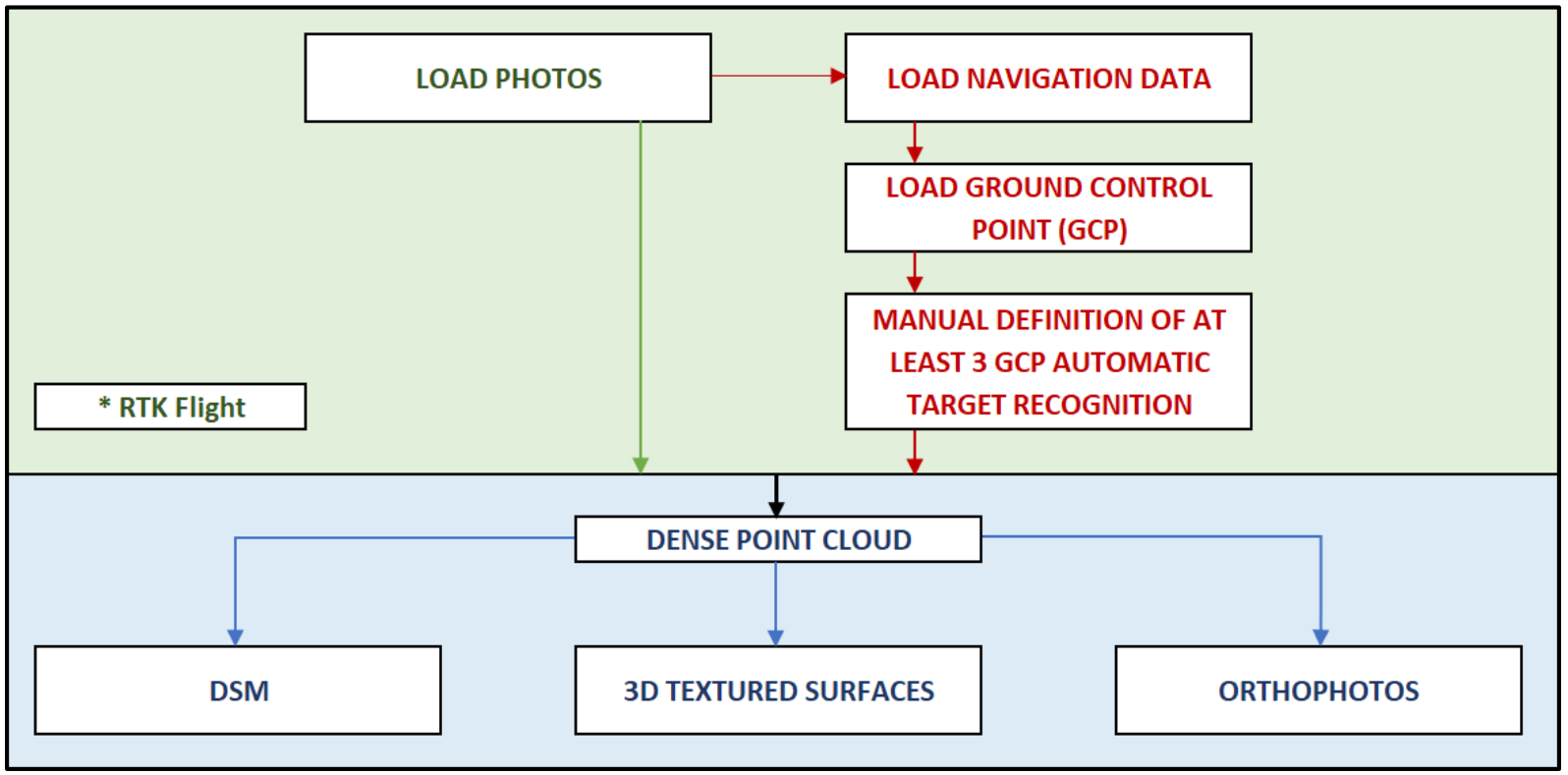
## GOAL

- Import and manage data to create Point Clouds and elaboration from images

## DATA

- X-PHOTO AERIAL.gfdoff
- Aerial Images Folder

# X-PHOTO Aerial




**(*) With RTK flight we can process data with 1, 2, 3,... or even without GCP. The GCPs are displayed directly on the estimated position**

# X-PHOTO Aerial

## GROUND CONTROL POINT – GCP

Points on the ground with known coordinates. During the aerial photographs survey it is possible to use visible markers or targets and determinate the position with a topographic survey.

## SPARSE CLOUD

It represents the Point Cloud created by the general alignment of the images used. It shows the Camera Orientation result.

## DENSE CLOUD

It represents the complete Point Cloud created by the advanced calculation based on the images alignment and the ground control points used

# X-PHOTO Aerial

## GRAPHIC PROCESSING UNIT - GPU

It is part of the graphic card which performs rapid mathematical calculation.
It is possible to use a dedicated GPU to improve Dense Cloud calculation

## DIGITAL SURFACE MODEL – DSM

It represents a digital 3D surface model which includes all the elements, natural and man-made structure (i.e. vegetation, buildings, bridges..)

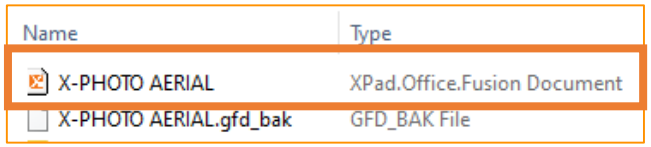
## SOLID ORTHOPHOTO

It represents the typical 2D raster orthophoto that automatically associates to each pixel a georeferenced height.

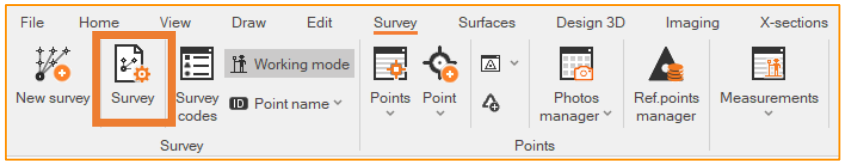
## STEREO DRAWING

It represents an advanced drawing tools based on analytical photogrammetry process. It is possible to use the Stereo Drawing funciton for the manual computation of coordinates in 3D space.

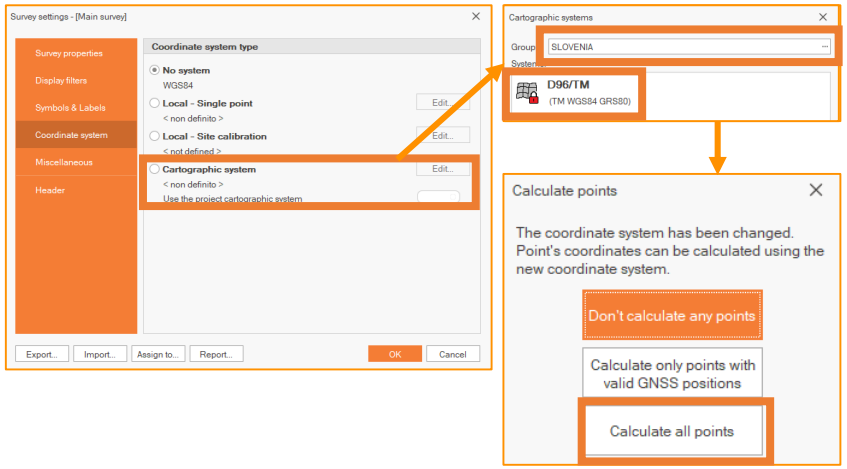
# Image Processing Project




From Image_Processing folder open Fusion project: **X-PHOTO AERIAL.gfdoff**




From Survey menu it is possible to select **Survey** option and from Survey Settings menu select the submenu Coordinate system – **Cartographic system**.



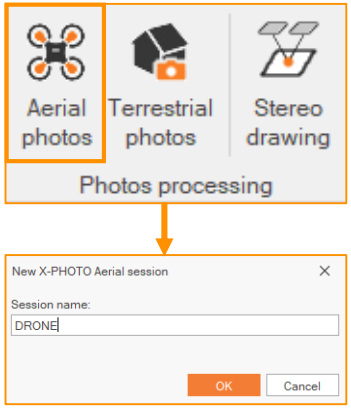

From default Cartographic System select **Slovenia D96/TM**

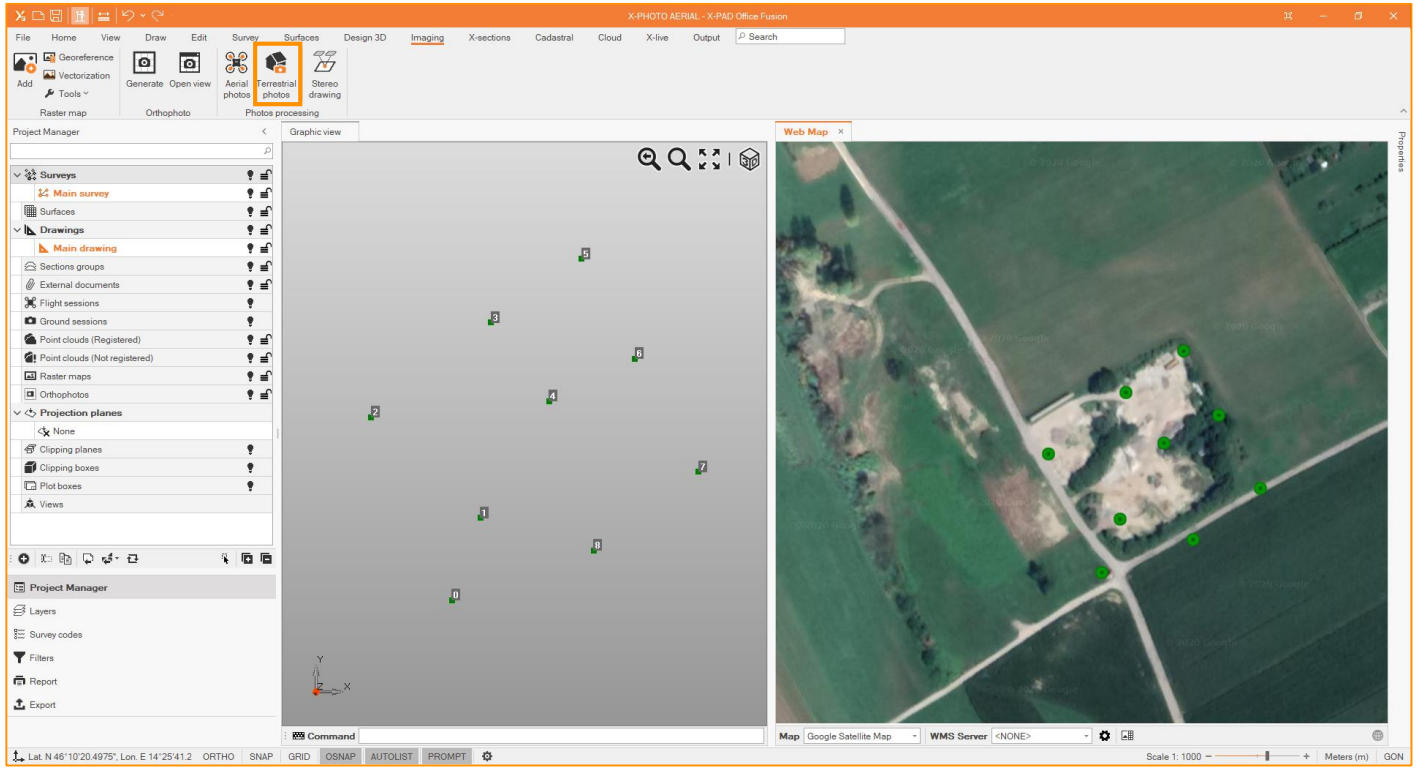
From Calculation points select **Calculate all points**

# Photo Processing

## Imaging Menu

**PHOTO PROCESSING** is available from Imaging menu, select **Aerial photo** and enter **Session Name**



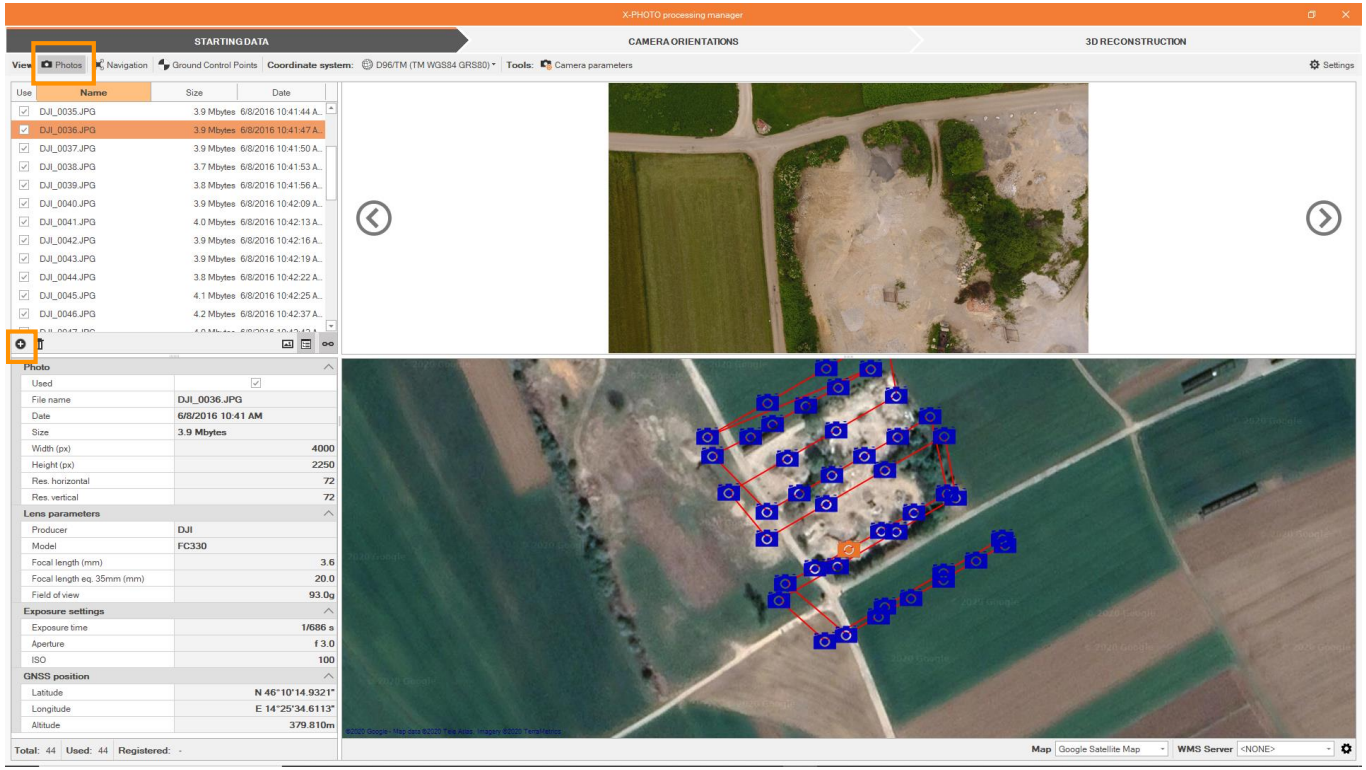




Starting Data — Camera Orientation — GCP — Optimise Orientation — Elaborations

# Aerial Photo Processing

## Images

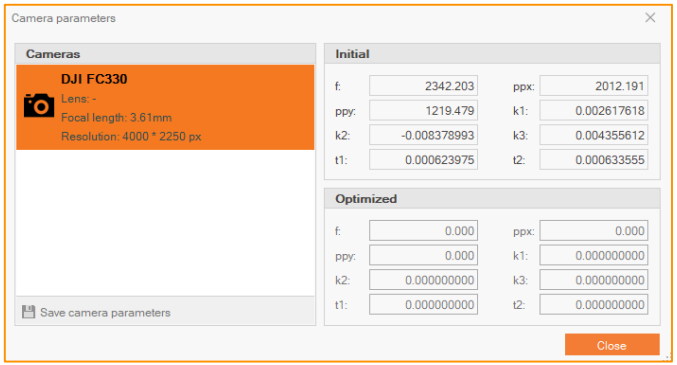
Use **Aerial Images folder** to load photos from which it is possible to visualize camera parameters and navigation data

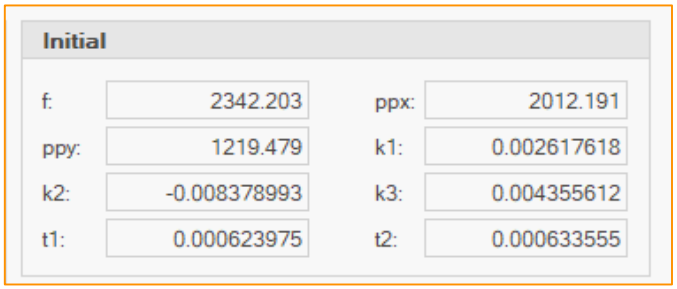

Other images formats are: JPG, BMP,PNG

# Aerial Photo Processing

## Images - Camera Parameters


If the camera used is already in our list of camera with calibration parameters, from **Starting Data** menu it is possible to select **Camera parameters** and check the initial parameters for the current camera.




**k1**, **k2**, **k3**: radial distorsion
**t1**, **t2**: tangential distorsion
**ppx**, **ppy**: principal point x and y (pixels refers to image angles)
**f**: focal lenght

# Aerial Photo Processing

## Images - Camera Parameters



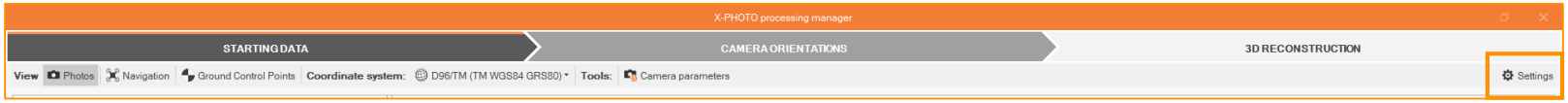
From main menu select **Settings**, then click on **Camera with calibration parameters** to check the camera's list.

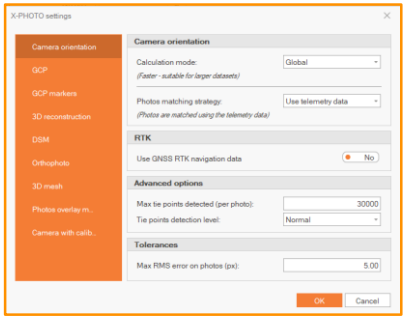
If the camera used is not in the list it's possible to continue with elaboration and create a customized profile for the camera

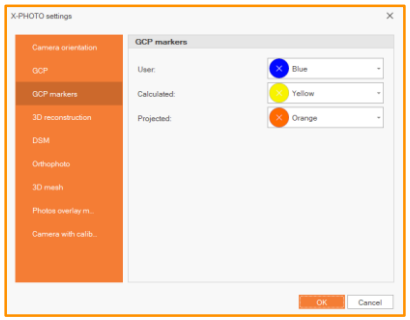
# Aerial Photo Processing

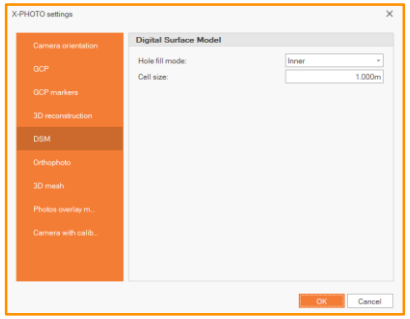
## Settings

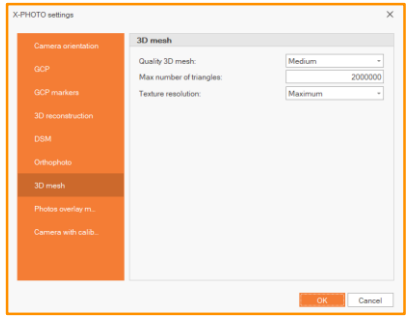
From main menu click on **Settings** to set the default parameters for each X-Photo menu and tools

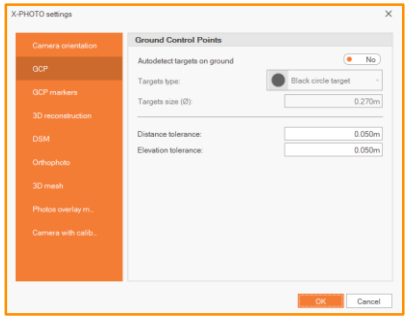


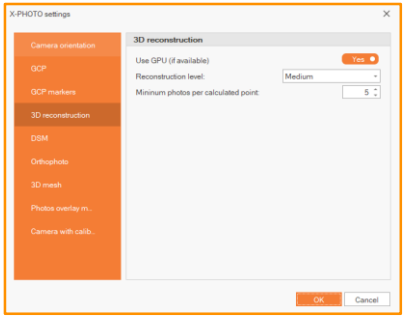



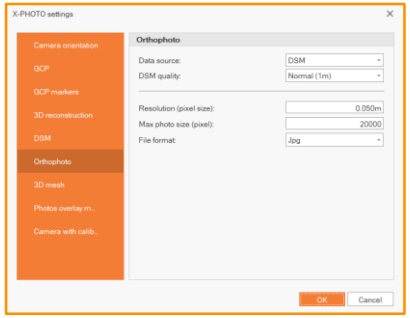



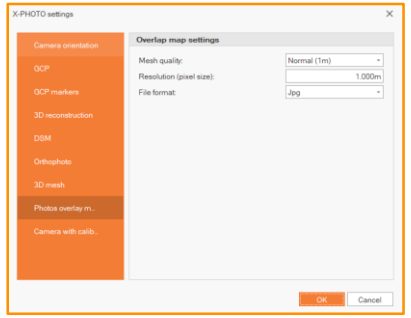



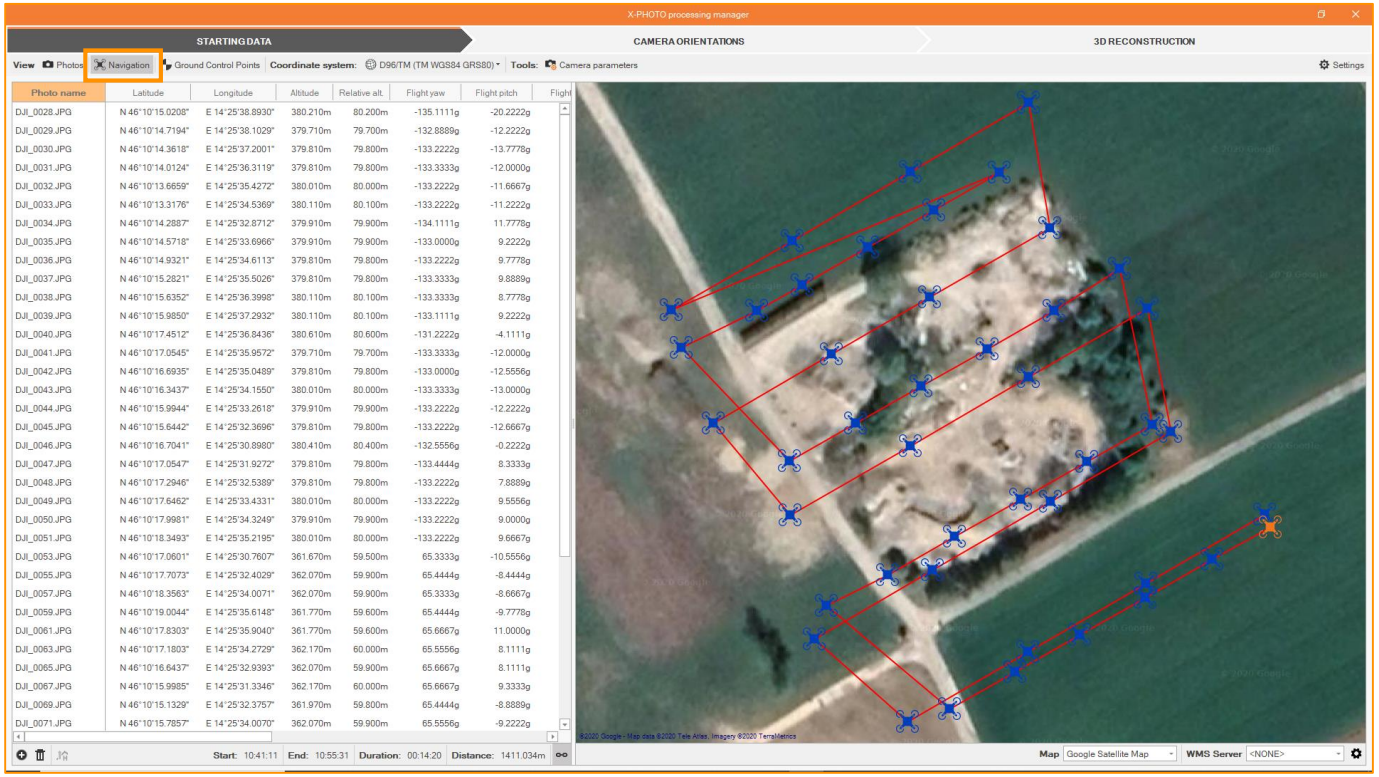



# Aerial Photo Processing

## Navigation Data

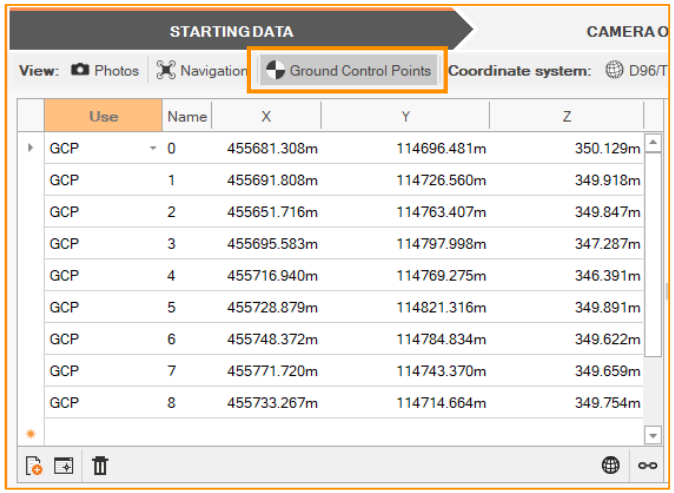
Load of **Navigation Data** whenever is possible; drones equipped with RTK GNSS receiver are also supported; in this case “one click” to get the final result.



# Aerial Photo Processing

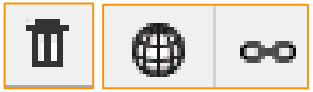
## Ground Control Points

Load of Ground Control Point (GCP) and Check points; X-PAD Fusion topographic points can be use

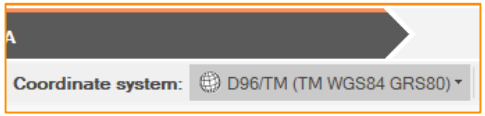



Use this function to import GCP as **TXT** and **CSV**

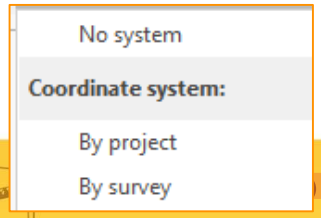
Use this function to import GCP from X-Pad Fusion's **Survey**



Use this functions to **Delete** or change point's View




It is possible to select this function to define a Coordinate System, if it has not been previously selected

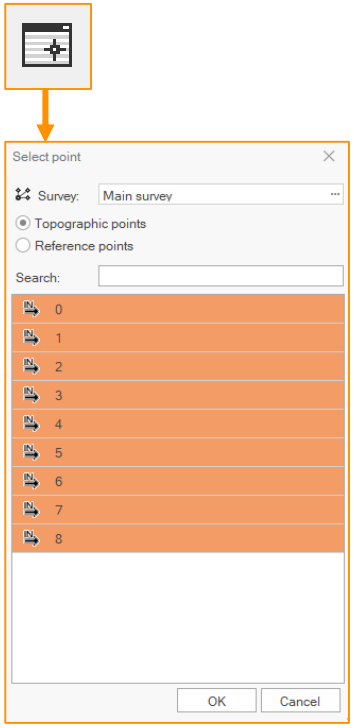


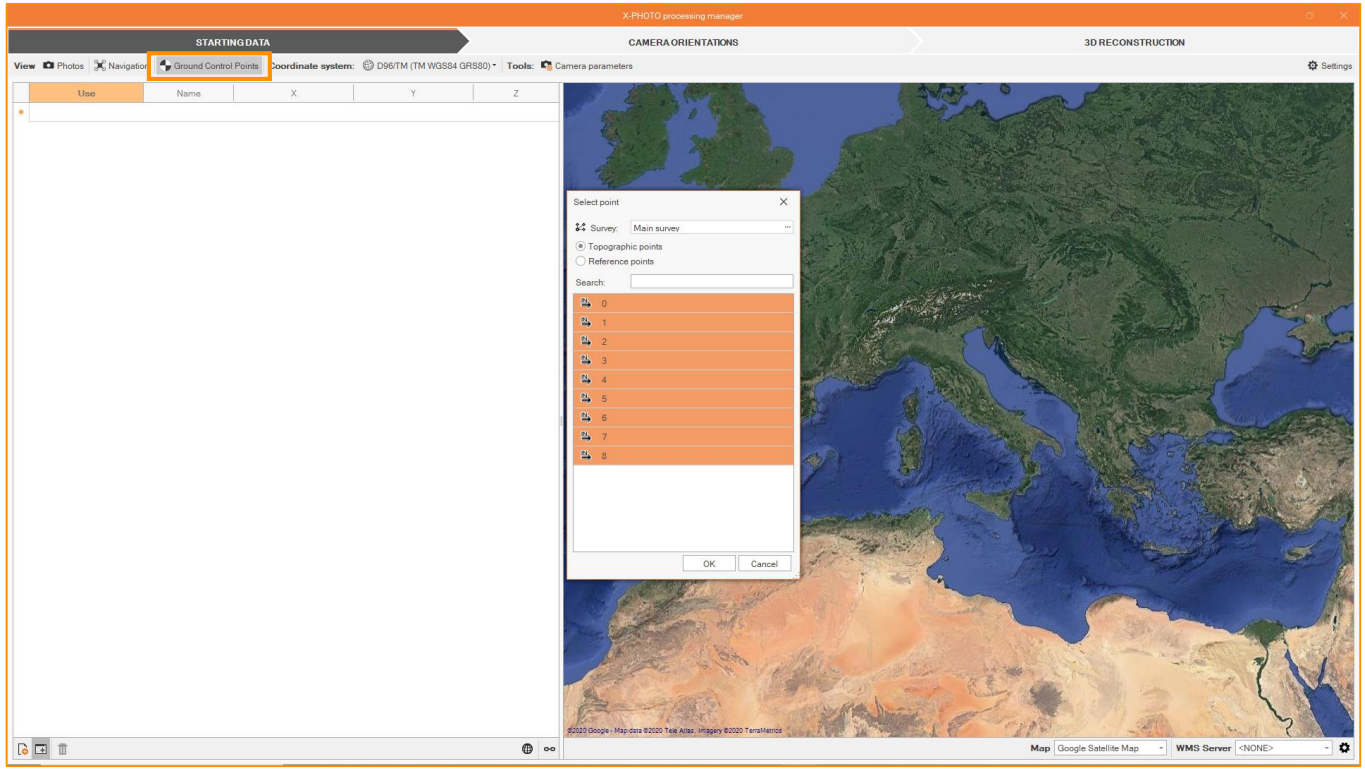

Using the Coord System manager it is possible to define the cartographic system

# Aerial Photo Processing

## Ground Control Points

Load of **Ground Control Point** (GCP) and Check points; X-PAD Fusion topographic points can be used

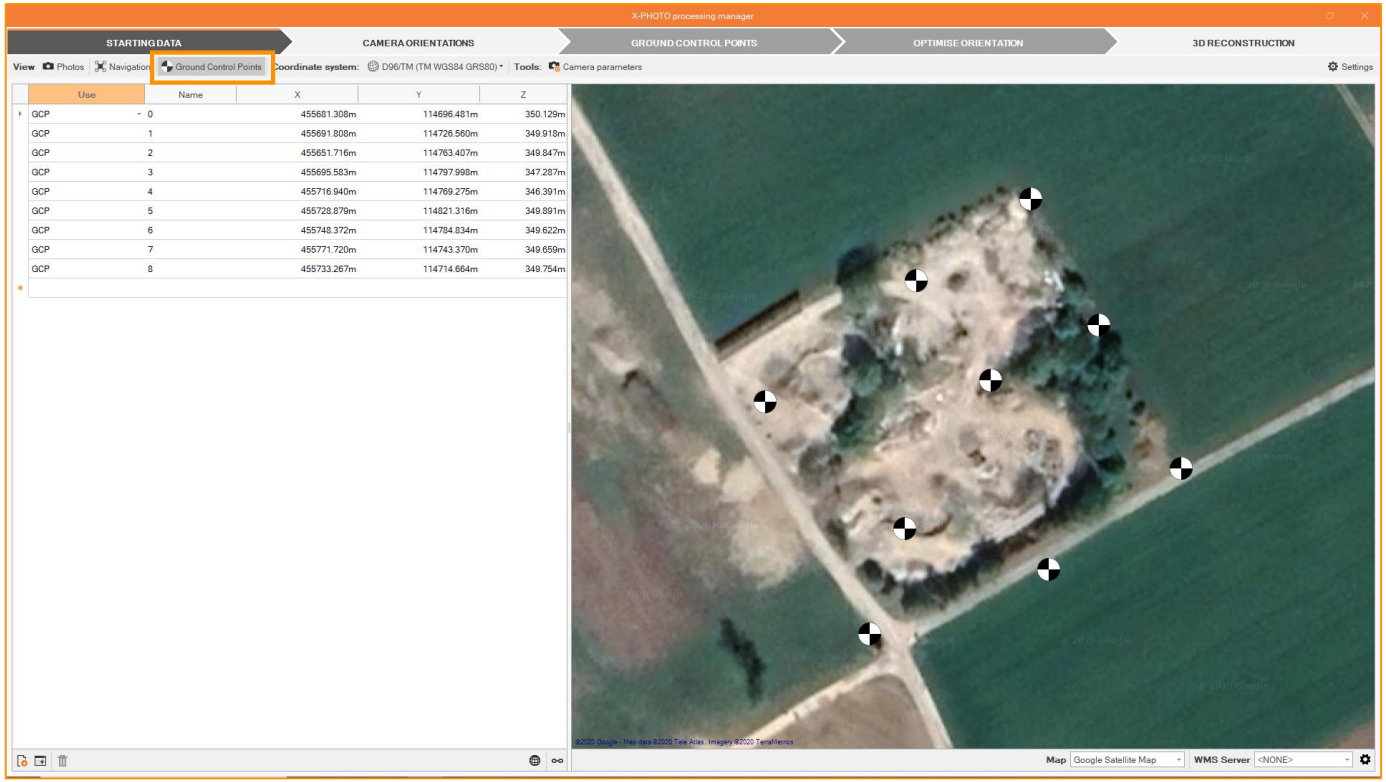


# Aerial Photo Processing

## Ground Control Points

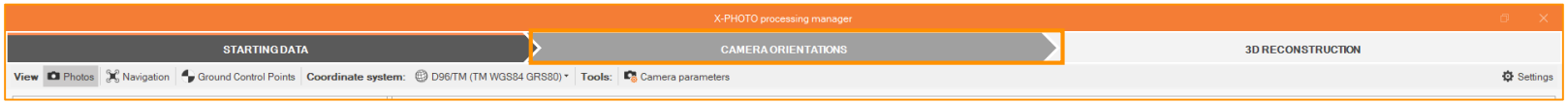
Load of Ground Control Point (GCP) and Check points; X-PAD Fusion topographic points can be used

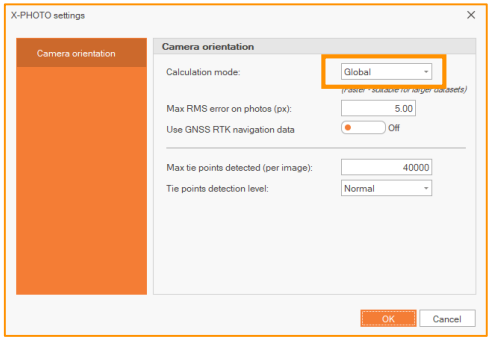


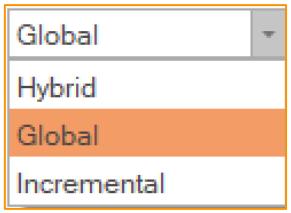
# Aerial Photo Processing

## Camera orientation

Camera orientation is the result of a general Alignment of the images used. From this menu select **Global**. It's a necessary step to find out if we have a sufficient overlap between images



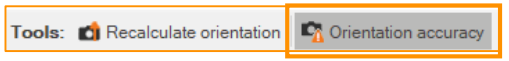



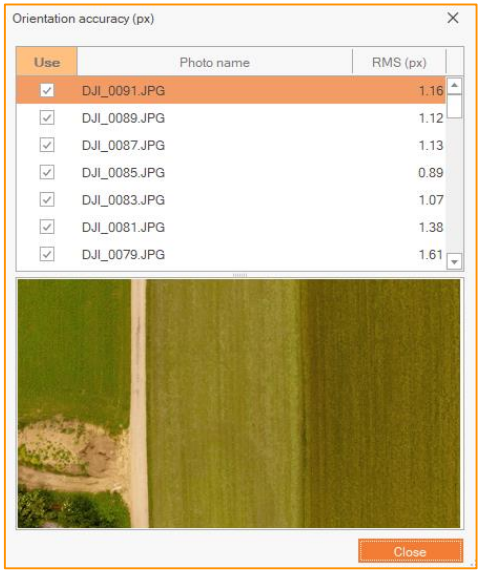

**CALCULATION MODE**
Different options are available with calculation algorithms based on the dataset

**Hybrid** Global + Incremental
**Global** Faster -suitable for larger database
**Incremental**
Slower - suitable for smaller database

**MAX RMS error**
**Root Mean Square** error, it is a global indicator of the quality. The lower is the RMS value, the better is the solution. After calculation, it's possible to select "**Orientation Accuracy**" to check the RMS values.

**Tie Points** are points of interest that can be recognized on images



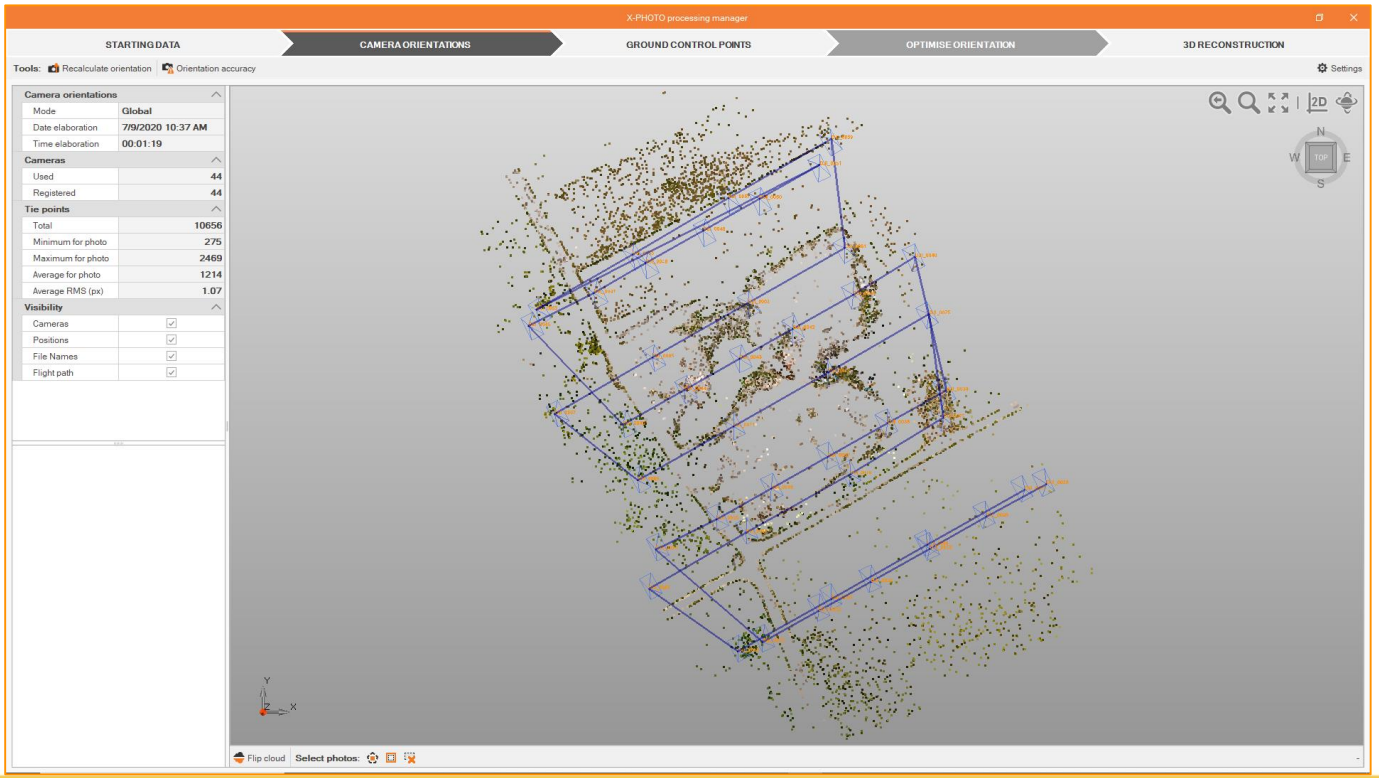
# Aerial Photo Processing

## Camera orientation

Camera orientation is the result of a general Alignment of the images used. From this menu select **Global**. It's a necessary step to find out if we have a sufficient overlap between images

| Camera orientations | |
|---|---|
| Mode | Global |
| Date elaboration | 7/9/2020 10:37 AM |
| Time elaboration | 00:01:19 |
| **Cameras** | |
| Used | 44 |
| Registered | 44 |
| **Tie points** | |
| Total | 10656 |
| Minimum for photo | 275 |
| Maximum for photo | 2469 |
| Average for photo | 1214 |
| Average RMS (px) | 1.07 |
| **Visibility** | |
| Cameras | ☑ |
| Positions | ☑ |
| File Names | ☑ |
| Flight path | ☑ |

**Hybrid**
Global+Incremental
**Global**
Faster - suitable for larger data base
**Incremental**
Slower - suitable for smaller database




Starting Data

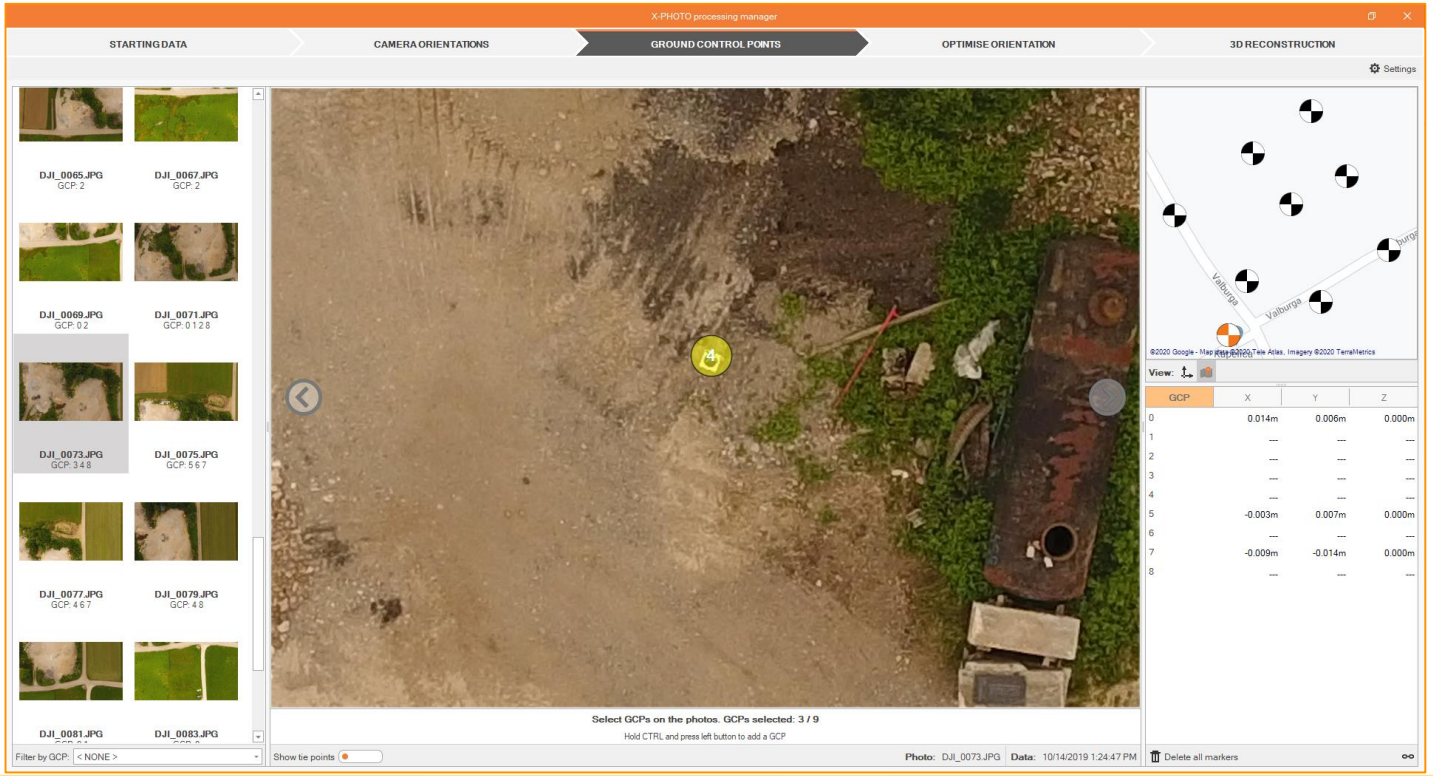
Camera Orientation

# Aerial Photo Processing

## GCP definition

Manual definition of at least three **GCP** and automatic target recognition of all the others. Hold CTRL and press left button to add a GCP, or press right button and select the GCP from the list to mark the GCP as a known GCP.


It is also possible to select the GCP using **filter** option or directly from **CAD/MAP**




Starting Data

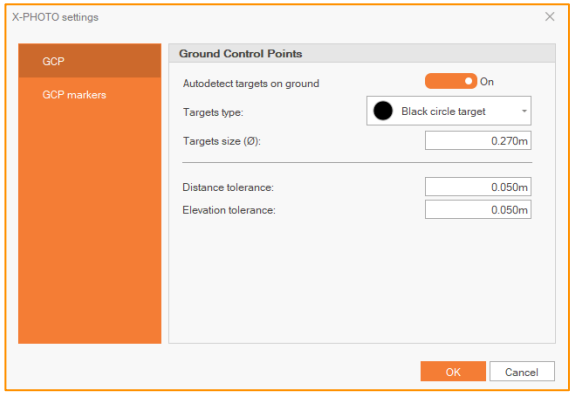
Camera Orientation

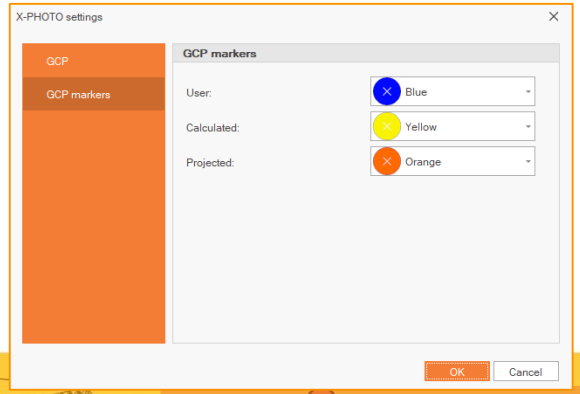
GCP

# Aerial Image Processing

## Targets Adjustment

After the manual definition of at least three GCP, we can use automatic target recognition of all the others using GeoMax type or distance and elevation tolerances.




Using "**Black circle marker**" it's possible to use **Automatic GCP detection**

Targets available from:

**C:\Program Files\GeoMax\X-PAD Office Fusion\Targets**

If no targets have been used, it is possible to set the tolerances for distance and elevation

**GCP markers** allows you to set different colors depending on whether the targets are chosen by: user, calculated or projected

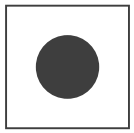
# Aerial Image Processing

## Targets Adjustment

After the manual definition of at least three GCP, we can use automatic target recognition of all the others using GeoMax type or distance and elevation tolerances.

We need to select minimum three GCPs on the images in order to start Calibration

Using images with GPS position it's possible to filter GCPs by position

Using "**Black circle marker**" it's possible to use
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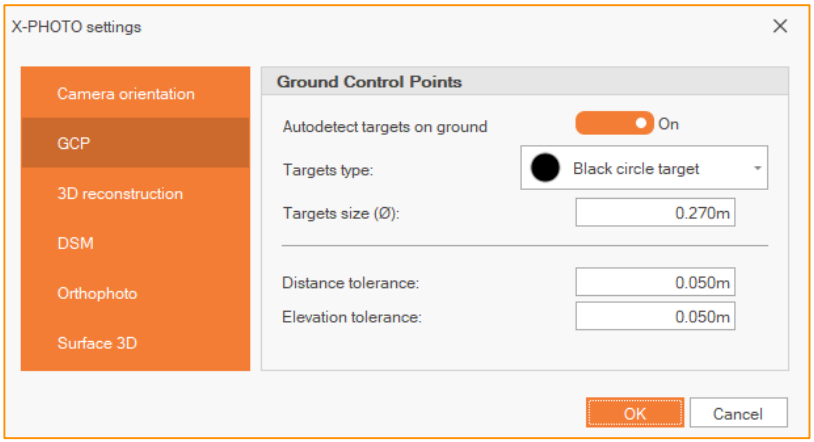
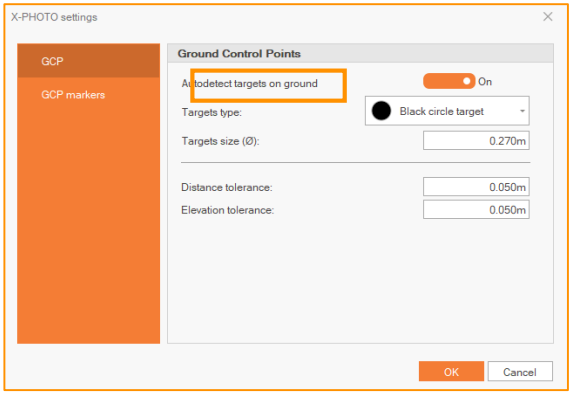


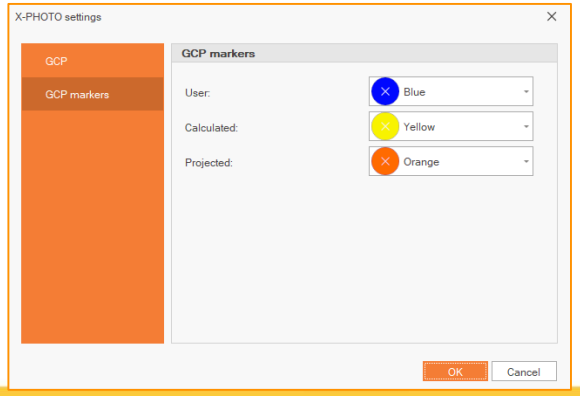

Targets available from: **C:\Program Files\GeoMax\X-PAD Office Fusion\Targets**

# Aerial Photo Processing

## Optimise Orientation

From **Optimise Calibration** menu it's possible to adjust markers position and improve the results of automatic target recognition




After the manual definition of at least three GCP, we can use automatic target recognition of all the others using GeoMax type or distance and elevation tolerances.

We need to select minimum three GCPs on the images in order to start Calibration

Using images with GPS position it's possible to filter GCPs by position

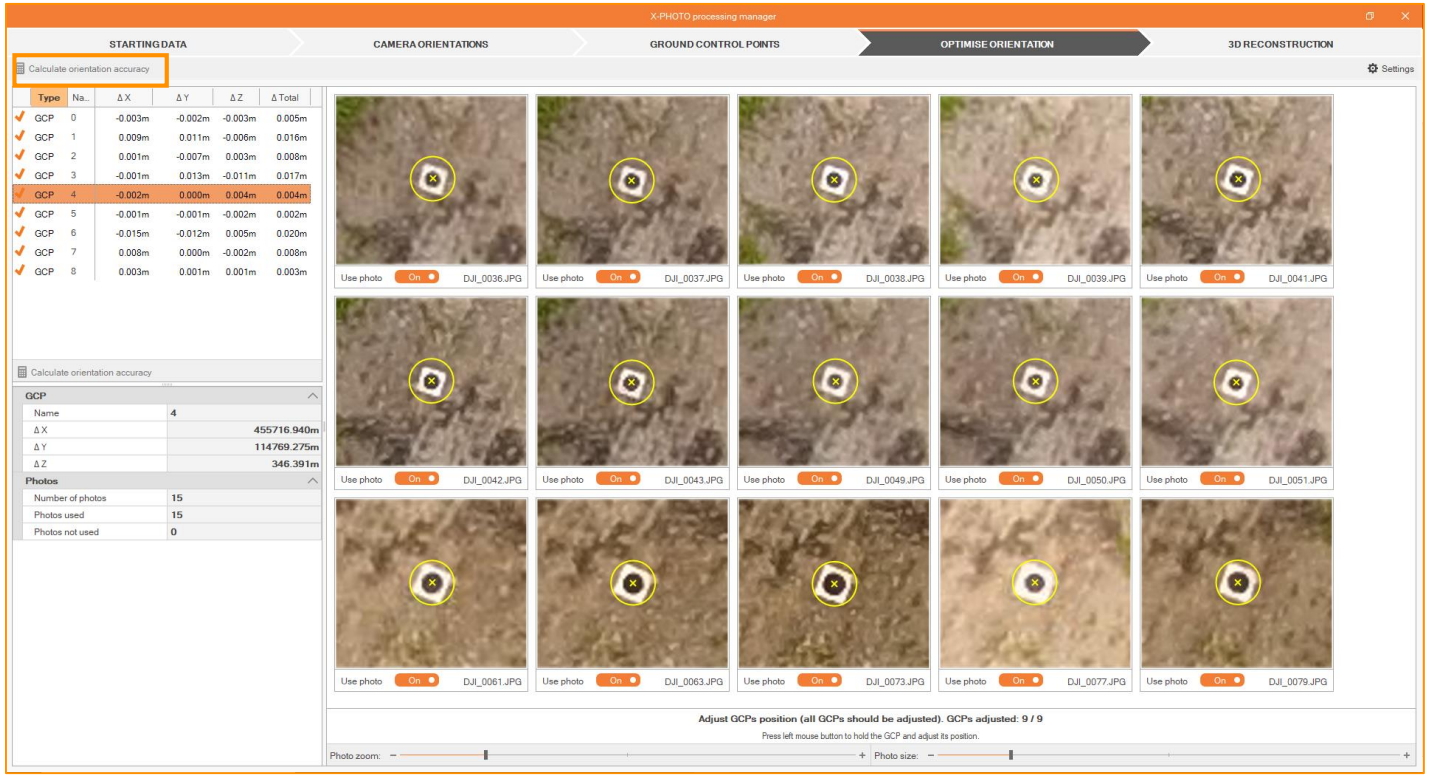
# Aerial Photo Processing

## Optimise Orientation

From **Optimise Calibration** menu it's possible to adjust markers position and improve the results of automatic target recognition

| Type | Na... | ΔX | ΔY | ΔZ | Δ Total |
|---|---|---|---|---|---|
| GCP | 0 | -0.003m | -0.002m | -0.003m | 0.005m |
| GCP | 1 | 0.009m | 0.011m | -0.006m | 0.016m |
| GCP | 2 | 0.001m | -0.007m | 0.003m | 0.008m |
| GCP | 3 | -0.001m | 0.013m | -0.011m | 0.017m |
| GCP | 4 | -0.002m | 0.000m | 0.004m | 0.004m |
| GCP | 5 | -0.001m | -0.001m | -0.002m | 0.002m |
| GCP | 6 | -0.015m | -0.012m | 0.005m | 0.020m |
| GCP | 7 | 0.008m | 0.000m | -0.002m | 0.008m |
| GCP | 8 | 0.003m | 0.001m | 0.001m | 0.003m |

Calculate orientation accuracy

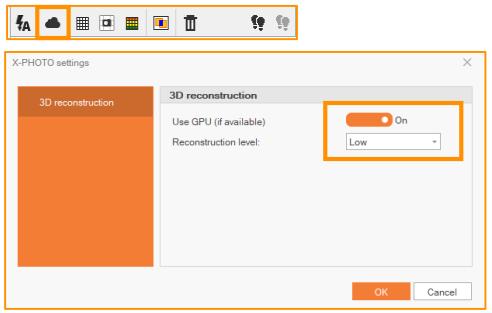



We recommend to adjust the GPCs position from at least three GCPs and using different images

# Aerial Photo Processing

## 3D Reconstruction

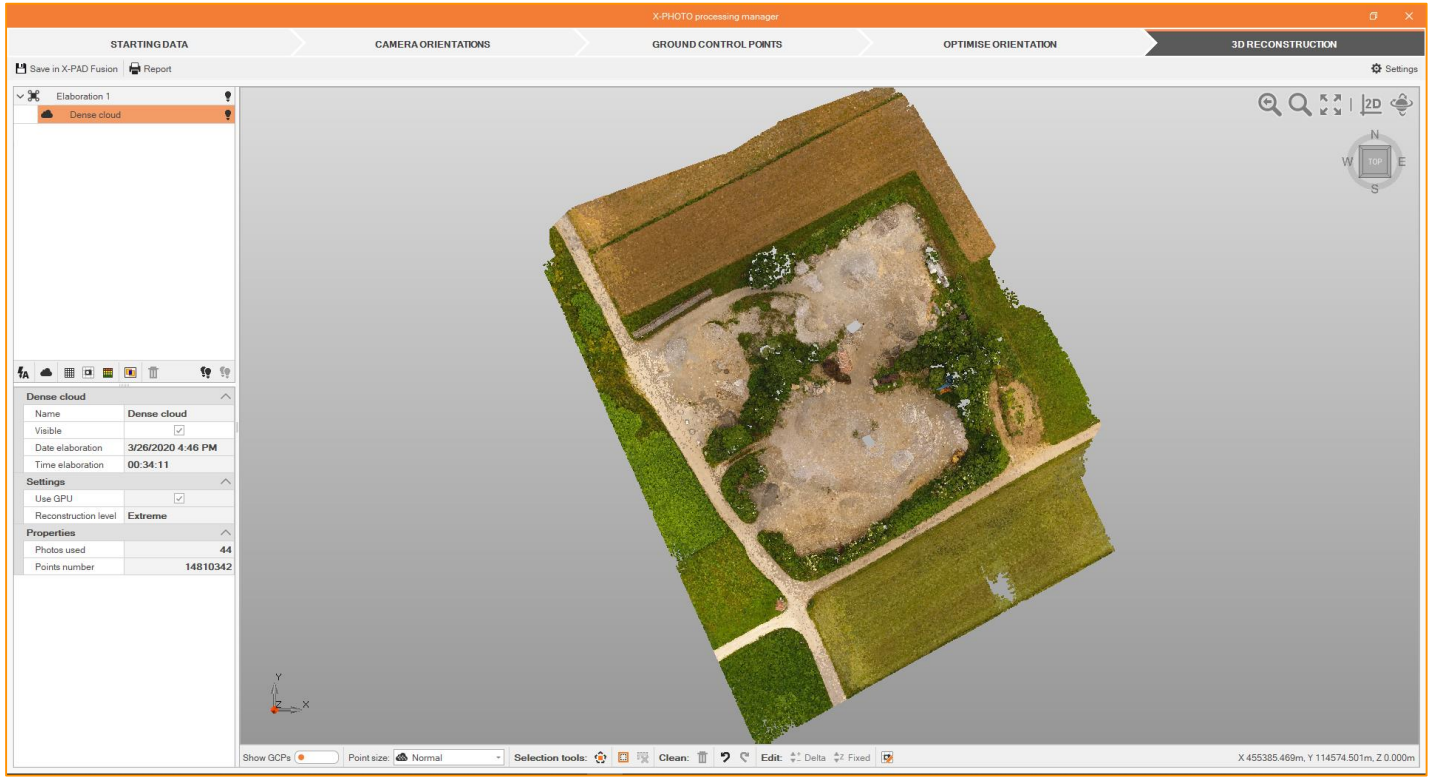
After Calibration we can run Dense Cloud process and create the corresponding Points Cloud in Low, Medium, High or Extreme resolution




### GPU

This command allows to improve calculation using the dedicated GPU (Graphic Processing Unit)

Using GPU we can increase the number of points created with the same reconstruction level

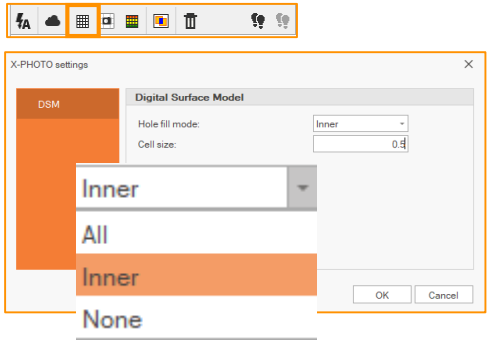



Starting Data → Camera Orientation → GCP → Optimise Orientation → Elaborations

# Aerial Photo Processing

## DSM

From Elaboration menu it's possible to create DSM (Digital Surface Model) from Dense Cloud. DSM is a surface representing the highest elevation of a terrain

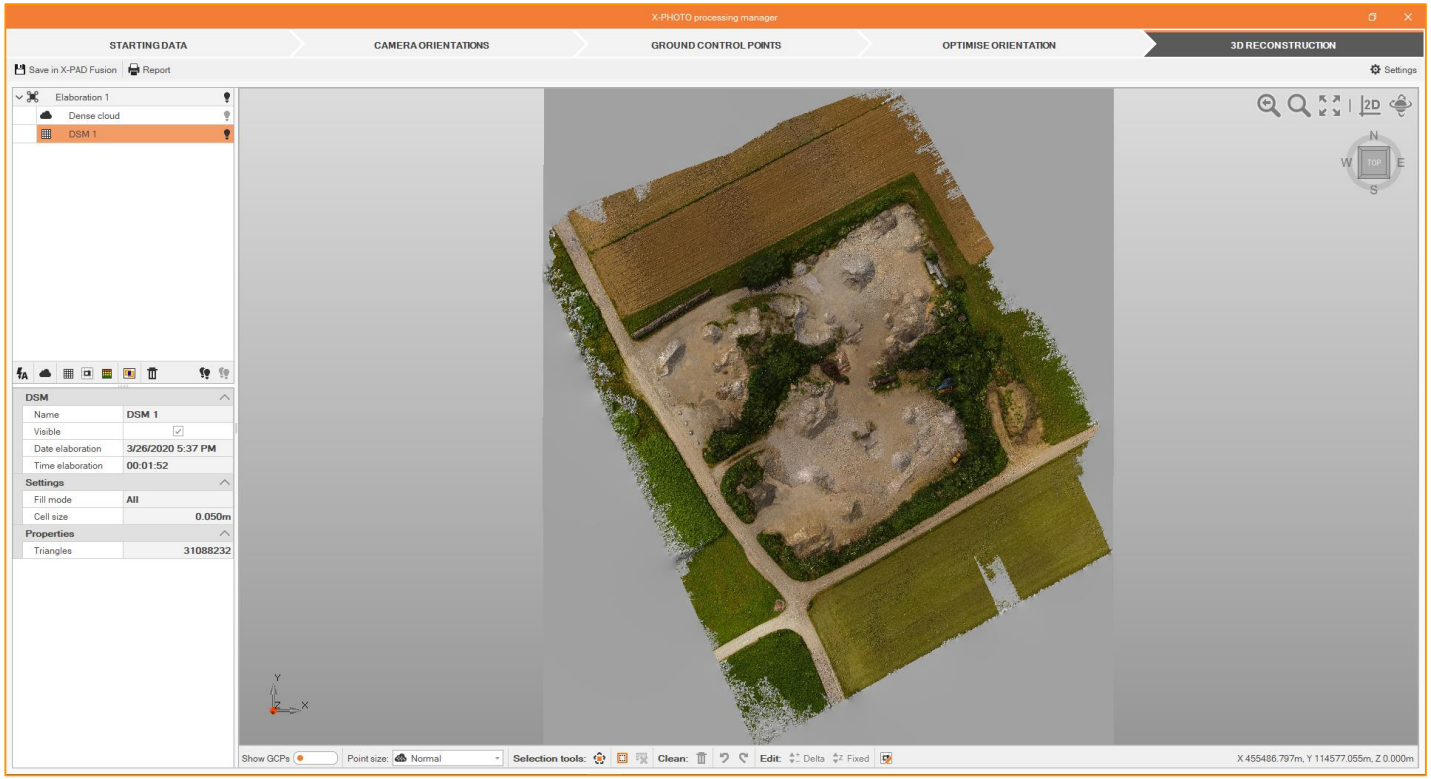



### Hole fill

It's possible to select one of the available mode to fill the DSM hole

### Cell Size

It's possible to reduce this value in order to increase the DSM quality

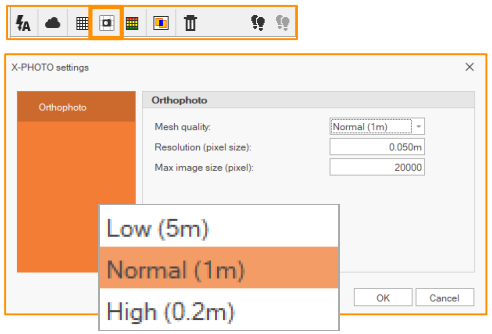



Starting Data → Camera Orientation → GCP → Optimise Orientation → Elaborations

# Aerial Photo Processing

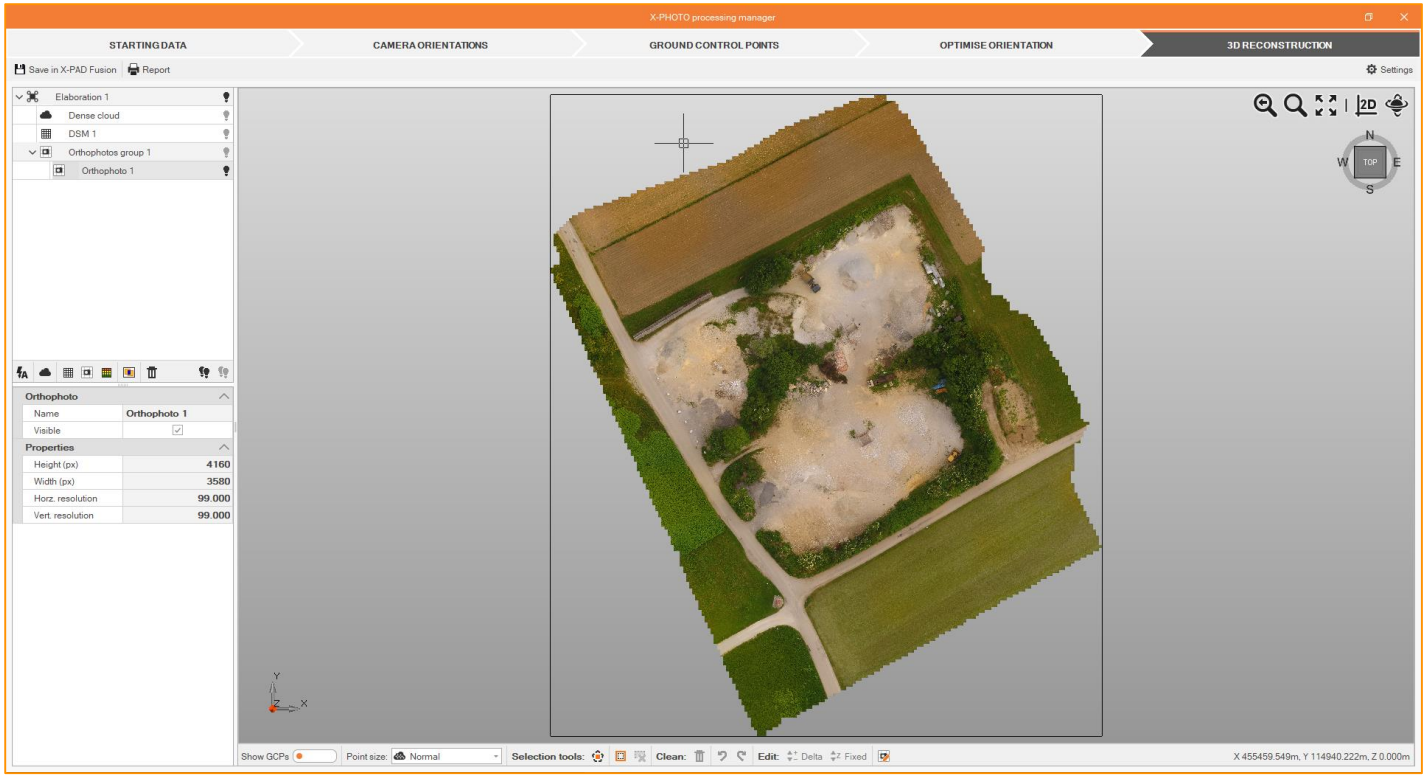
## Orthophoto

From Elaboration menu it’s possible to create Orthophotos from Dense Cloud




**Mesh quality**
It’s possible to select one of the available quality

**Resolution and size**
It’s possible to reduce the resolution value and increase the image size in order to increase the result

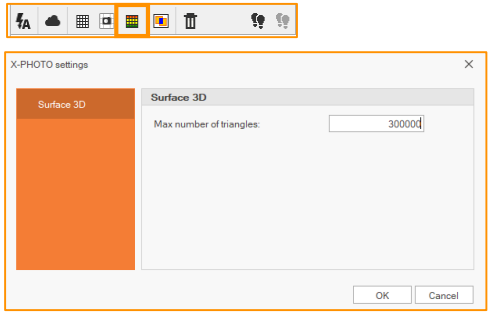



Starting Data — Camera Orientation — GCP — Optimise Orientation — Elaborations

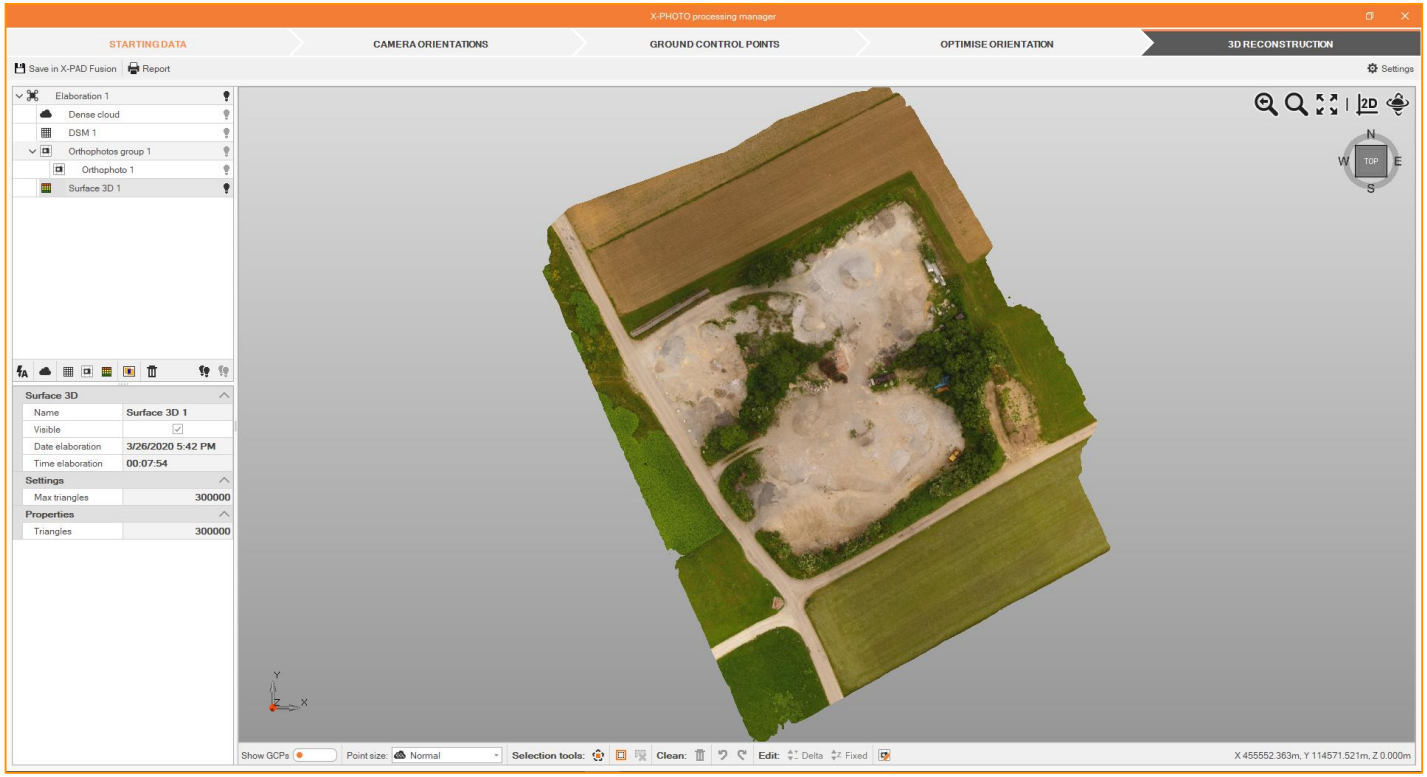
# Aerial Photo Processing

## 3D Textured Surface

From Elaboration menu it’s possible to create Surface 3D from Dense Cloud




**Resolution and size**
It’s possible to increase the max number of triangles in order to increase the result

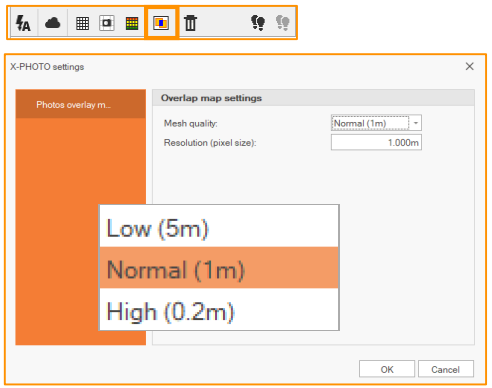


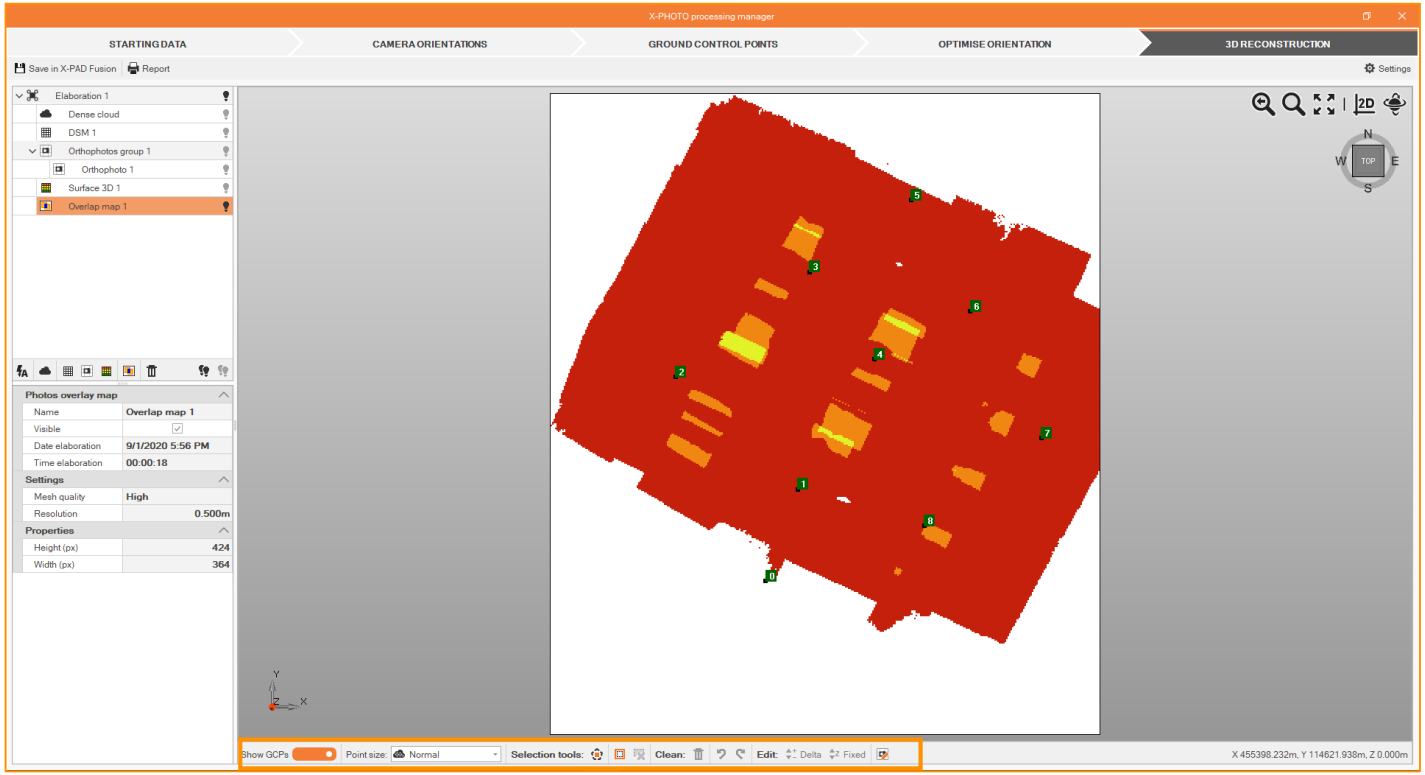

Starting Data → Camera Orientation → GCP → Optimise Orientation → Elaborations

# Aerial Photo Processing

## Photos Overlay Map

From Elaboration menu it's possible to create Photos Overlay Map elaboration, which allows to check the overlaption between photos




Starting Data

Camera Orientation

GCP

Optimise Orientation

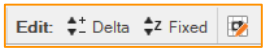
Elaborations

# Aerial Photo Processing

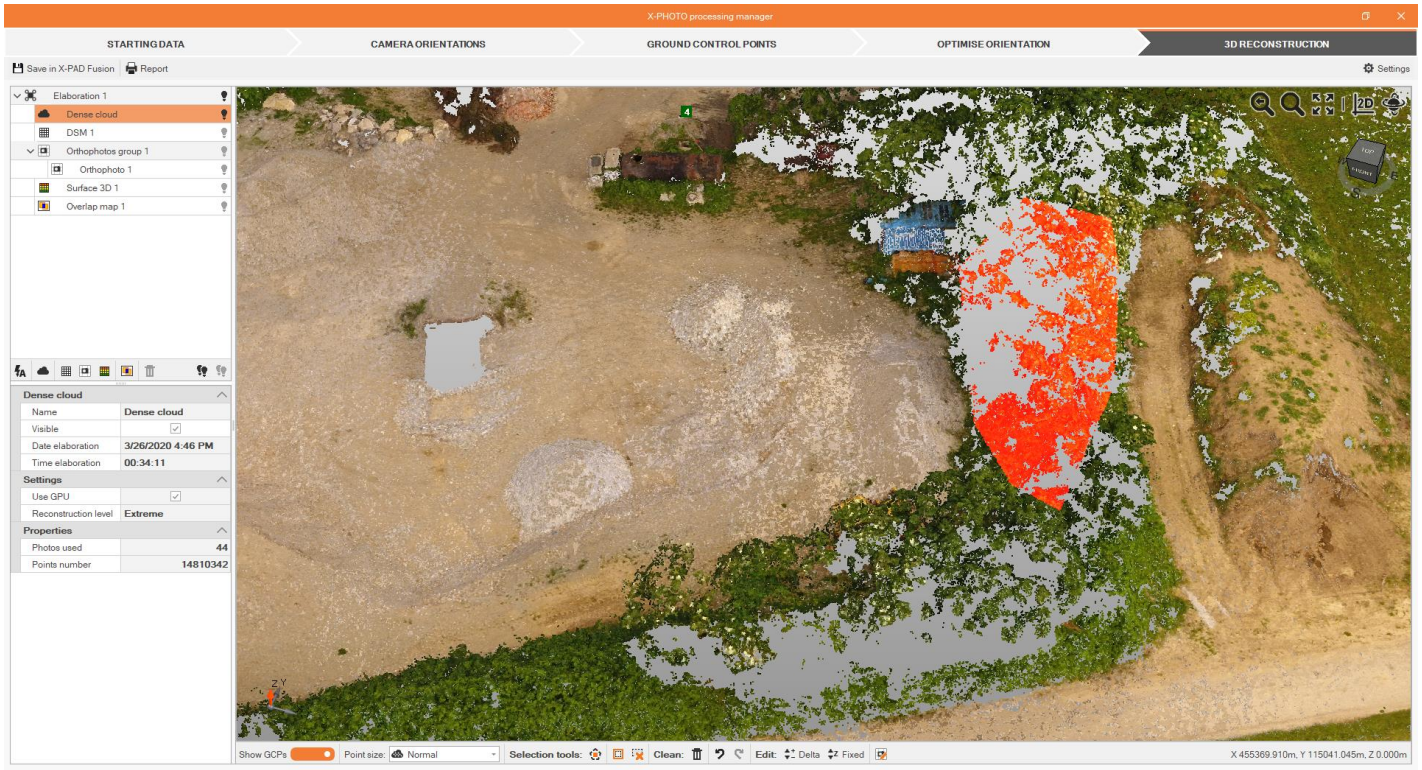
## X-Photo Tools

From Elaboration menu it's possible to use different tools for Visualization, Clean and Editing Point Cloud


Selection tools available to clean Point Cloud



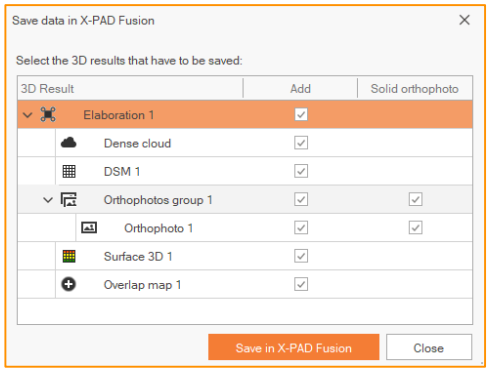

Editing tools available to modify elevation of selected points with a delta or fixed elevation; corrects the selected zone of the orthophoto by applying one single photo



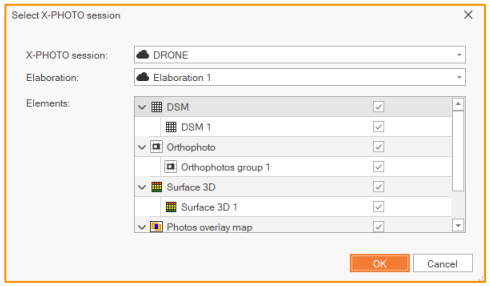
# Arial Photo Processing

## Save Elaboration - Report

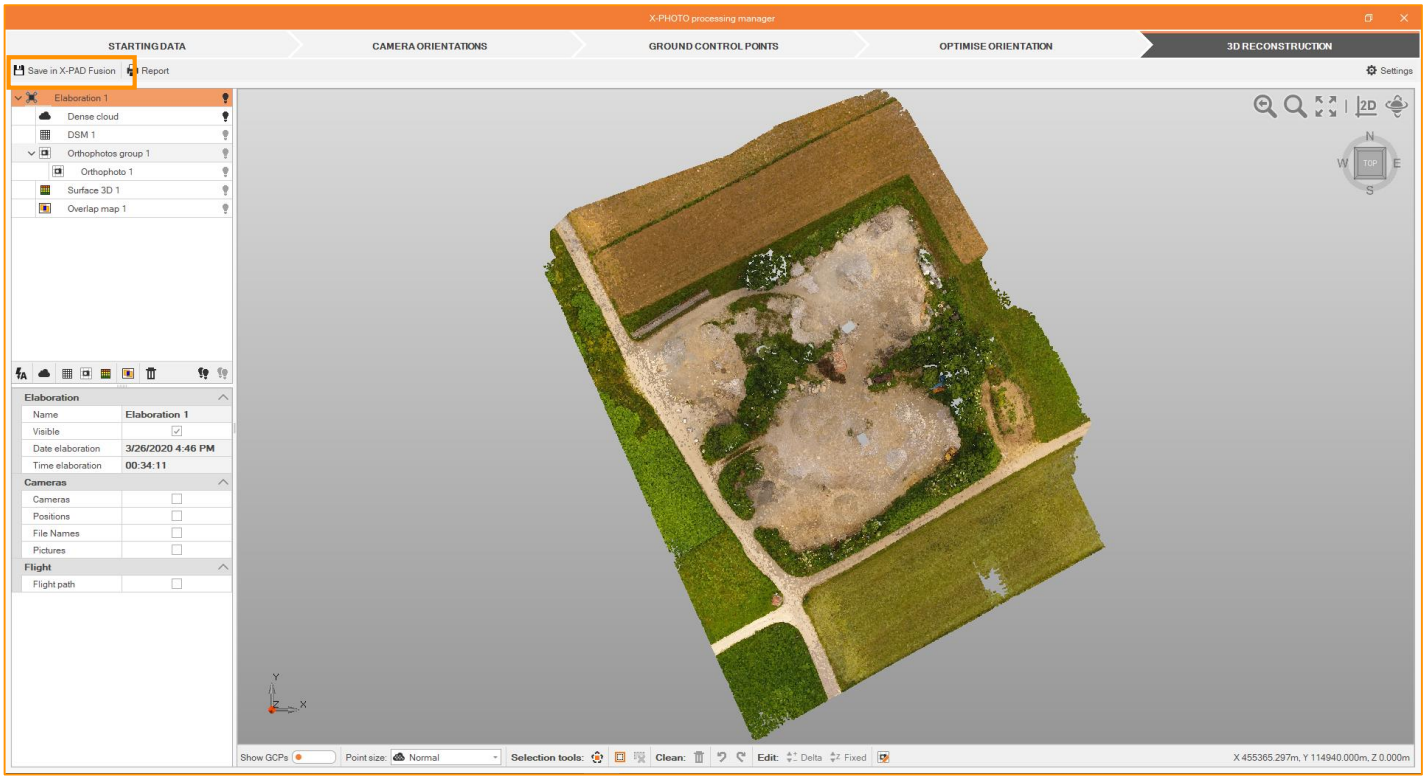
From main menu it's possible select **Save data in X-PAD Fusion** with the outputs that have to be saved or create the **X-Photo Report**




Save Data



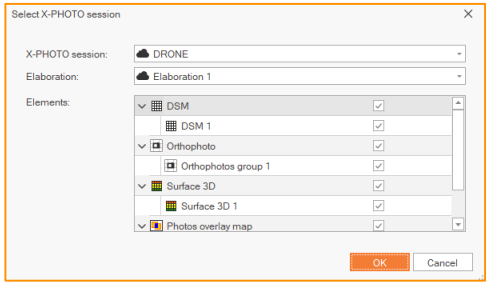

Report

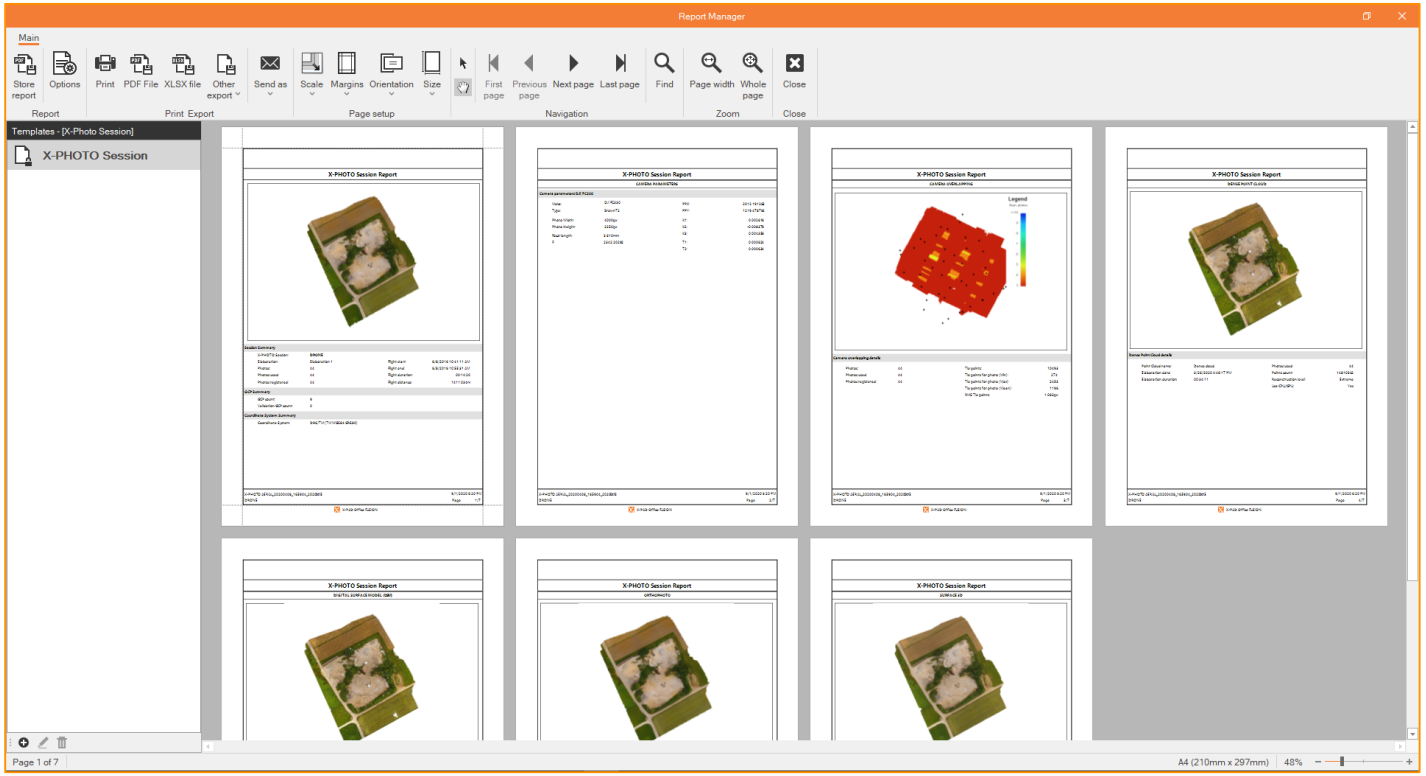


# Arial Photo Processing

## Report

From **X-Photo Report** it's possible to create a summary reports from processing to selected outputs




Starting Data

Camera Orientation

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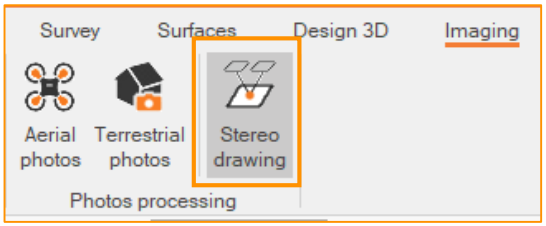
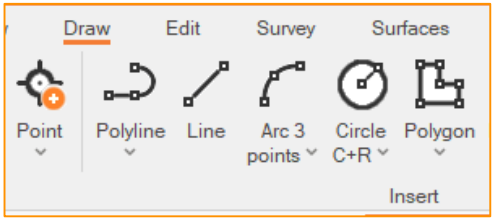
# Stereo Drawing

## X-Photo Drawing tools




Based on analytical photogrammetry process we can use the Stereo Drawing funciton for the manual computation of coordinates in 3D space




After selecting **Stereo Drawing** function, we can use one of the drawing tools from Draw menu.

We can select points and vertexes from **graphic view** or directly from the photos from **Stereo Drawing** panel.

Once created the point or  object we can re-open Stereo Drawing panel and adjust vertexes position

# Solid Orthhophoto Drawing

## X-Photo Drawing tools

We can use drawing functionalities on the **Solid Orthophotos** created from X-Photo menu. The point's selection is done in 2D while the Point's **elevation** is automatically adjusted by the information from X-Photo data