Project on Geospatial Information for Sustainable Land Development in Tirana - Durres Area

Ground Control Point Survey

Manual (v.1)

MAY 2020

JICA Project Team

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1. Introduction

1.1. General

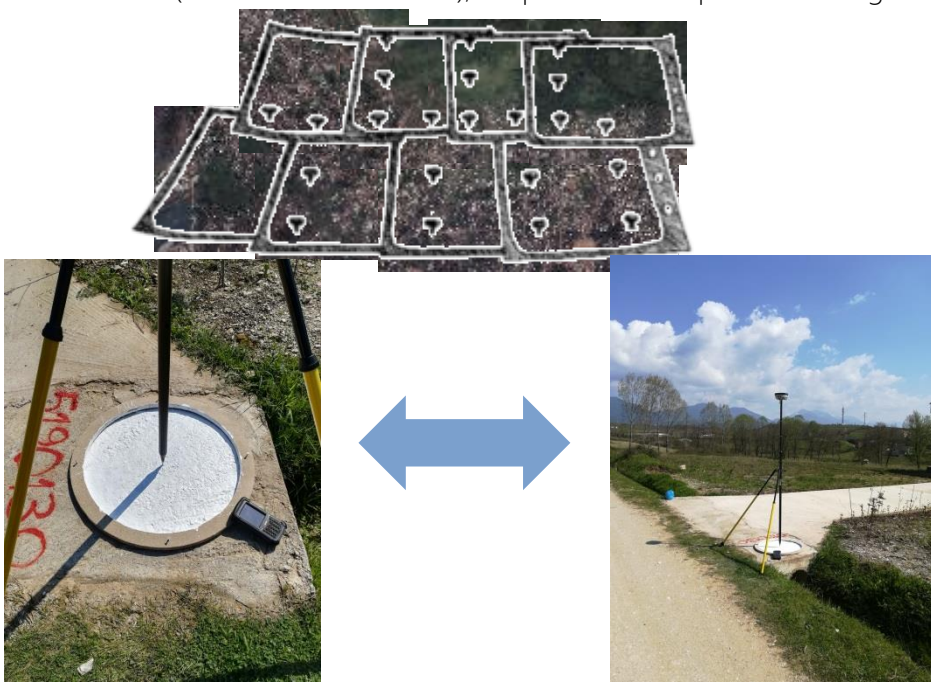
In order to create a topographic map by aerial photogrammetry, establishing a relationship between image space and ground space is required. It is called aerial photography orientation.

For the aerial photography orientation, photo control points are the actual points appearing in the photos (that have known ground coordinates and elevation) are used.

1.2. GCP

Field surveying for photo control points is a measurement coordinates and elevation of the photo control points that are monumented or identifiable features located on the ground.

(Hereafter called "GCP" (Ground Control Points), for photo control points on the ground, in this manual.)



Basically existing survey control points shall be used for GCP. But, if the number of the existing survey control points are insufficient in the study area, new GCP shall be installed.

GCP Survey is a field work of installation and measurement (by GNSS & Levelling) of the GCP.

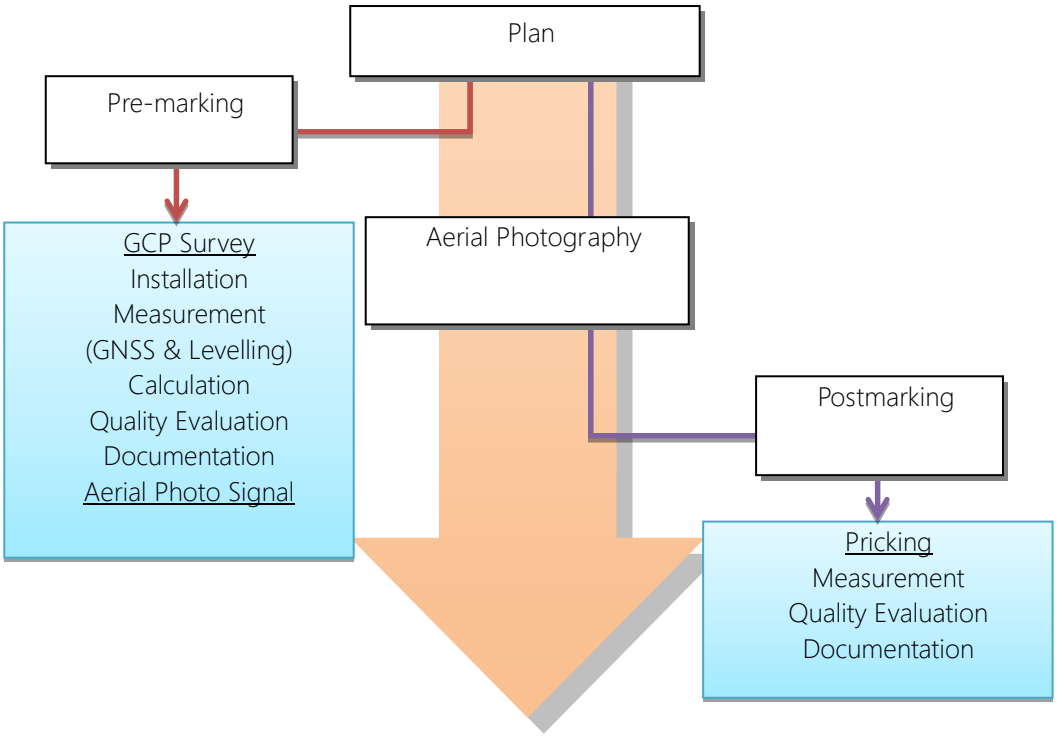
1.3. Marking

GCP shall be marked to make it identifiable on the photos by

a) Aerial Photo Signal (Pre-marking) :
   Marking control points with targets before the flight
b) Pricking (Postmarking) :
   Selecting identifiable image points after the flight

"Pricking (Postmarking)" shall be available, when "Aerial Photo Signal (Pre-marking)" is not well-defined on the photos.

1.4. Process



2. Survey Standard

2.1. Survey Standard

The following survey standard shall be applied in the all survey works.

The survey standard is the backbone of a survey project. It provides the framework to tie together all field survey and map data. The survey standards must be specified for the final map product.

Reference Ellipsoid (Spheroid)	GRS80 a = 6,378,137 m 1/f = 298.257 222 101
Projection System	Transversal Mercator Scale factor: 1 at the central meridian Central Meridian = 20 degrees east longitude Coordinates at the origin: E = 500,000.00m N = 0.00m
Coordinates System	ETRS89
Height Standards	Mean Sea Level of Adriatic Sea

2.2. Accuracy

The positional accuracy of digital topographic data for "Map Information Level"

Map Information Level	Map Scale	Standards deviation		
		Horizontal position	Vertical position	Contour line
2,000	1/2,000	Less than 40cm	Less than 53cm	Less than 80cm

The accuracy of the photo control points

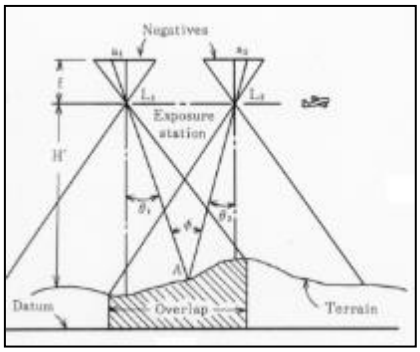
Map Information Level	Map Scale	Standards deviation	
		Horizontal position	Vertical position
2,000	1/2,000	Less than 3cm	Less than 5cm

3. Aerial Photogrammetry

3.1. General

Aerial Photogrammetry is a method of creating topographic map using aerial photography.

In the case a study area necessitates the gathering of a large amount of information. Aerial Photogrammetry offers advantage that the information can be obtained very rapidly.



Advantages

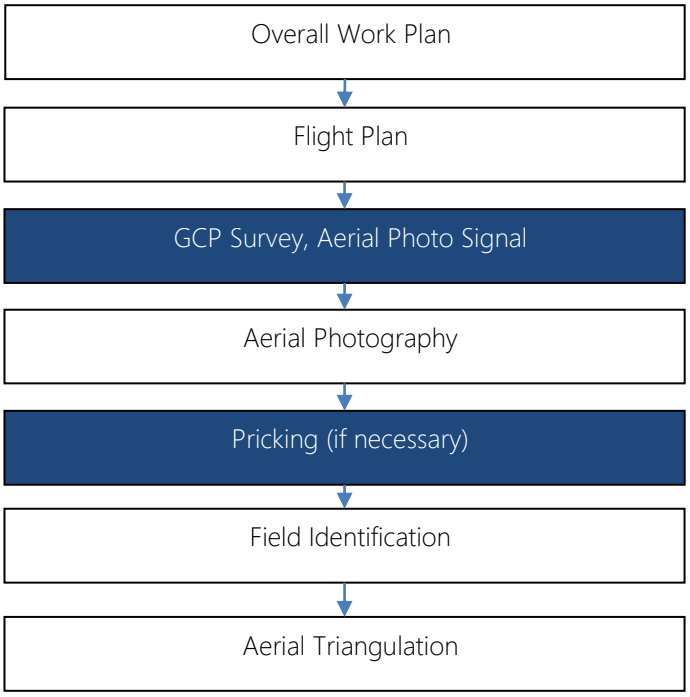
- Large amount of the information covering a wide area can be obtained very rapidly
- The faithful reproduction of the field
- Anywhere can be a survey site (even the hard access place)
- The uniformity of the accuracy

Disadvantages

- The map accuracy is dependent on the photo accuracy (photo quality and resolution)
- Low accuracy in the blurred spot of the photo (i.e. building shadow, under building roof, mountain

streams, under dense trees)

3.2. Process



4. Work manual

4.1. GCP Survey

(1) General

GCP Survey is a field work of installation, and measurement coordinates and elevation, of the GCP for the aerial photography orientation.

GNSS survey shall be applied for horizontal control, and the Levelling for vertical control.

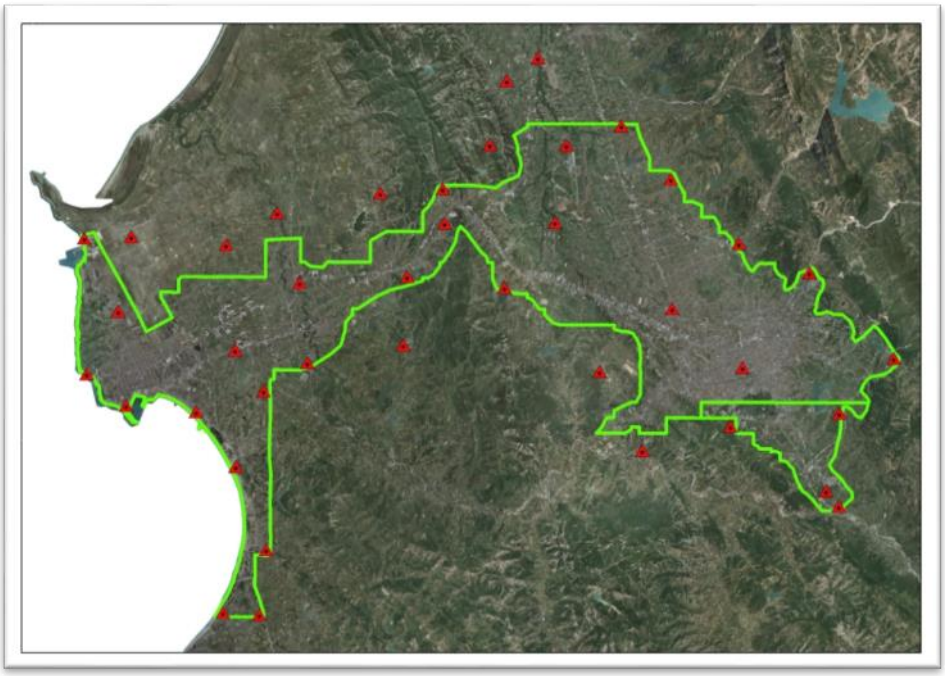
The purposes of installation GCP monuments or marks are, to establish points on which to be placed in the field and maintained until Aerial Photography is completed, and to make them identifiable on the photos.

(2) Plan

Plan is one of the most important parts of a survey.

The concerning equipment, member of engineers, schedule, and the location of GCP and Levelling route shall be planned at the beginning of project.

The survey plan map that consist of the network of existing survey control points / benchmarks / planning GCP positions shall be designed on a topographic map.



(3) Reconnaissance

Based on the survey plan map, the existing survey control points / benchmarks / Levelling route shall be verified in the field. And select the best location for new GCP.

For the actual collection of GNSS data, the observing station must have a clear view of the sky.

Based on the reconnaissance, Network design of GNSS observation and Levelling route shall be determined.

Mark Location

A mark is useless if it is destroyed or lost. It is important to locate new marks in areas where they will be protected from damage caused by road and utility construction, farming operation, etc.

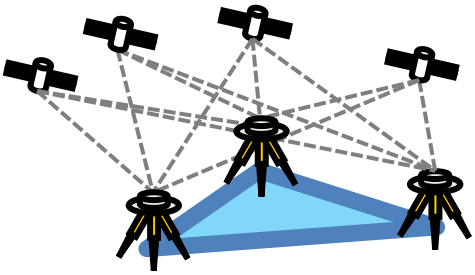
Marks should be located on accessible public place where possible. Parks, road area, churches, schools, hospitals, cemeteries, government buildings and government installations are good locations.

When necessary, marks can be located on private property with the permission of the property owner.

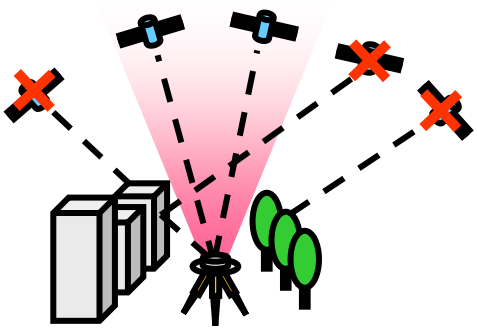
(4) Observation

GNSS

Horizontal control of GCP shall be observed by GNSS Static method. GNSS receivers that are set up at stations receive signals from the same 4 or more satellites simultaneously during a same time observation (a session), several-hours.



- Confirm the information of satellites and radio signals condition, and the balance of satellites positions in the plan.
- The observing station must have a clear view of the sky for at least 15 degrees or greater above the horizon during the observation when observable satellites are in the sky.



Levelling

Vertical control of GCP shall be observed by Differential Levelling in principal.

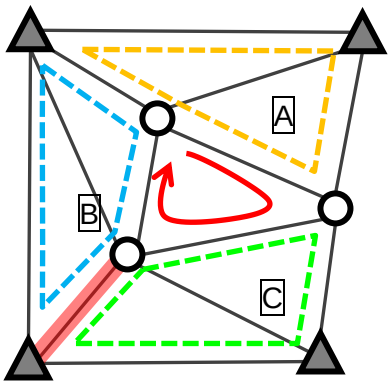
But, when vertical control cannot be determined by Differential Levelling due to the field condition, vertical control can be observed by Trigonometric Levelling.

(5) Calculation

GNSS

GNSS observation data is post-processed for analysis and result as follows.

- Baseline analysis
- Loop closures inspection
- Repeat baselines inspection
- Network adjustments (Minimum constrained network adjustment for evaluation, Fully constrained network adjustment)



Repeat Baselines

Loop Closure Check for 3 sessions by

If the Loop closures or differences of Repeat baselines inspections are not within the tolerances specified, re-observation is required.

Levelling

The differences of the Double-run levelling and the elevations of BMs that are turned through shall be calculated and checked from the beginning BM elevation.

If the closing error is not within the tolerance specified, the level run or part(s) of the level run must be re-observed to find the error.

(6) Documentation

The final Observation documents should be finalized the following information.

- GNSS Network design map
- GNSS Observation logs
- GNSS Baseline processing results
- GNSS Loop closures
- GNSS Repeat baselines
- GNSS Minimum constrained network adjustment results
- GNSS fully constrained network adjustment results
- Levelling route map
- Levelling calculation results
- GCP Final coordinates and elevations list
- GCP descriptions
- Reference stations and BMs list

4.2. Aerial Photo Signal

(1) General

Aerial Photo Signal is a marking control point with target before the flight (Pre-marking).

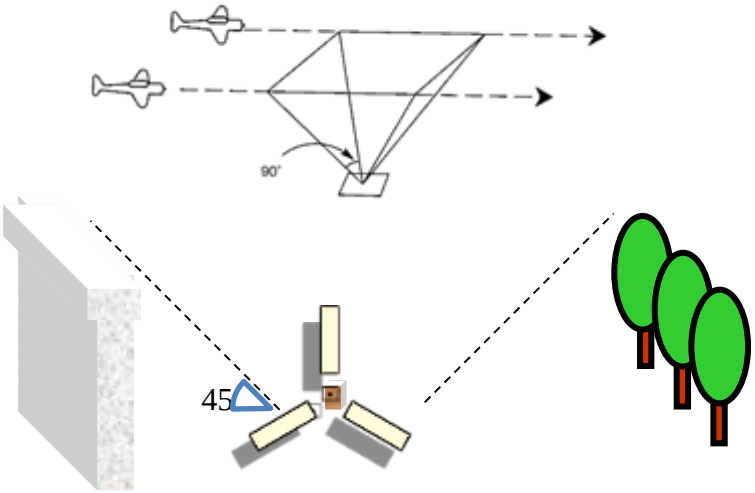
Existing survey points in the national control point network can also be targeted.

Even in the featureless terrain, Aerial Photo Signal always produces a well-defined marking. The placed targets in the field must be maintained until flying is completed.

(2) Location

It is important that the target to be placed in open areas to make them identifiable on the photos and maintained until Aerial Photography is completed.

The target must have a clear view of the sky, for at least 45 degrees or greater above the horizon, due to the obstructions will be blocked a view from the camera on aircraft.



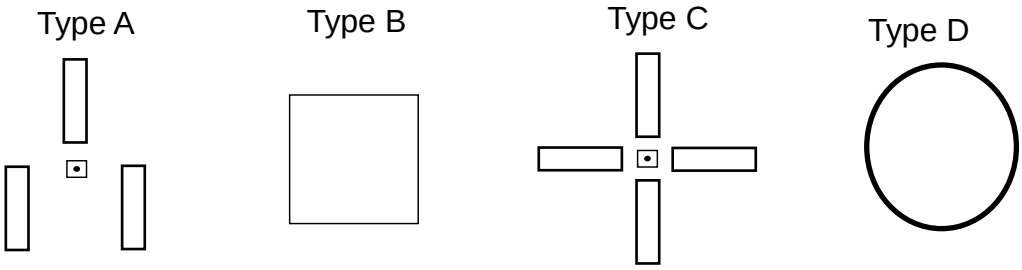
(3) Specification

Type and size

Target size should be designed on the basis of intended photo scale so that the target images are the optimum size for pointing on the photos.

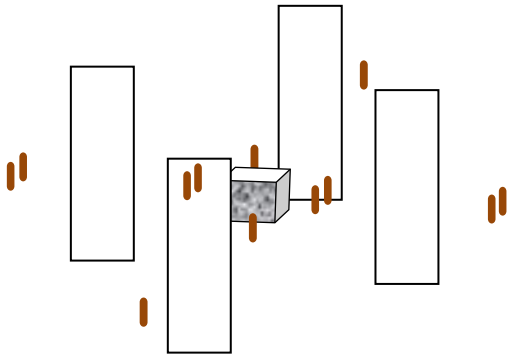
The legs of target help in identifying the targets on the photos and also in determining the exact centre of the target which are unclear.

The following type and size shall be used for the target.



type of the target is Type A and B.

Map Scale	Type A and C(cm)	Type B(cm)	Type D(cm)	Thick
1/2,000	40×10	40×40	Radius 30	4mm∼5mm



Colour

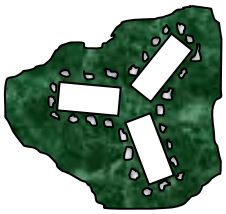
The basic colour of the target is white, and yellow or black can be used if field conditions require alternate colours.

The target should have good contrast with its background.

- White paint on new asphalt
- Black paint on new concrete
- Yellow paint on snow
- Small rocks in outline of the target

Materials

Targets can be made of cloth/plastic, or painted on plywood/fibreboard/similar sheet material, or on pavement.



Small rocks around the target for good contrast

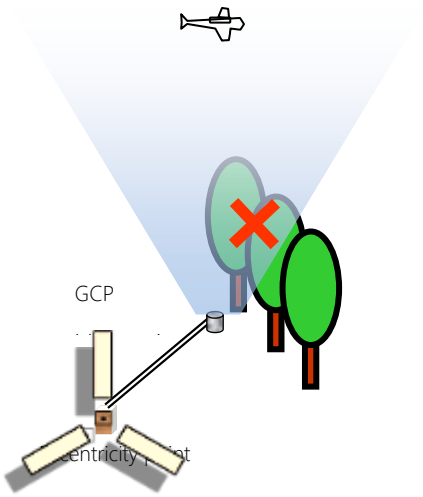
Maintenance

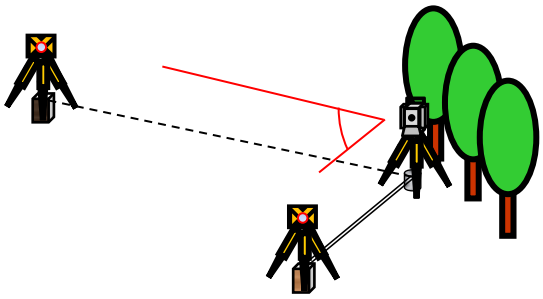
All targets should be maintained and protected from or restored after damage by man, animals, or weather until aerial photography is completed. If the target has been moved from its proper position, or damaged or lost, targets must be replaced with a new flight.

(4) Eccentricity

If a target cannot be placed at a GCP due to the field conditions, the target can be placed at an eccentric point instead of the GCP.

The eccentricity point shall be determined its position between the main station, by measurement of distance, horizontal angle, and difference of height or vertical angle, using main station and another visible known control point.





(5) Inspection

As soon as after Aerial photography, identification of all targets shall be inspected on the photos. If some unidentified targets are found, as an alternative to replacing all unidentified targets with a new flight, pricking for photo control points can be used (Number of the pricking points must be less than 30% of all targets).

(6) Documentation

The final Aerial Photo Signal installation documents shall be finalized the following information.

- Aerial Photo Signal descriptions
- Aerial Photo Signals list
- Eccentricity processing results
- Quality control sheet

Digital Aerial Photography of Republic of Albania territory,
production of oriented aerial images, LiDAR data, DTM, Orthophoto and Training

GCP N° 10280	Index Map 1/25000 K-34-100-B-b

Nation	ALBANIA		
Local Government	TIRANË	Local Government unit	34
Municipality	DAJT		

ETRS89 Geographical Coordinates (ref. ALBPOS)		KRGJSH 2010 (ETRS89-TMzn)	
φ:	41°19'56,52404"N	N (m):	4577489,301
λ:	19°54'24,09666"E	E (m):	492189,209
Height Ellipsoidal (m):	474,035	Height Orthometric (m):	436,843

The orthometric heigths were calculated with the software ALBAGEO 3

Auxiliary Information
LOT 1

Permanent GPS Stations Connected	Errors	σ E (m)	σ N (m)	σ h (m)
ALBPOS Network		0,01	0,012	0,023

Marked GCP	13/04/2015
Measured GCP	13/04/2015

4.3. Pricking

(1) General

Pricking is a method to determine photo control points in the field that are clearly identifiable features on photos, after the flight (Postmarking).

Instead of replacing all unidentified targets that are found in the inspection after Aerial photography, new additional photo control points shall be selected by pricking.

(2) Method

Pricking shall be carried out as soon as after Aerial photography during field situation has not been changed.

Extreme care should be taken to identify features accurately due to the natural feature is not as well defined as a target of Aerial Photo Signal. Therefore, stereoscope shall be used with photos to identify features in the field.

Once a photo control point is selected, its position on the photos and in the field shall be recorded on a brief description or sketch.

Then, the photo control points shall be observed by GNSS and Levelling measurement in order to calculate the coordinates from the known control points in the field.

Horizontal control requirements

Horizontal positions on the photos must be precisely measured. Photo control points for horizontal control must be very sharp and well defined horizontally.

Vertical control requirements

Vertical positions on the photos must not be exact position and well defined horizontally. However, should be well defined vertically.

The best location is relatively flat areas with some natural features nearby that assist with stereoscopic depth perception.

Horizontal control Location

Vertical control Location

(3) Documentation

The final Pricking documents shall be finalized the following information.

- Pricking Point Descriptions
- Eccentricity processing results
- Pricking points map
- Quality control sheet

end