Hellenic Cadastre
Quality Checking of Ortho Imagery

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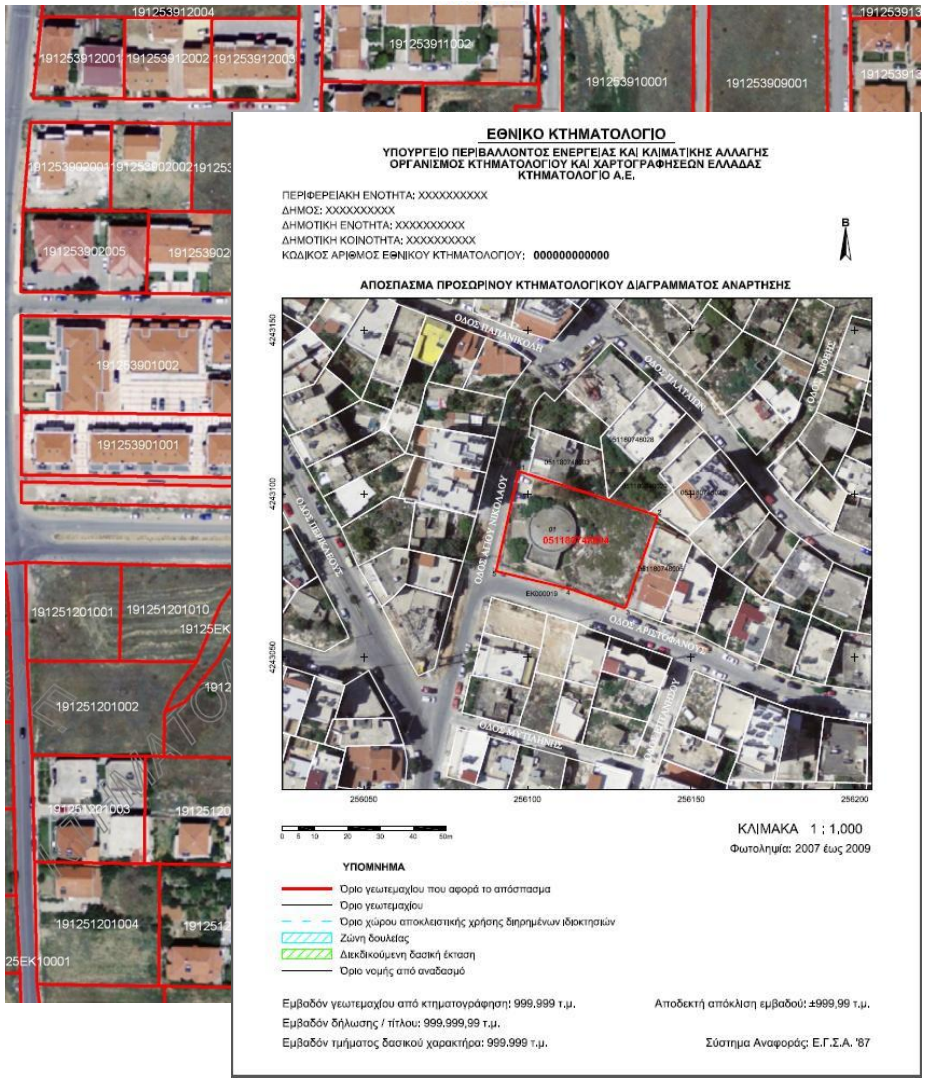
Background

The Hellenic Cadastre has been under development since 1995 and we are expected to finish till the end of 2021

- Partially created using External Contractors



Orthoimagery

- ✓ *Collection of spatial cadastral information using digitization of parcel boundaries in orthoimages*
- ✓ *visualization of cadastral information*

History

- ✓ *Pilot projects (340 municipalities)*
- ✓ *Main projects*

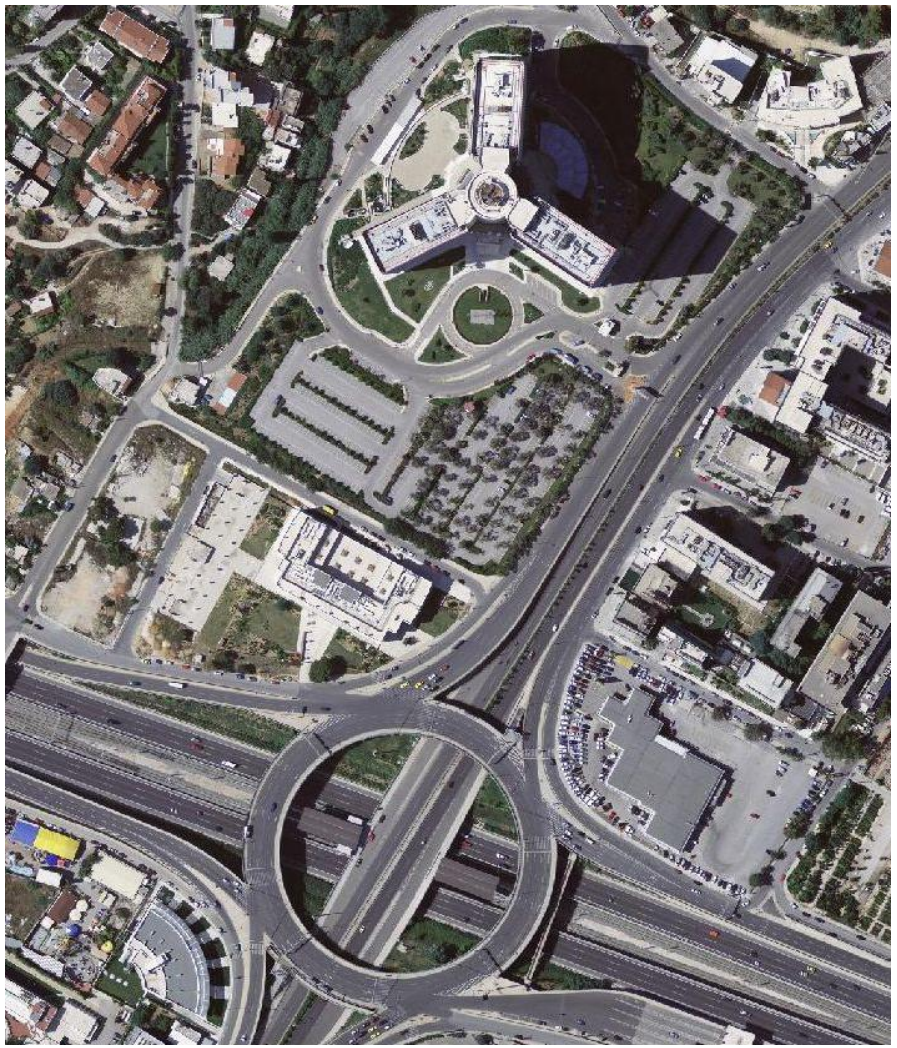
Hellenic Cadastre basemaps
Basic characteristics

Very Large Scale Orthophotos (VLSO)
Fully Rectified Imagery (True Orthos)
58 cities - 3.959 km^2
Flights: 2007 – 2008

Orthophotos	
Pixel size (GSD):	0.20 m
Radiometric Resolution:	True Color (24 bit)
No of images:	13.125
Image type	JPEG2000
Image dimensions	800 m X 600 m
DSM	
Pixel size (GSD):	0.80 m
Image type	ESRI Floating Point Grid
Perimetric covering:	80 m

http://www.ktimatologio.gr

ORTHOPHOTOS VIEWING SERVICE



http://gis.ktimanet.gr/wms/ktbasemap/default.aspx

Hellenic Cadastre basemaps
Basic characteristics

Large Scale Orthophotos (LSO) 3 contracts All Greece ~ 132.000 km^2 Flights: 2007 – 2009	
Orthophotos	
Pixel size (GSD):	0.50 m
Radiometric Resolution:	True Color (24 bit)
No of images:	13.150
Image type	JPEG2000
Image dimensions	4000 m X 3000 m
DEM	
Pixel size (GSD):	5.00 m
Image type	ESRI Floating Point Grid
Perimetric covering:	300 m

http://www.ktimatologio.gr

ORTHOPHOTOS VIEWING SERVICE

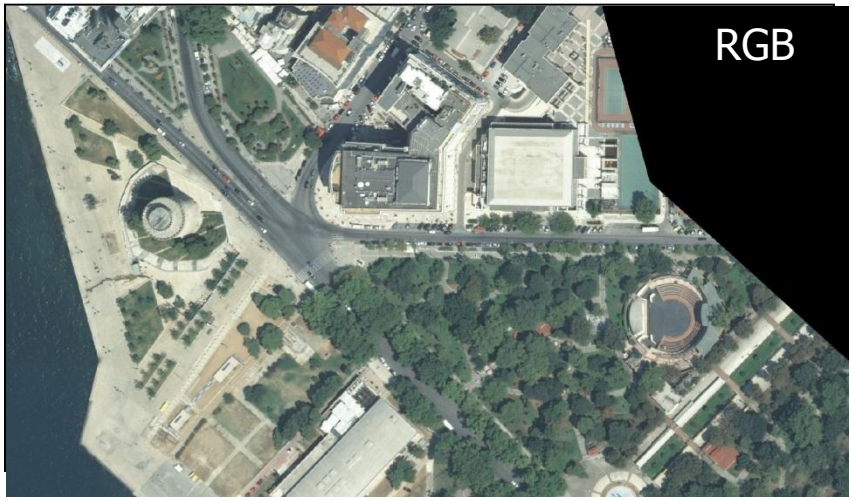
http://gis.ktimanet.gr/wms/ktbasemap/default.aspx

Hellenic Cadastre basemaps
Basic characteristics

Orthophotos & DTM (COAST)
Orthophotos and DTM (bare earth)
Total length ~ 15.994 km
on generalized lines
Flights: 2007 – 2008

Orthophotos	
Pixel size (GSD):	0.25 m
Radiometric Resolution:	True Color, NIR
No of images:	37.338
Image type	TIFF
Image dimensions	800 m X 600 m
DTM	
Pixel size (GSD):	1.00 m
Image type	ESRI Floating Point Grid
Perimetric covering:	80 m

300 meter-wide zone along the coast of the country and the banks of the 'large' lakes and 'navigable' rivers.



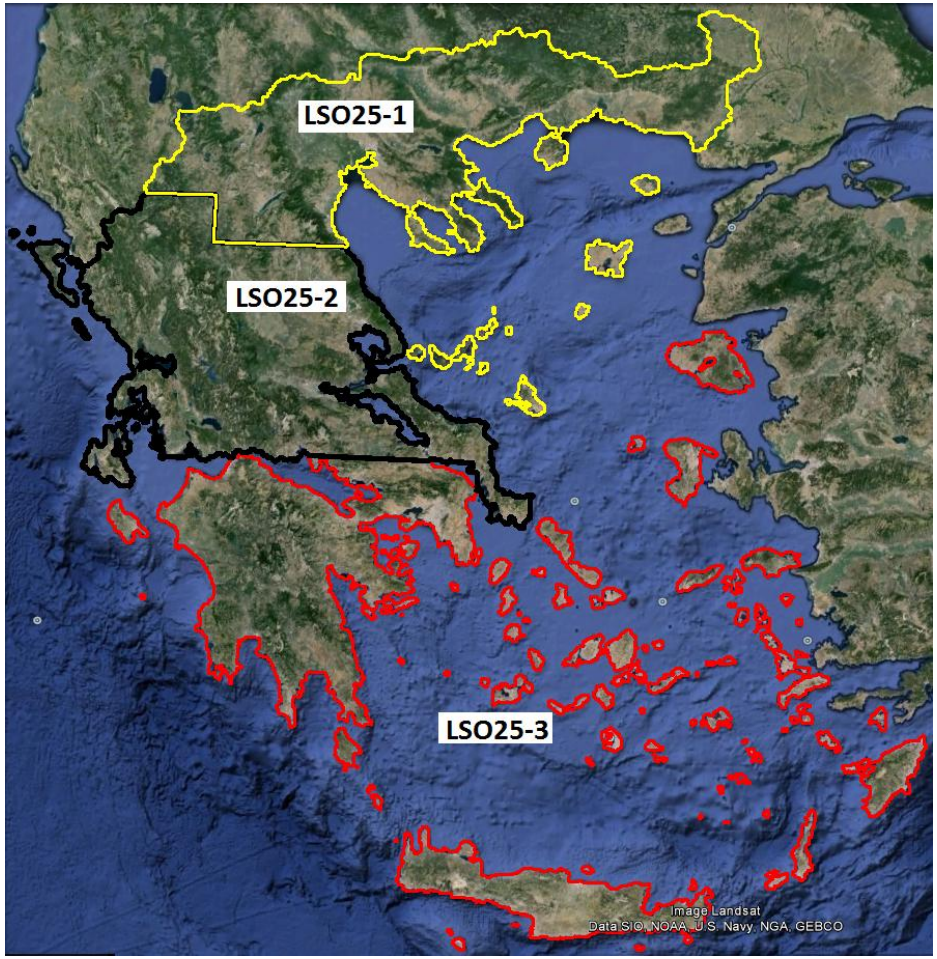
Hellenic Cadastre basemaps
Basic characteristics

Historical Orthophotos
From year 1945 / 1960
All Greece ~ 132.000 km^2
Flights: 1945 & 1960

Orthophotos	
Pixel size (GSD):	1.00 m
Radiometric Resolution:	Panchromatic (8 bit)
No of images:	13.315
Image type	TIFF
Image dimensions	4000 m X 3000 m
DSM	
Pixel size (GSD):	40.00 m
Image type	ESRI Floating Point Grid
Perimetric covering:	300 m

Camera: Military non photogrammetric

Large Scale Orthophotos 25
Basic characteristics



Three contracts (Oct 2014 ~ Sep 2016)

Cover: Greece ~ 132.000km^2

Flights: 2014 - 2015

Orthophotos

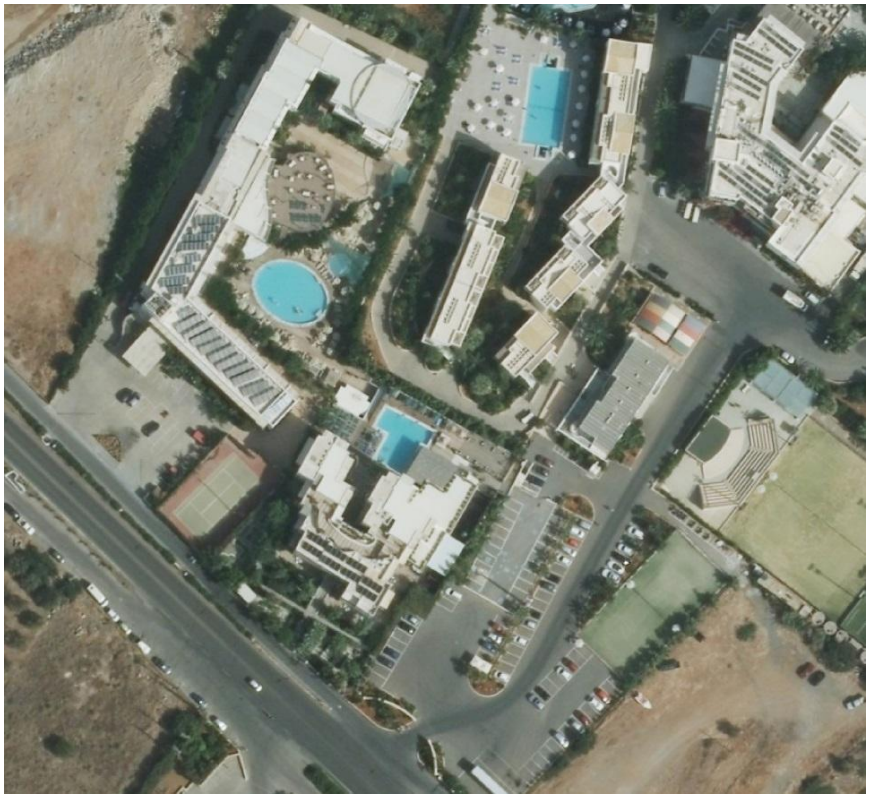
Pixel size (GSD)	0.25 m
Radiometric resolution	True Color, NIR
Image type	JPEG2000 + Worldfile
Image dimensions	2000 m X 1500 m
Number of images	48.051

Digital Elevation Model

Pixel size (GSD)	2.00 m
Perimetric covering	150 m
Image type	GeoTiff Floating
Image dimensions	2300 m X 1800 m

3 contracts ~ €3.0 M

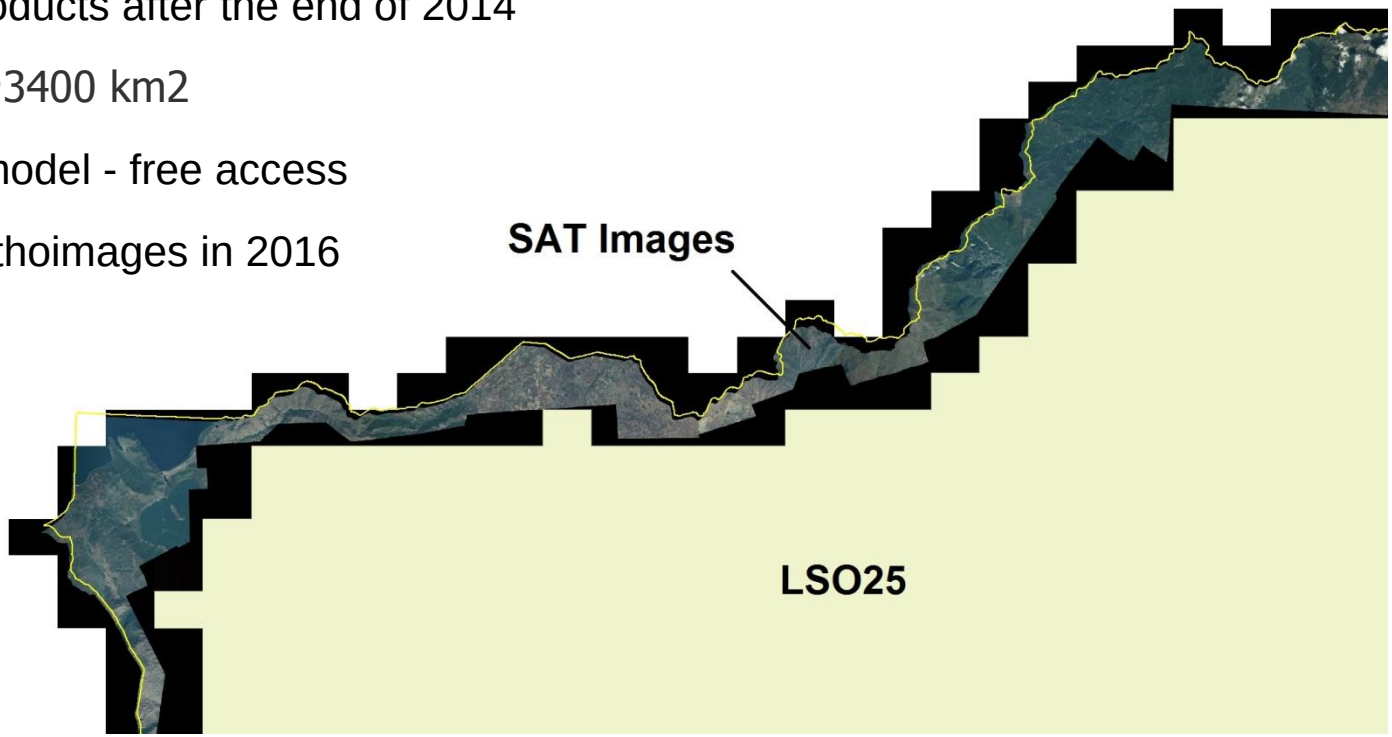
Large Scale Orthophotos 25 Samples



Large Scale Orthophotos 25
LSO vs LSO25

Large Scale Orthophotos 25
Border regions – Flight constraints

- Border constraints in Northern Greece: Satellite images WorldView II
- 0,50 m GSD at nadir point
- Satellite products after the end of 2014
- Coverage ~3400 km2
- Licensing model - free access
- Produce orthoimages in 2016



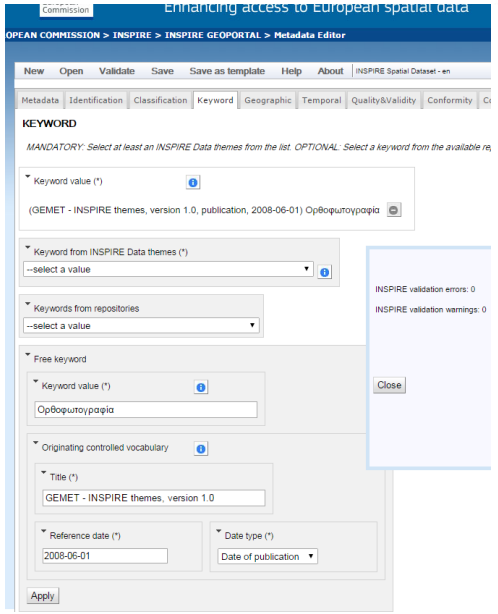
Large Scale Orthophotos 25 Metadata

Project LSO25

Metadata

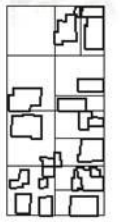
1) Production of data according to the requirements of Greek Law 3882/2010 "National Infrastructure for Geospatial Information" (Implementing the Directive 2007/2/EC INSPIRE).
2) For all project deliverables (intermediate and final), INSPIRE metadata files were created.
3) Compatibility check of metadata for all orthoimages and DEMs using INSPIRE metadata editor.
4) Due to limited functionality of the INSPIRE metadata editor, it was not possible to check the compatibility of aerial photographs

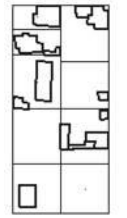
INSPIRE metadata editor



(http://inspire-geoportal.ec.europa.eu/editor/)

Large Scale Orthophotos 25
Quality checking of deliverables





Audit basic categories

- Completeness of deliverables
- Visual inspection
- Radiometry checks
- Geometric accuracy checks

Quality plan

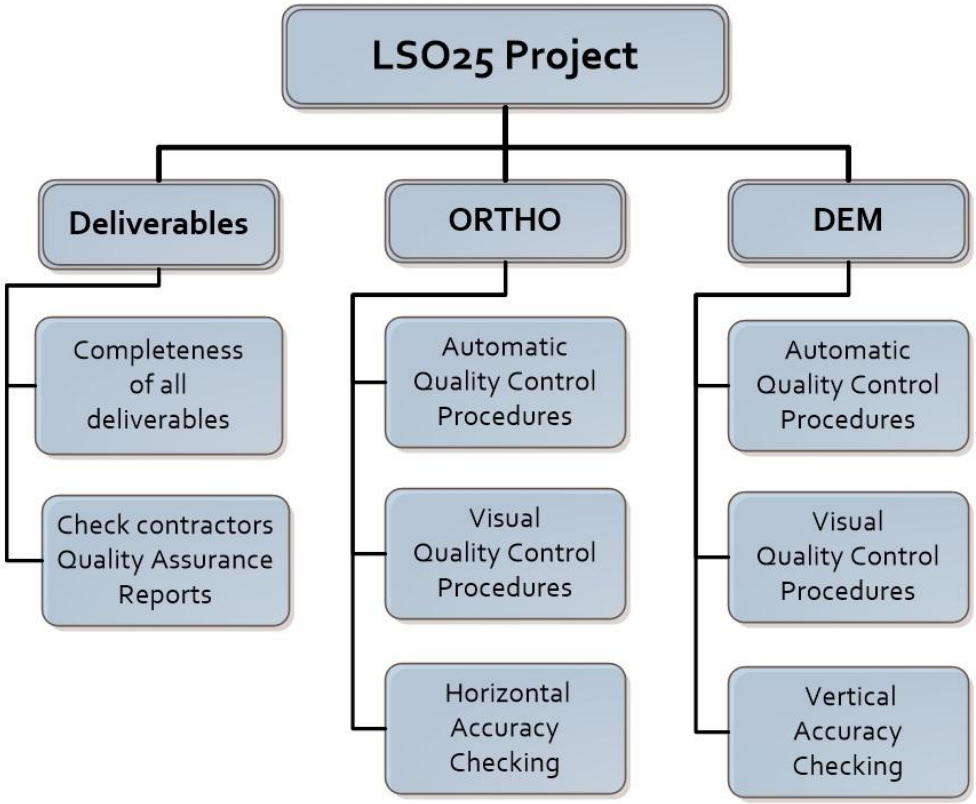
In order to check and assure the products quality, agency draw up a internal Quality Plan.

The quality plan is drawn up according to the

- ISO 10005:2005 Quality management systems - Guidelines for quality plans
- Ministerial decisions no 501:2000, no 502:2003 and no 215:2009

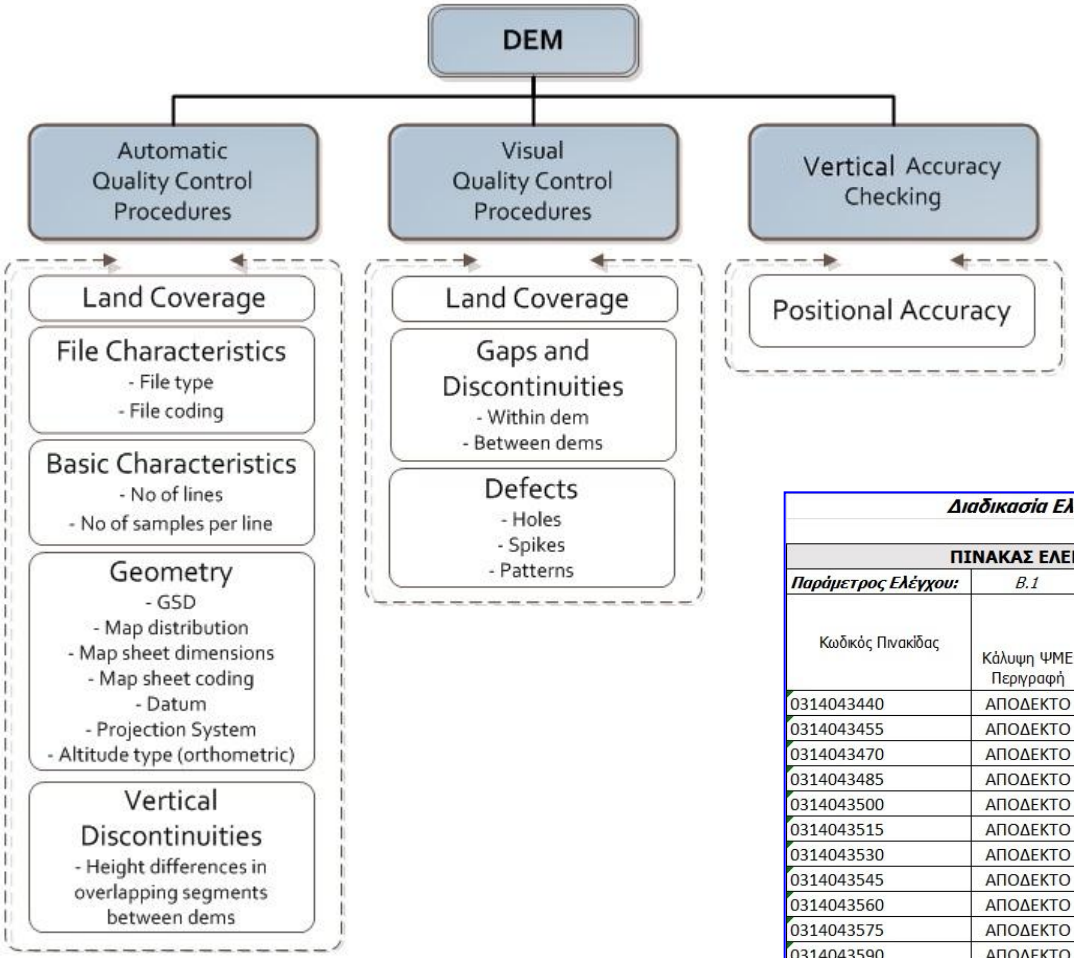
Project Quality Plan can be defined as a set of activities planned at the beginning of the project that helps inspect and achieve quality in the Project being executed.

Large Scale Orthophotos 25
QC Work Breakdown Structure



Deliverables
Camera Calibration Report
Flight Plans
Aerial GPS/INS data
Aerial Photos
Control Points field Measurements (GPS data)
Control Points Deliverables
Orthoimages
Digital Elevation Models
Intermediate deliverables (breaklines, DEM Seamlines etc)
Quality Assurance Reports
Project Report

Large Scale Orthophotos 25
QC of DEMs (1)



Quality Control Records

Shapefile for every separate Quality parameter (visual QC)

Excel file for every separate Quality parameter (all)

Διαδικασία Ελέγχου Ποιότητας Ψηφιακού Μοντέλου Εδάφους: 2

ΠΙΝΑΚΑΣ ΕΛΕΓΧΟΥ ΠΟΙΟΤΗΤΑΣ ΨΗΦΙΑΚΟΥ ΜΟΝΤΕΛΟΥ ΕΔΑΦΟΥΣ

Παράμετρος Ελέγχου:	*Β.1*	*Β.2*	*Γ.8*	*Γ.9*	*Γ.10*	*Γ.11*	
Κωδικός Πινακίδας	Κάλυψη ΨΜΕ Περιγραφή	Πληρότητα	Συνέχεια DEM Κενά - Ασυνέχειες	Συνέχεια DEM Αιχμές - Τρύπες	Γενική εμφάνιση ΨΜΕ	Συνένωση γειτονικών ΨΜΕ	Αποδεκτή
0314043440	ΑΠΟΔΕΚΤΟ	✓	✓	✓	ΑΠΟΔΕΚΤΟ	ΑΠΟΔΕΚΤΟ	ΑΠΟΔΕΚΤΟ
0314043455	ΑΠΟΔΕΚΤΟ	✓	✓	✓	ΑΠΟΔΕΚΤΟ	ΑΠΟΔΕΚΤΟ	ΑΠΟΔΕΚΤΟ
0314043470	ΑΠΟΔΕΚΤΟ	✓	✓	✓	ΑΠΟΔΕΚΤΟ	ΑΠΟΔΕΚΤΟ	ΑΠΟΔΕΚΤΟ
0314043485	ΑΠΟΔΕΚΤΟ	✓	✓	✓	ΑΠΟΔΕΚΤΟ	ΑΠΟΔΕΚΤΟ	ΑΠΟΔΕΚΤΟ
0314043500	ΑΠΟΔΕΚΤΟ	✓	✓	✓	ΑΠΟΔΕΚΤΟ	ΑΠΟΔΕΚΤΟ	ΑΠΟΔΕΚΤΟ
0314043515	ΑΠΟΔΕΚΤΟ	✓	✓	✓	ΑΠΟΔΕΚΤΟ	ΑΠΟΔΕΚΤΟ	ΑΠΟΔΕΚΤΟ
0314043530	ΑΠΟΔΕΚΤΟ	✓	✓	✓	ΑΠΟΔΕΚΤΟ	ΑΠΟΔΕΚΤΟ	ΑΠΟΔΕΚΤΟ
0314043545	ΑΠΟΔΕΚΤΟ	✓	✓	✓	ΑΠΟΔΕΚΤΟ	ΑΠΟΔΕΚΤΟ	ΑΠΟΔΕΚΤΟ
0314043560	ΑΠΟΔΕΚΤΟ	✓	✓	✓	ΑΠΟΔΕΚΤΟ	ΑΠΟΔΕΚΤΟ	ΑΠΟΔΕΚΤΟ
0314043575	ΑΠΟΔΕΚΤΟ	✓	✓	✓	ΑΠΟΔΕΚΤΟ	ΑΠΟΔΕΚΤΟ	ΑΠΟΔΕΚΤΟ
0314043590	ΑΠΟΔΕΚΤΟ	✓	✓	✓	ΑΠΟΔΕΚΤΟ	ΑΠΟΔΕΚΤΟ	ΑΠΟΔΕΚΤΟ
0314043605	ΑΠΟΔΕΚΤΟ	✓	✓	✓	ΑΠΟΔΕΚΤΟ	ΑΠΟΔΕΚΤΟ	ΑΠΟΔΕΚΤΟ
0314043620	ΑΠΟΔΕΚΤΟ	✓	✓	☒	ΑΠΟΔΕΚΤΟ	ΑΠΟΔΕΚΤΟ	ΜΗ ΑΠΟΔΕΚΤΟ
0314043635	ΑΠΟΔΕΚΤΟ	✓	✓	✓	ΑΠΟΔΕΚΤΟ	ΑΠΟΔΕΚΤΟ	ΑΠΟΔΕΚΤΟ
0314043650	ΑΠΟΔΕΚΤΟ	✓	✓	✓	ΑΠΟΔΕΚΤΟ	ΑΠΟΔΕΚΤΟ	ΑΠΟΔΕΚΤΟ

Large Scale Orthophotos 25
QC of DEMs (2)

DEM

Product Specification

Determine the data quality result (methodology of visual inspection)

1. Conversion from Geotiff to Hillshade
2. Upload to GIS in sets that contained at least 80 hillshades
3. Visual inspection of hillshades at scale 1:1 or 2:1
4. When detected non-compliance, the auditor digitizes the problem area with polygon and classifies the possible error

Shapefile

Excel File

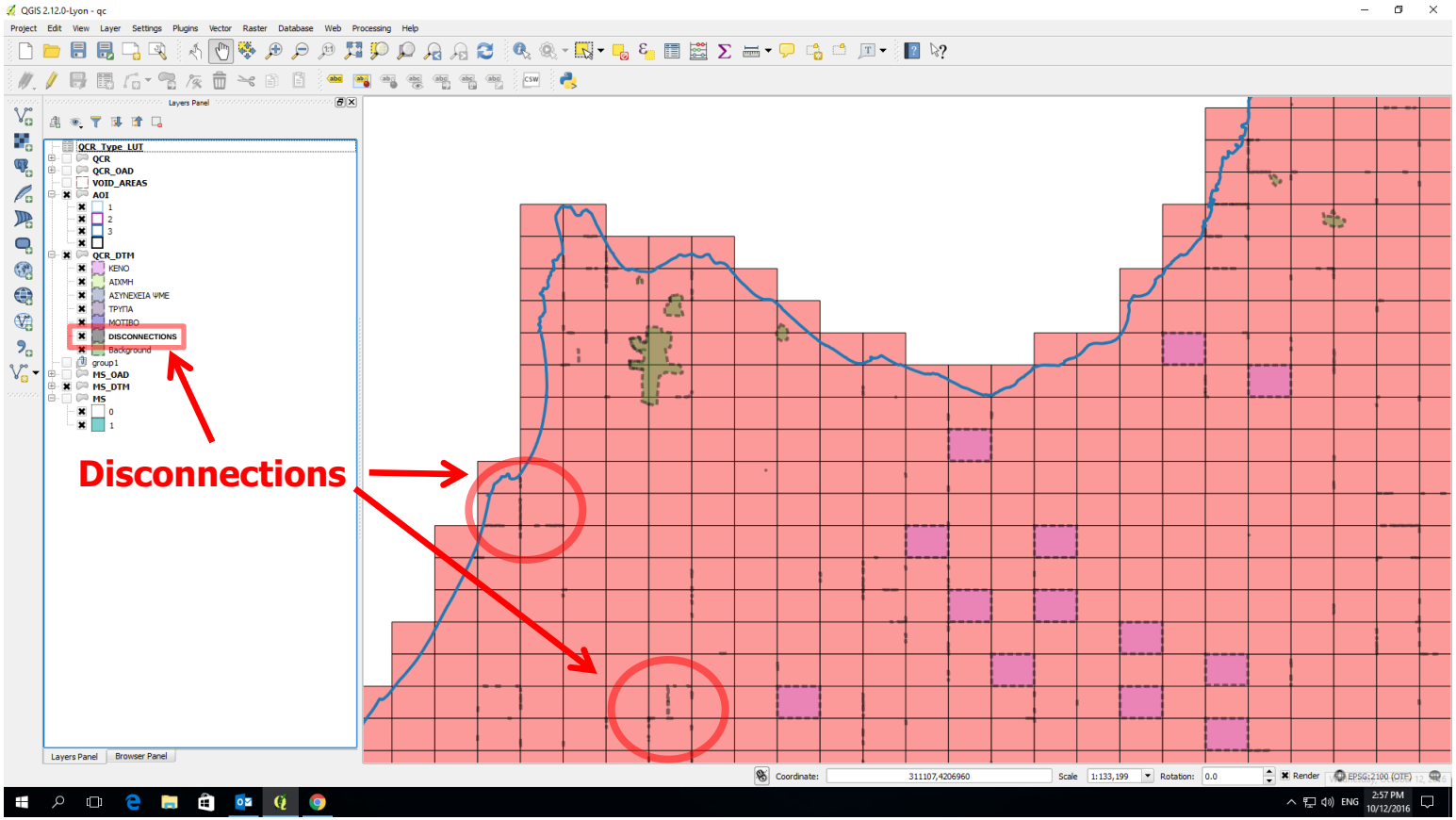
Validation of results by HC

Sent report and corrective actions to Contractor

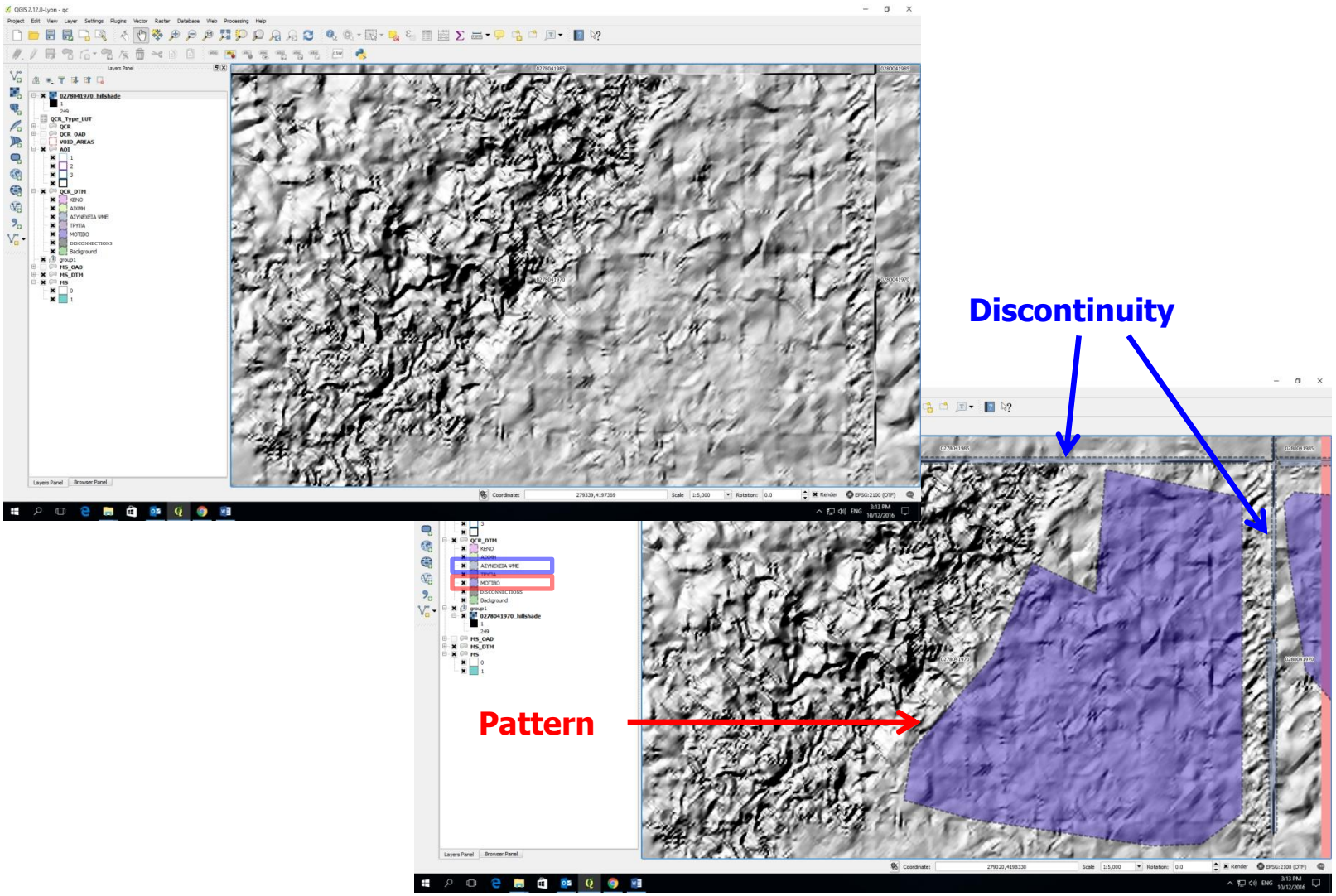
The procedure of quality inspection, quality parameters and the determination of conformity levels and acceptance limits are described in detail in technical specifications.

The QC result is recorded in special forms and reports and compared to predetermined acceptance limit, in order to determine whether the deliverable will be accepted or will be returned to the Contractor for corrections and additions.

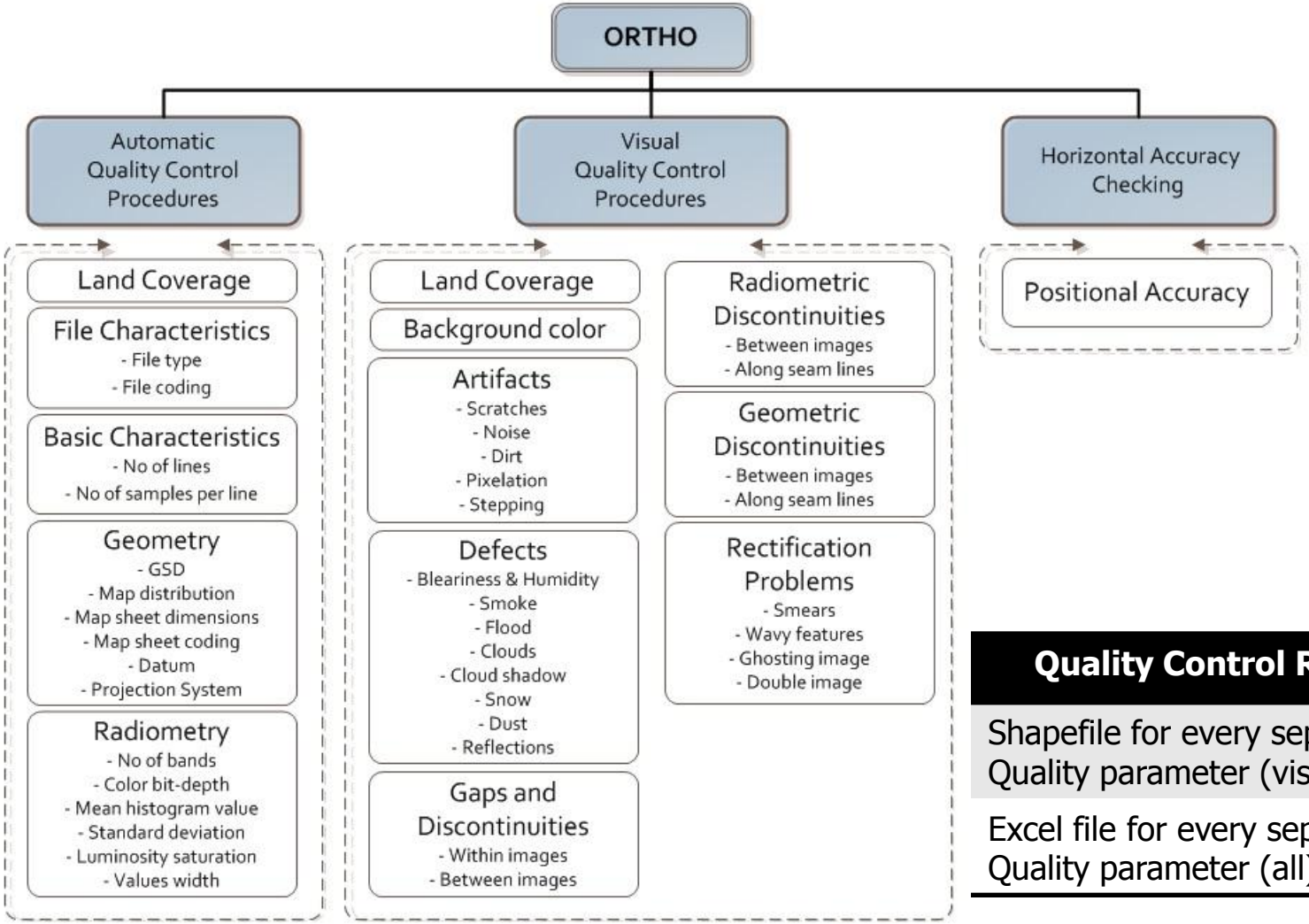
Large Scale Orthophotos 25
QC of DEMs (3)



Large Scale Orthophotos 25
QC of DEMs (4)



Large Scale Orthophotos 25
QC of Orthoimages (1)



Quality Control Records

Shapefile for every separate Quality parameter (visual QC)

Excel file for every separate Quality parameter (all)

Large Scale Orthophotos 25
QC of Orthoimages (2)

ORTHO

Product Specification

Determine the data quality result (methodology of visual inspection)

1. Upload to GIS in sets that contained at least 20 images
2. Visual inspection of orthoimages at scale 1:1
3. When detected non-compliance, the auditor digitizes the problem area with polygon and classifies the possible error

Shapefile

Excel File

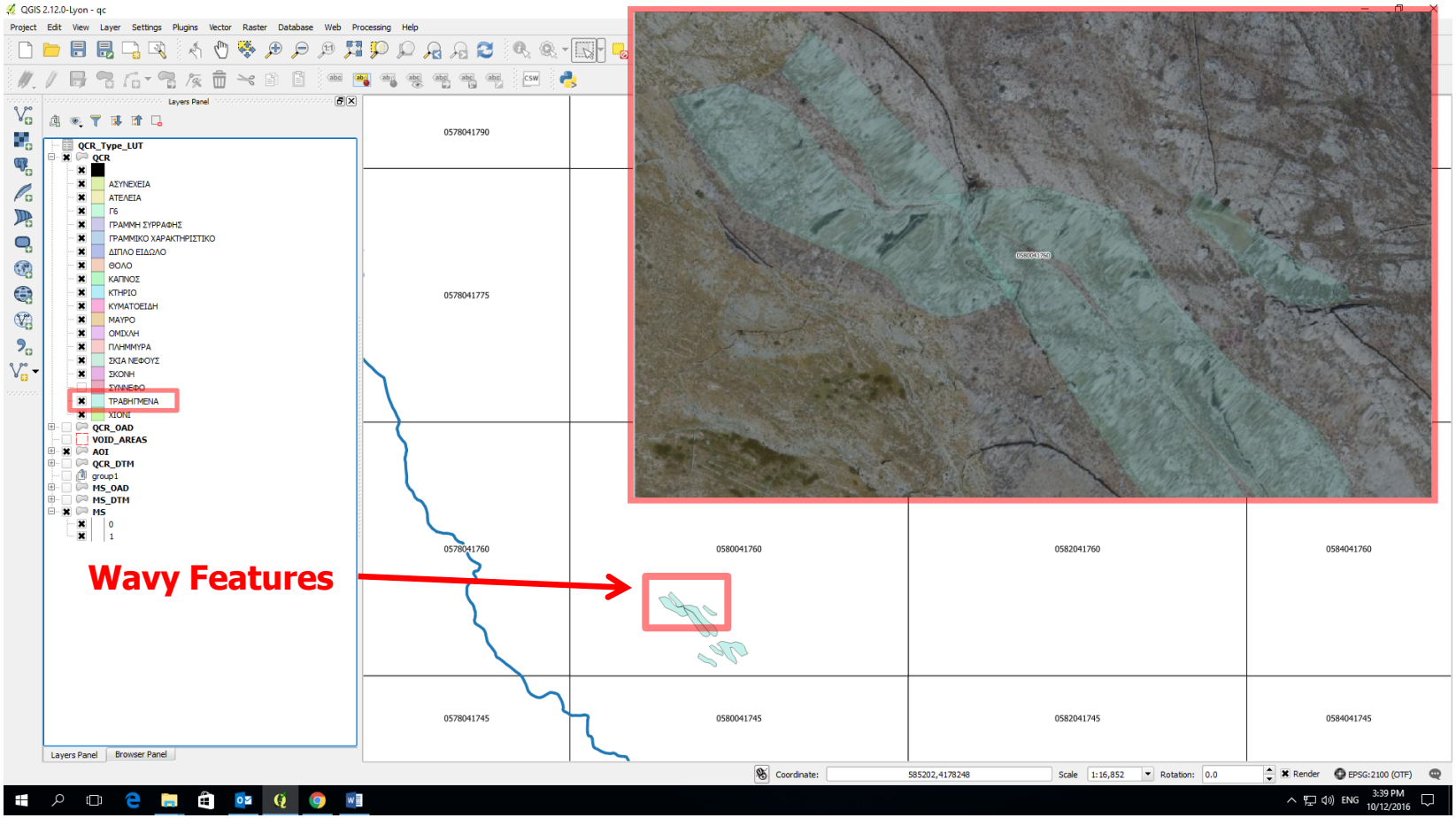
Validation of results by HC

Sent report and corrective actions to Contractor

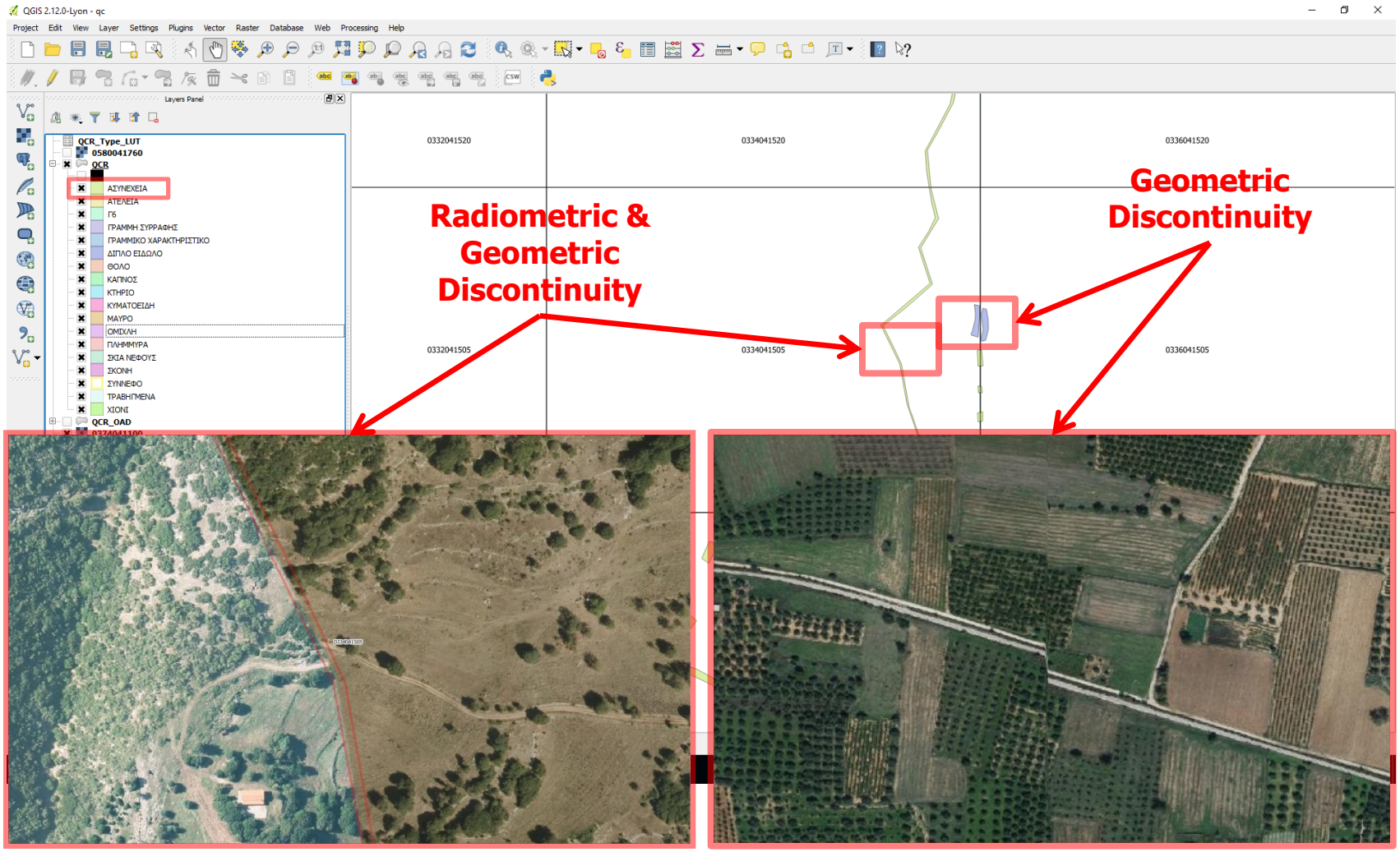
The procedure of quality inspection, quality parameters and the determination of conformity levels and acceptance limits are described in detail in technical specifications.

The QC result is recorded in special forms and reports and compared to predetermined acceptance limit, in order to determine whether the deliverable will be accepted or will be returned to the Contractor for corrections and additions.

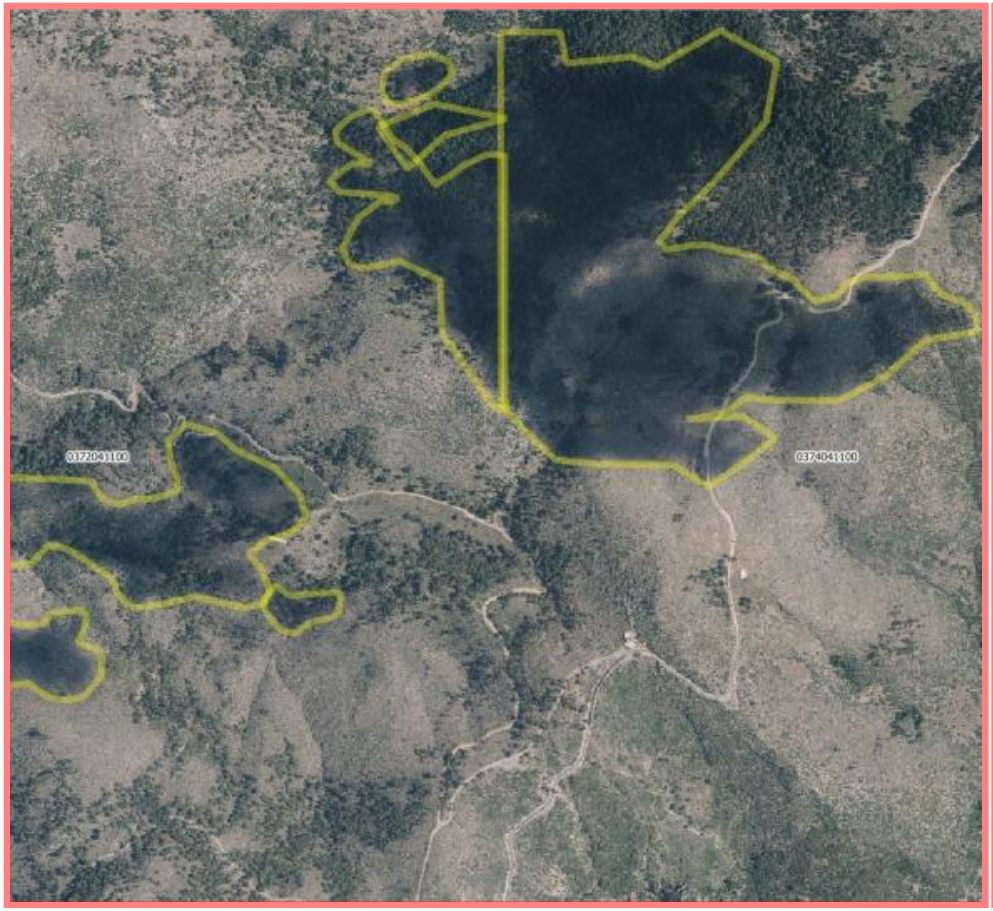
Large Scale Orthophotos 25
QC of Orthoimages (3)



Large Scale Orthophotos 25
QC of Orthoimages (4)



Large Scale Orthophotos 25
QC of Orthoimages (5)



Cloud Shadow

Double image

Large Scale Orthophotos 25
Orthoimages – Geometric Accuracy (1)

GCP sampling

- Settlements, engineering structures, road networks
- Sampling units were selected by the agency
- Fast Static & RTK GPS methods (using HEPOS)

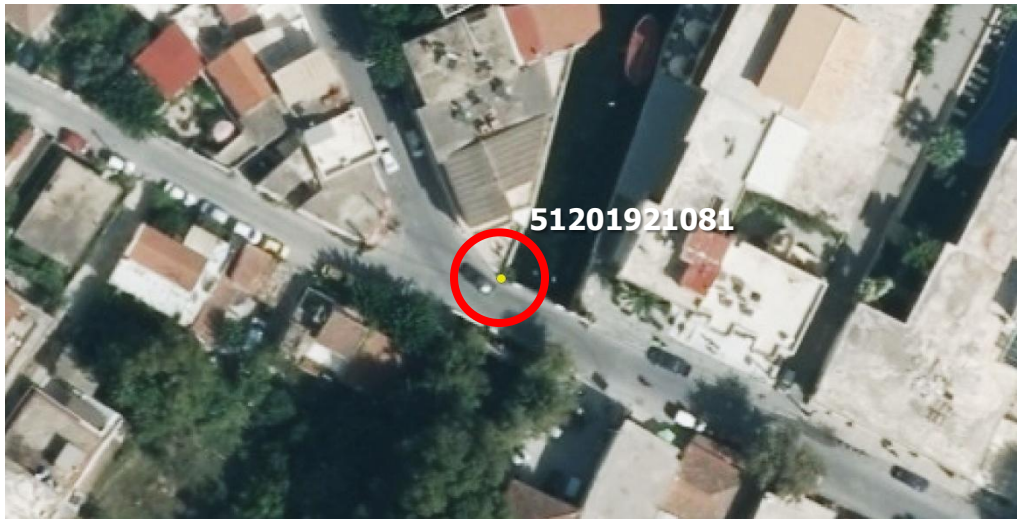
Sample

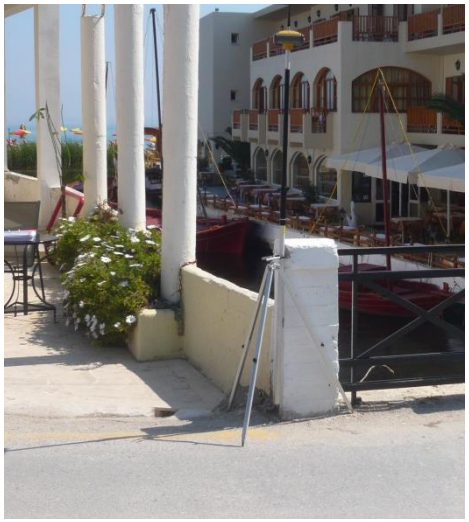
QC_LSO25: 2500 gcps

Old Basemaps gcps: 2200 gcps

***Total**: 4700 gcps*

Large Scale Orthophotos 25
Geometric Accuracy (2)



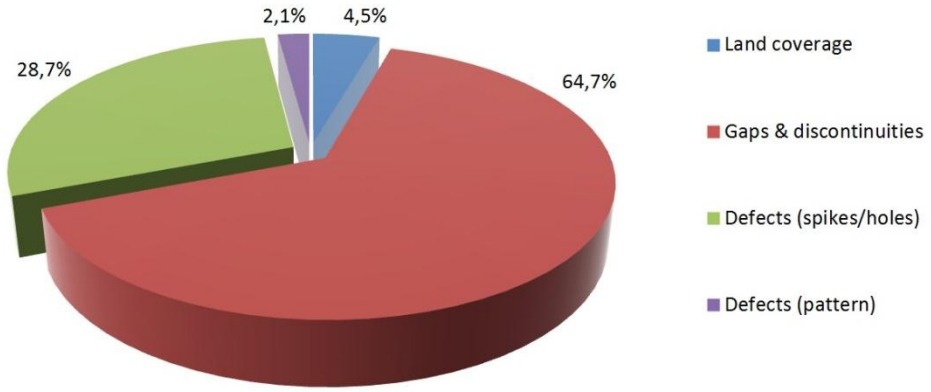


	Αριθμός Σημείου	Περιγραφή Σημείου	X Ανεξάρτητο	X Υποβάθρου	ΔX	ΔX²	Y Ανεξάρτητο	Y Υποβάθρου	ΔY	ΔY²	ΔX²+ΔY²
82	51201894042	Όριο/ Χ.Σ. Γεωτ.	514770.492	514770.54	-0.049	0.002	3895386.34	3895386.08	0.258	0.067	0.069
83	51201921082	Όριο/ Χ.Σ. Γεωτ.	515075.739	515075.48	0.258	0.067	3923443.23	3923443.23	0.006	0.000	0.067
84	51201921083	Όριο/ Χ.Σ. Γεωτ.	515466.057	515466.17	-0.108	0.012	3923082.15	3923082.16	-0.010	0.000	0.012
85	51201900044	Όριο/ Χ.Σ. Γεωτ.	515552.048	515552.07	-0.025	0.001	3901178.39	3901178.29	0.099	0.010	0.010
86	51201912047	Όριο/ Χ.Σ. Γεωτ.	515578.488	515578.74	-0.249	0.062	3912759.59	3912759.73	-0.145	0.021	0.083
87	51201921081	Όριο/ Χ.Σ. Γεωτ.	515604.126	515604.20	-0.073	0.005	3922887.09	3922887.33	-0.247	0.061	0.066
88	51201927011	Όριο/ Χ.Σ. Γεωτ.	515618.808	515618.87	-0.061	0.004	3928636.56	3928636.76	-0.201	0.040	0.044
89	51601921080	Όριο/ Χ.Σ. Γεωτ.	516101.515	516101.48	0.040	0.002	3922984.35	3922984.54	-0.194	0.038	0.039

Product	RMSEx	RMSEy	RMSExy	RMSEz	Accuracy RMSExy*1.73 for 95% confidence level	Accuracy Checking using control points (field measurements)	Achieved RMSExy / RMSEz
Ortho	≤ 0,25m	≤ 0,25m	≤ 0,35m		0.60m	4.300 gcp	0.18 m
DEM				≤ 0,70m	1.21m	2.500 gcp	0.38 m

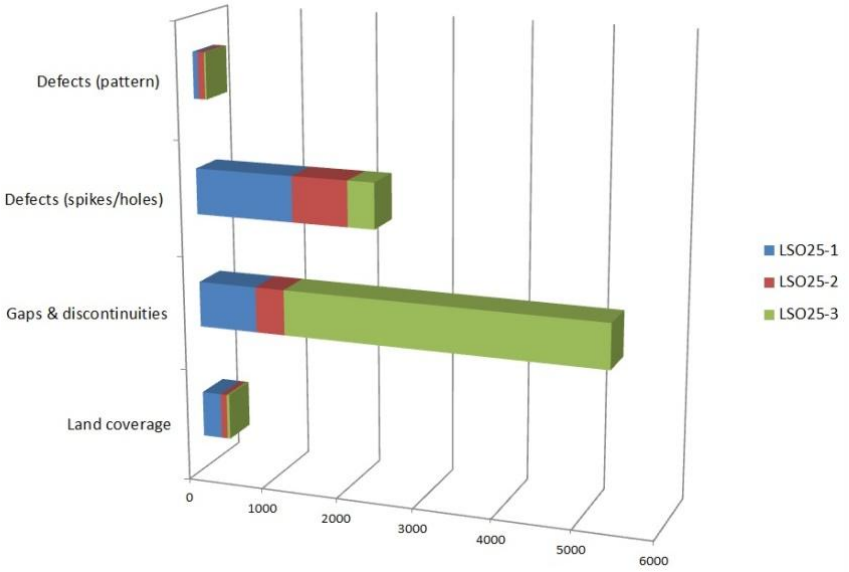
Large Scale Orthophotos 25
Geometric Accuracy (3)

DEM Visual Quality Control - Results

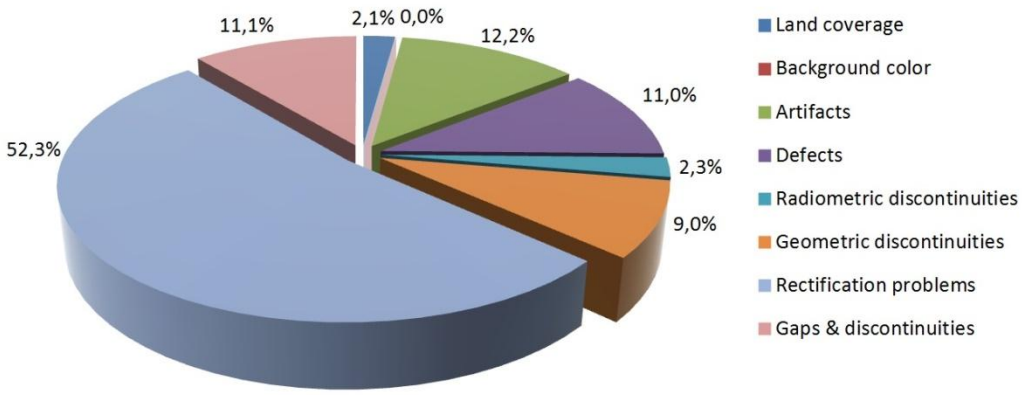


Error Classification	No of Polygons
Land coverage	369
Gaps & discontinuities	5.320
Defects (spikes/holes)	2.358
Defects (pattern)	174

Error Classification	No of Polygons		
	LSO25-1	LSO25-2	LSO25-3
Land coverage	251	82	36
Gaps & discontinuities	767	381	4.172
Defects (spikes/holes)	1.282	729	347
Defects (pattern)	68	85	21

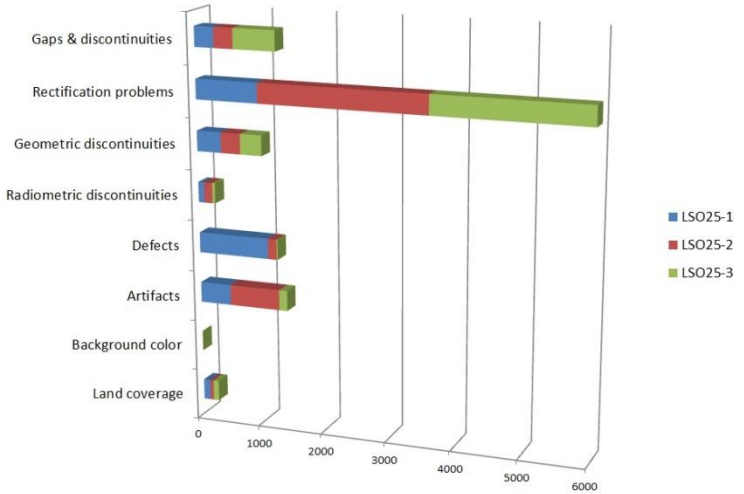


Ortho Visual Quality Control - Results



Error Classification	No of Polygons
Land coverage	244
Background color	0
Artifacts	1.394
Defects	1.254
Radiometric discontinuities	267
Geometric discontinuities	1.026
Rectification problems	5.981
Gaps & discontinuities	1265

Error Classification	No of Polygons		
	LSO25-1	LSO25-2	LSO25-3
Land coverage	104	54	86
Background color	0	0	0
Artifacts	479	787	128
Defects	1.100	139	15
Radiometric discontinuities	92	133	42
Geometric discontinuities	382	306	338
Rectification problems	972	2.613	2.396
Gaps & discontinuities	304	303	658



Project QC-LSO25

Project QC-LSO25	
Total cost	**€ 169.000**

Outsourced Quality Control

Two groups with separate tasks:

- ✓ Spatial Accuracy QC
  - *Horizontal Accuracy*
  - *Heights (DEM)*
  - *2.500 ground control points*
- ✓ Image & DEM QC
  - *Radiometry*
  - *Image Quality*
  - *~132.000 km²*

Start: February 2016
Finish: August 2016

Project QC-LSO25	Project Team
Total	28 members
Field Measurements	8 members
Visual Inspection	8 members

Productivity per man-day (average)	Visual Inspection	
	DEM files	Orthoimages
Start of Project	180~200	45~50
1st Week	200~350	80~90
1st Month	400~500	120~150

The productivity depends on the following factors:

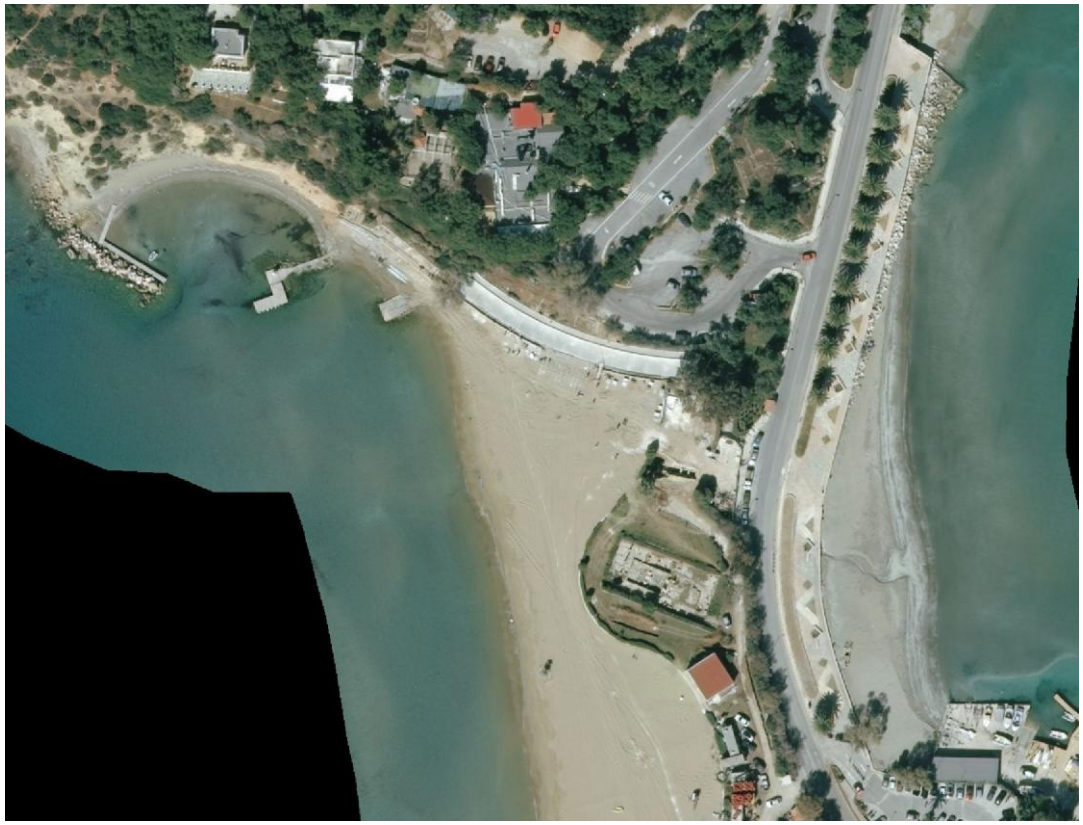
1. if the images is complete covered by land or not (islands and coastal zones)
2. if they have many errors or not
3. if contains urban or rural area

Conclusions

- ✓ The results of quality control performed in the deliverables meet compliance criteria set in the specifications.
- ✓ To accept the data, needed 1 or 2 in extra cases re-submissions by the data producer with corrections or clarifications resulting from the quality checking.

The project's success is mainly based on following factors:

- Detailed technical specifications resulting from the HC extensive experience of controlling older basemaps (VLSO, LSO, COAST, Historical orthoimages)
- Mandatory implementation of internal quality checking (described in details in our technical specs) by the contractor and submit their results to HC for checking and validation.
- Quality control implementation by an experienced contractor using trained personnel and specialized software applications
- Implementation of quality checking from the HC using quality plan and detailed quality procedures,
- Using both the contractor and HC detailed quality plan based on ISO 10005



Thank you for your attention