

From field-work to... “air-work”: photogrammetric applications in Neolithic landscape reconstruction

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index

- “Neolithic Thessaly”
 - A/RS “Hardware” (methods/methodology)
 - Software (photogrammetric workflow)
 - Acquisition/checking
 - Archiving/cataloguing
 - AutoGR-Toolkit 3.2 (w/ photogrammetry module)

“Neolithic Thessaly”

Outline of the project

GeoSat Research Project



“Neolithic Thessaly”

- IGEAN (Innovative Geophysical Approaches for the Study of Early Agricultural Villages of Neolithic Thessaly)
 - Implemented under the "ARISTEIA" Action of the "Operational Programme Education and Lifelong Learning"
 - co-funded by the European Social Fund (ESF) and National Resources
- It consists in the development of methodologies for the registration and mapping of the specific Neolithic settlements through geomorphological and aerial remote sensing approaches.

“Neolithic Thessaly”



- 1901-1903: Excavations at Sesklo and Dimini
1908: Excavations at Zerelia



- 1960-1977: Trial Excavations at several neolithic sites by D.R. Theocharis and Vl. Milojcic
1977-1979: Excavations at Dimini by G. Hourmouziades



- 1984: Halstead's catalogue of prehistoric sites in Thessaly, based on a survey made by French
1992: Gallis' catalogue of sites in E. Thessaly.



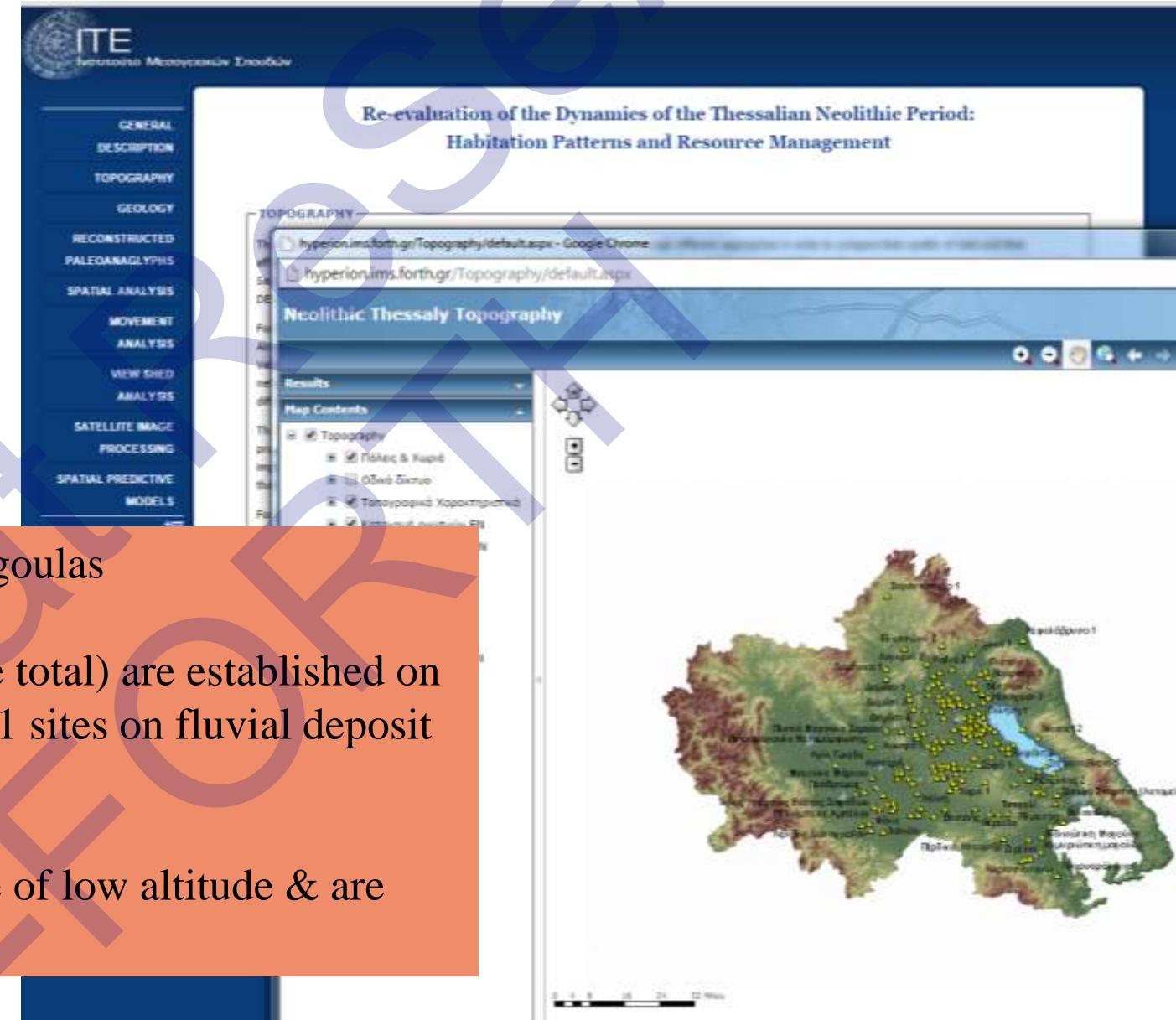
- 1990-present: Field survey in Almiros plain 13th EPCA & the Netherland Institute at Athens
1990-2005: Rescue excavations (national road, Lake Karla)



- 2005-present: Extensive satellite R.S. & geophysical survey by GeoSat ReSeArch Lab of IMS (FORTH). PENED (2005-2007), INSTAP (2006-2010), ARISTEIA (2013-2015)

“Neolithic Thessaly”

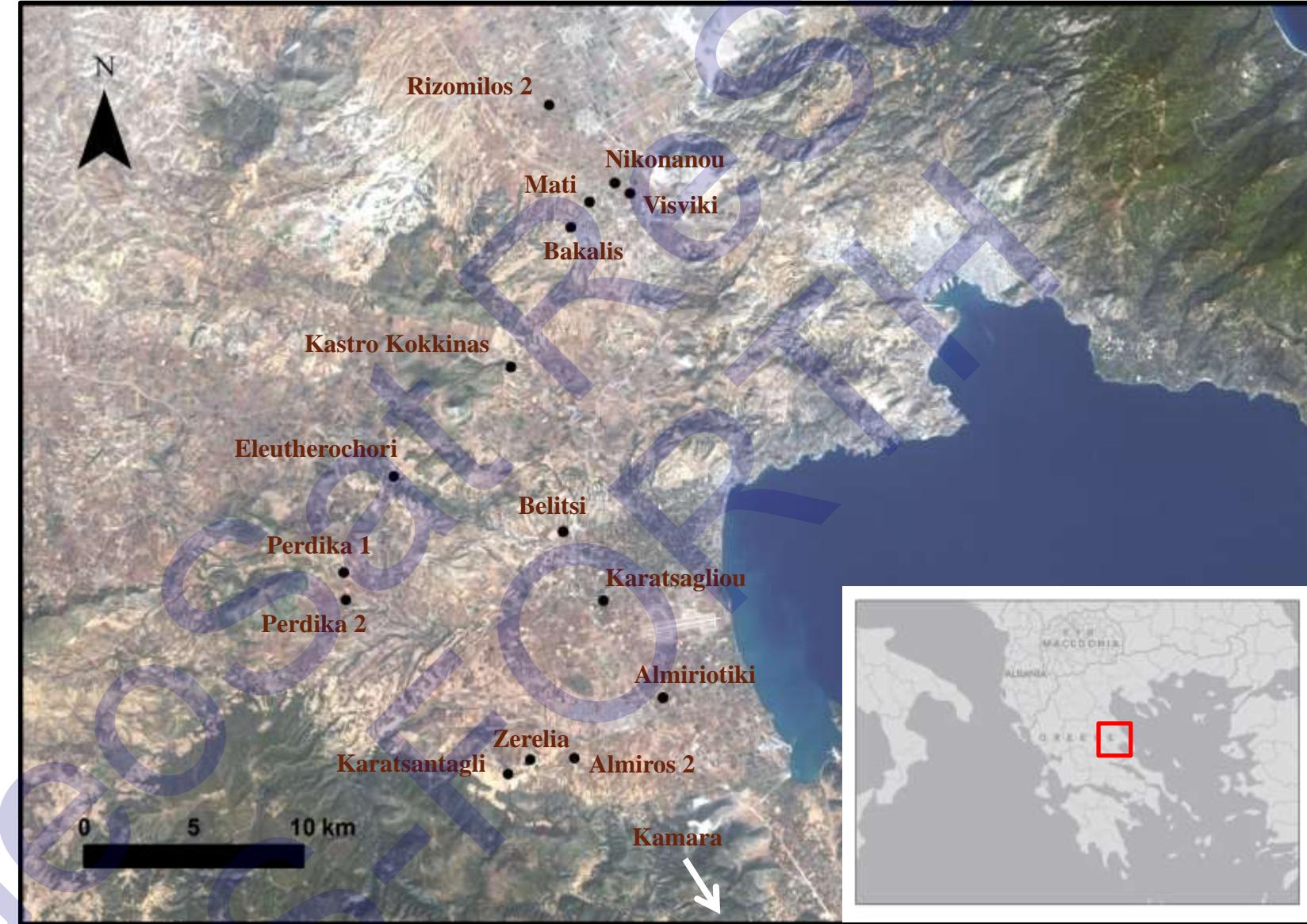
<http://neolithichessaly.ims.forth.gr/>



- 342 documented magoulas
- 181 sites (53% of the total) are established on alluvial deposits & 81 sites on fluvial deposit areas.
- These formations are of low altitude & are ideal for cultivation.

“Neolithic Thessaly”

Area of interest



ARS “Hardware”

A/RS “Hardware” (methods/methodology)

Methodologies

Multi-magnetometer Techniques (large scale scanning)



Sensorik & Systemtechnologie (SENSYS) MX Compact system

8 multi-channel measurement system
Equipped with FGM600 fluxgate
radiometers separated by 0.25-0.5m &
connected to a DGPS navigation system



Bartington single sensor unit also in use in thick vegetation areas

Methodologies

Electromagnetic Techniques (large scale scanning)

GEM2 - Geophex



Depth of investigation

CMD Mini explorer – GF Instruments



	GEM2		CMD Mini explorer		
Electrical conductivity	HCP	2.5 m	HCP	0.5 m	1 m
Magnetic susceptibility	HCP	1.7 m	VCP	0.3 m	0.7 m

Methodologies

GPR



8 channels MALA MIRA GPR,
400 MHz antennas
Sampling 10 x 2.5 cm

Penetration Depth ~2.5m



Sensors & Software

Noggin Plus System w/ 250MHz antennas

Sampling 50 x 2.5 cm

Methodologies

Soil Resistance Techniques



Geoscan Research RM85 resistance meter

Twin Probe array of electrodes with spacing $a=1m$

Penetration Depth $\sim 1.5m$

Methodologies

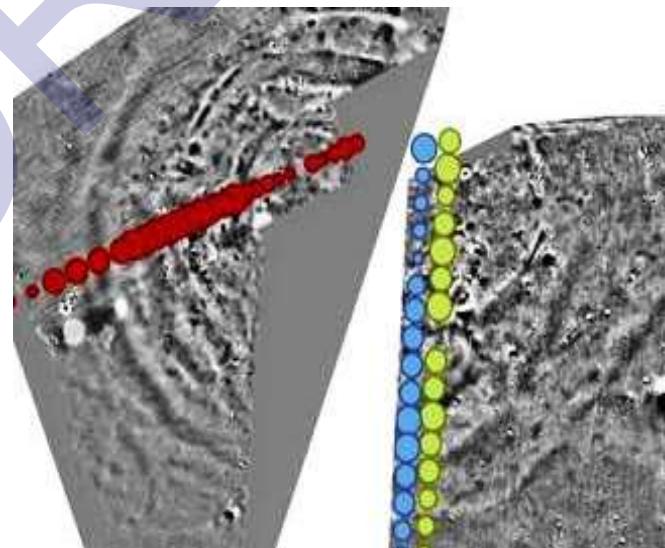
Magnetic Susceptibility Measurements



Coring and soil analysis in the Lab.

Bartington MS2B Double Frequency sensor

Low & High Frequency susceptibility & Frequency dependent susceptibility





Methodologies

UAV photography/photogrammetry



Methodologies

UAV photography/photogrammetry

Quadrocopter DroidWorx CX4
DJI navigation, viewpoint and failsafe
Average altitude 100-200 m above surface
Autonomy ~13-15min with camera load



Methodologies

UAV photography/photogrammetry



Methodologies

UAV photography/photogrammetry



Methodologies

UAV photography/photogrammetry



ΕΠΙΧΕΙΡΗΣΑΚΟ ΔΙΠΛΩΜΑΤΙΚΑ ΕΠΑΛΛΑΞΗΣ ΚΑΙ ΔΙΒΟΥ ΜΑΝΙΦΕΣΗ
ΕΠΑΛΛΑΞΗΣ ΣΕ ΕΠΑΛΛΑΞΗΣ ΛΟΓΟΤΥΠΟ
ΕΠΑΛΛΑΞΗΣ ΠΑΙΔΙΚΩΝ ΚΑΙ ΠΡΩΤΟΥ ΗΛΙΟΥ ΛΟΓΟΤΥΠΟ
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Quadrocopter DroidWorx CX4

- DJI navigation, viewpoint and failsafe
- Average altitude 100-200 m above surface
- Autonomy ~15-18min (with camera load)



Canon S100

Methodologies

UAV photography/photogrammetry



LegGiaDrone 1.0

Methodologies

UAV photography/photogrammetry



GCP
(in case the GPS fails)

SITE	COVERAGE (in hectares)			
	Magnetics	EM	GPR	UAV
1. Almiriotiki	8.42	7.75	1.28	20.84
2. Almiros 2	6.60	2.39	0.37	7.31
3. Bakalis	0.45	0.36	0.29	-
4. Belitsi	1.32	1.78	0.37	11.74
5. Eleutherochori	-	0.18	0.18	-
6. Kamara	0.88	1.06	0.10	-
7. Karatsangliou	2.96	1.20	0.37	13.22
8. Karatsantagli	2.71	0.58	0.20	12.38
9. Kastro Kokkinas	1.08	0.72	0.09	-
10. Nikonanou	2.91	1.37	-	-
11. Mati	3.33	2.40	0.32	-
12. Perdika 1	5.19	2.32	0.44	-
13. Perdika 2	3.90	2.21	0.32	-
14. Rizomilos 2	10.48	3.16	0.36	-
15. Visviki	5.12	-	1.90	-
16. Zerelia	4.83	1.88	0.72	33.88
TOTAL (<5 weeks fieldwork)	60.18	29.36	7.31	99.37

Methodologies

UAV photography/photogrammetry

Site INDEX	Merged photogrammetric patches (hectare)	Hectare coverage per minute
Almiriotiki	20.7	0.56
Almiros 2	8.12	0.78
Belitsi	11.73	0.42
Karatsagliou	13.07	1.58
Karatsantagli	12.39	1.04
Zerelia	32.2	0.90

About 1 hectare/minute

Methodologies

UAV photography/photogrammetry

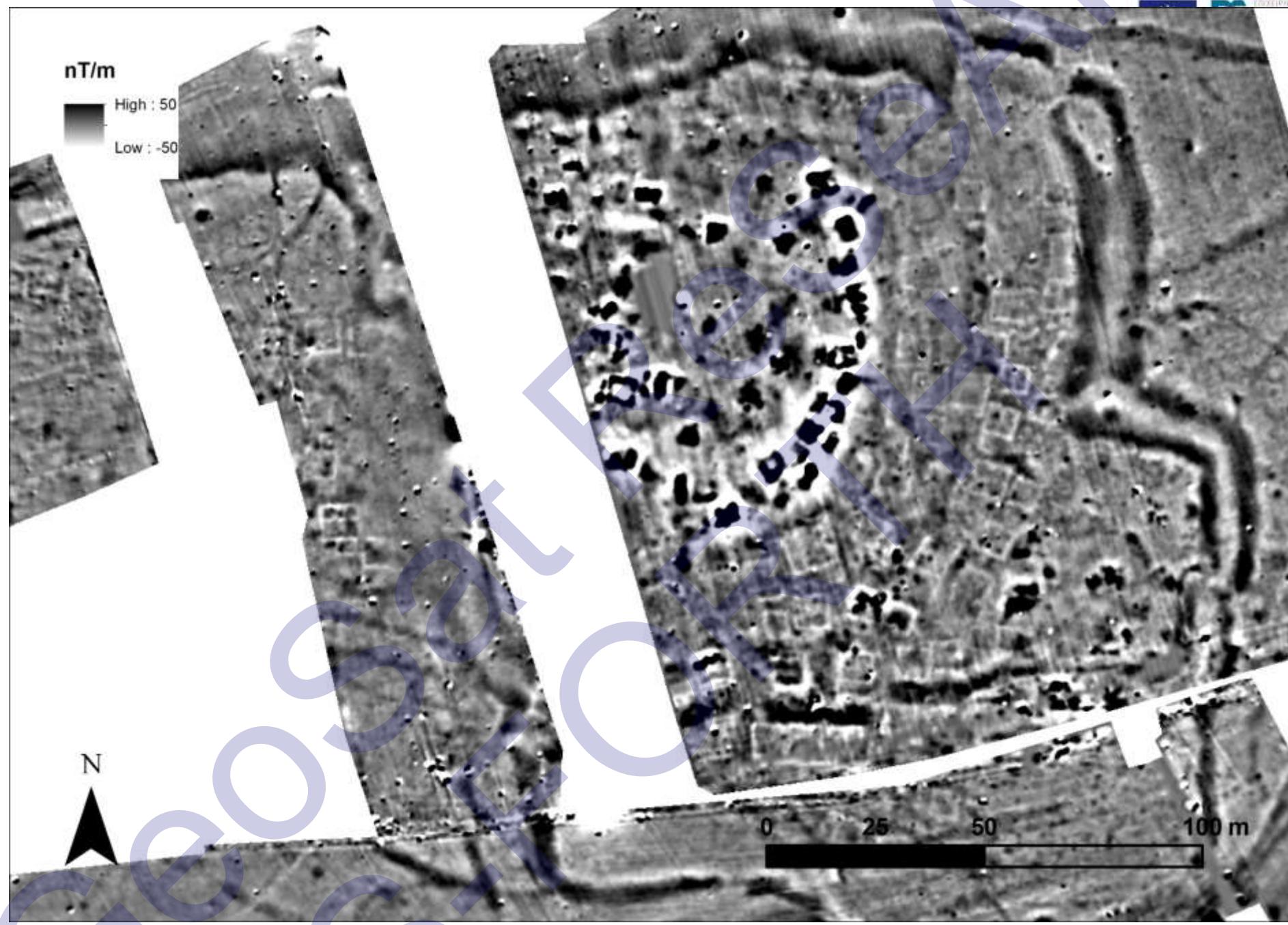
Magoula Almiriotiki
Early Neolithic – Late Bronze Age



Methodologies

UAV photography/photogrammetry





Methodologies

UAV photography/photogrammetry



Methodologies

UAV photography/photogrammetry



Methodologies

UAV photography/photogrammetry



Software Research S-FORTH

Software ∴ Commercial

- Commercial solutions
 - Pix4D



PRODUCTS SOLUTIONS SUPPORT BUY OR RENT ABOUT US LOGIN

Pix4D Workshops

2014 dates and program
out now!

Read more and sign-up now!

• • •



Pix4D is your solution to convert thousands of aerial images, taken by lightweight UAV or aircraft into geo-referenced 2D mosaics and 3D surface models and point clouds.



Version 1.1 out now!

Precision Agriculture meets cutting-edge UAV technology: with Pix4Dmapper Version 1.1 you can

Software ∴ Commercial

- Commercial solutions
 - MosaicMill

MosaicMill

GeoSat ReSeArch

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Products

Software for UAVs

- EnsoMOSAIC UAV
- EnsoMOSAIC 3D
- Camera Calibration
- Terrain modelling
- Image pre-processing
- Seamline editing

Software for manned operations

- EnsoMOSAIC
- EnsoMOSAIC 3D
- Flight planning
- NavCam
- Camera Calibration
- Terrain modelling
- Image pre-processing
- Seamline editing

Hardware

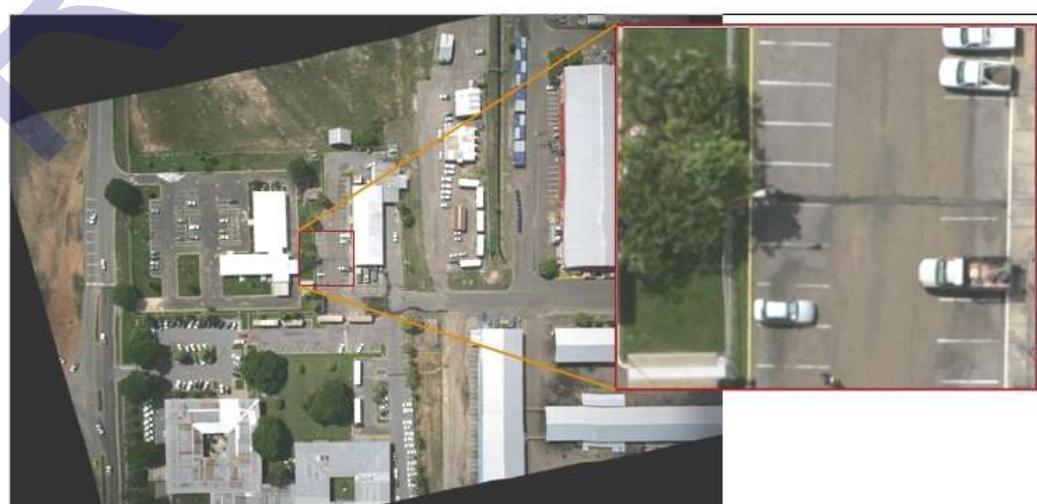
- Flight control for manned operations
- Cameras for UAVs and manned operations

Complete solution for manned operations

MosaicMill software for UAVs

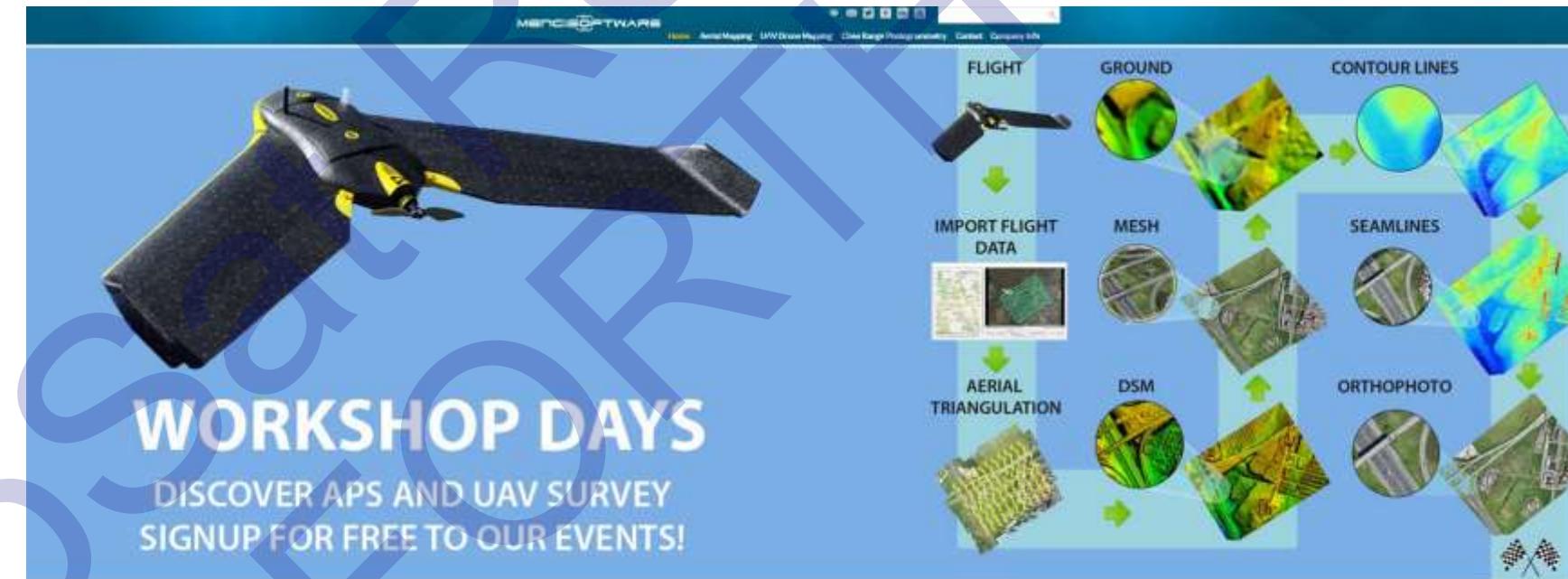
EnsoMOSAIC software consist of core items and supportive programs. The software components are listed here with a brief description. For full details please select an item of the left panel.

- EnsoMOSAIC UAV - photogrammetric software for aerial triangulation and orthomosaicking - all you need to start mapping
- EnsoMOSAIC 3D - 3D mapping software for data extraction and point cloud management
- Camera calibration - calibration software for calculation of camera internal orientation
- Terrain modelling - point cloud software, creates "lidar point cloud" from oriented images
- Image pre-processing - preprocessing software for optimizing RAW CIR and RGB images
- Seamline editing - software for improving mosaics of city and town areas



Software ∴ Commercial

- Commercial solutions
 - MenciSoftware



Photogrammetry Software



Aerial Mapping
Software specifically designed for the rapid processing of aerial



UAV Drone Mapping
Software with high performance for the rapid processing of aerial



Close Range Photogrammetry
Software for the rapid processing of aerial images and images from

Software ∴ Commercial

- Commercial solutions
 - Agisoft Photoscan

Software ∴ Commercial

- Commercial solutions
 - Agisoft Photoscan

Geosat Report

The screenshot shows the Agisoft PhotoScan Professional edition product page. It includes a large image of a landscape, a detailed description of the software's capabilities, a list of main features, and examples of 3D reconstructions.

Agisoft PhotoScan Professional edition

Agisoft PhotoScan Pro allows to generate high resolution georeferenced orthophotos (up to 5 cm accuracy with GCP) and exceptionally detailed DEMs / textured polygonal models. The full automated workflow enables a non-expert to process thousands of aerial images on a desktop computer to produce professional class photogrammetric data.

Main Features

- Aerial and close-range triangulation
- Point cloud generation (sparse / dense)
- Polygonal model generation (plain / textured)
- Setting coordinate system
- Digital Elevation Model (DEM) generation
- True orthophoto generation
- Georeferencing using flight log and / or GCPs
- Multispectral imagery processing
- 3D reconstruction for dynamic scenes
- Python scripting support

3D Examples (the latest version of Adobe Reader is required)

See also: [Featured projects with Agisoft PhotoScan](#)

Agisoft PhotoScan Professional edition

[Compare with Standard edition](#)

Download demo
for Win32, Win64, Mac OS, Linux
Agisoft PhotoScan Professional edition

Document

- Agisoft PhotoScan Professional edition
- Agisoft PhotoScan Standard edition
- Python API
- Change Log



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Agisoft PhotoScan Professional edition

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- Multispectral imagery processing
- 3D reconstruction for dynamic scenes
- Python scripting support

3D Examples

(the latest version of Adobe Reader is required to view these models)



See also: [Featured projects with Agisoft PhotoScan](#)

Products

Supported formats

Input formats: JPEG, TIFF, PNG, BMP, JPEG Multi-Picture Format (MPO).

Output formats: GeoTIFF, xyz, ASPRS LAS, Google KMZ/KML, COLLADA, VRML, OBJ, PLY, 3DS, FBX, Universal 3D, PDF, etc.

Agisoft StereoScan
Binaural stereo reconstruction software.
Free

Agisoft Lens
Lens calibration software.
Free

Support

If you have already read the [FAQ](#) and have any questions, please use this form.

Your name

Your e-mail

Your question

[Help me please](#)

Agisoft PhotoScan Professional edition for only \$3499

[Compare with Standard edition](#)

Download demo

for Win32, Win64, MacOS, Linux

Documentation

- [Agisoft PhotoScan User Manual \(English\)](#)
- [Agisoft PhotoScan User Manual \(Russian\)](#)
- [Python API Reference](#)
- [Change Log](#)

Software ∵ Free

- Free or Open Source software
 - Online – cloud based
 - “Bundler” based
 - VisualSFM

Software ∵ Free

- Main issues:
 - Orthophotos or textured models
 - Georeferencing

Software ∵ Free | | Textured model

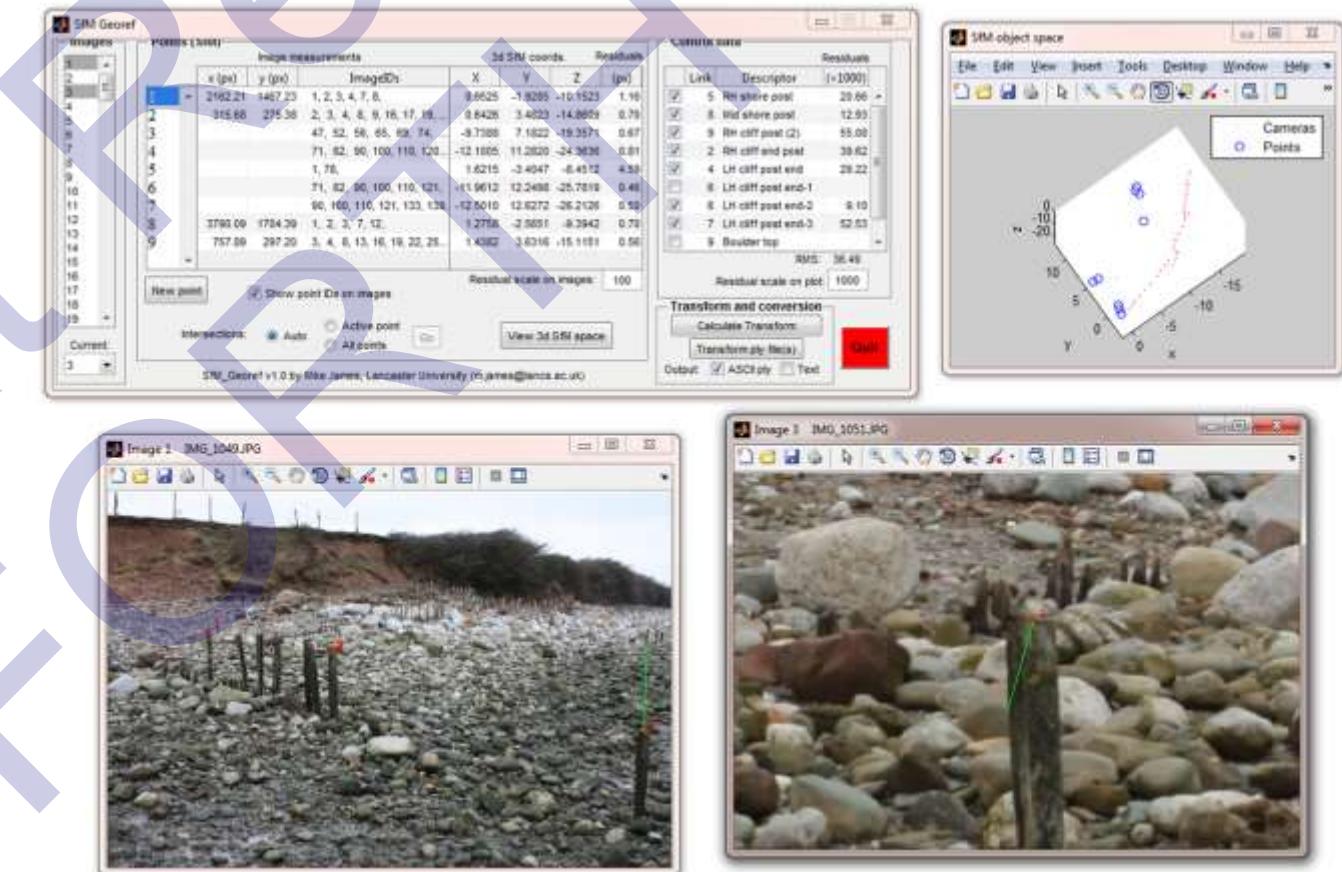
- **Online cloud solution**
 - Good results but sometimes...
 - with limitation or image compression

Software ∴ Free || Textured model

- Desktop solution
 - CloudCompare
 - Great for surface creation but no texture
 - Great for “cleaning” and refinement
 - Possibility to export ortho-view
 - Meshlab
 - Good for texture (raster projection)
 - Good for surface
 - Possibility to export ortho-view
 - ... if it doesn't crash!?!?

Software ∴ Free || Georeferencing

- Sfm_georef
 - Manual georeferencing
 - on photos
(manual correspondences)

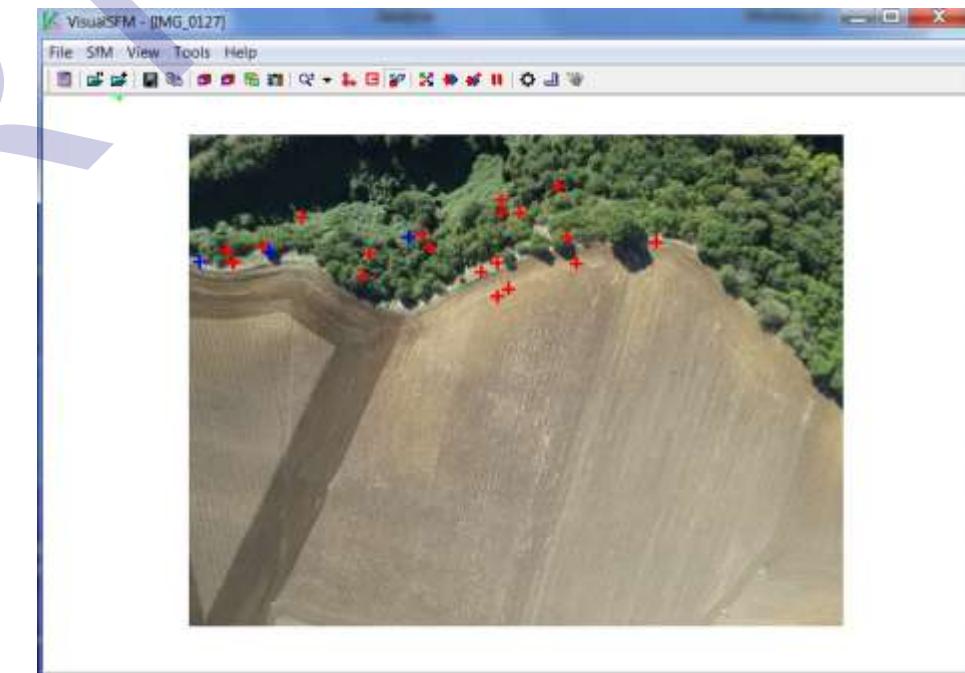


Software ∴ Free || Georeferencing

- VisualSFM
 - Manual georeferencing
 - on photos
 - on point-cloud
 - Automatic georeferencing
 - via GPS (EXIF) or GCPX
 - Semi Automatic georeferencing
 - GCP file

Software ∵ Free || Georeferencing

- **VisualSfM**
 - GCP file
 - filename image_point_x image_point_y 3d_point_x 3d_point_y 3d_point_z
 - Requirements: at least 3 points visible in at least 3 images each!



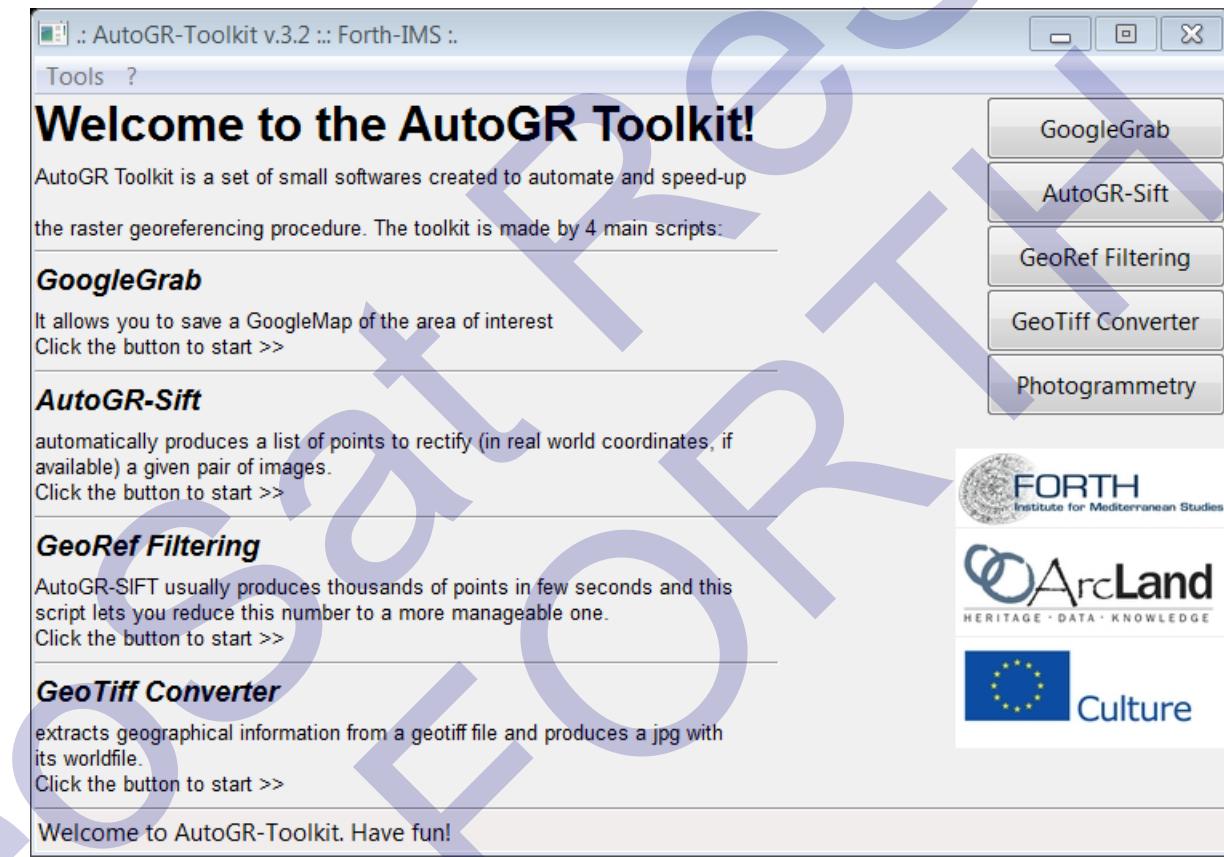
Software ∴ Free || Georeferencing

- VisualSFM
 - GCP file
 - filename image_point_x image_point_y 3d_point_x 3d_point_y 3d_point_z
 - Requirements: at least 3 points visible in at least 3 images each!
- HOW TO GET POINTS AUTOMATICALLY AND ACCURATELY?

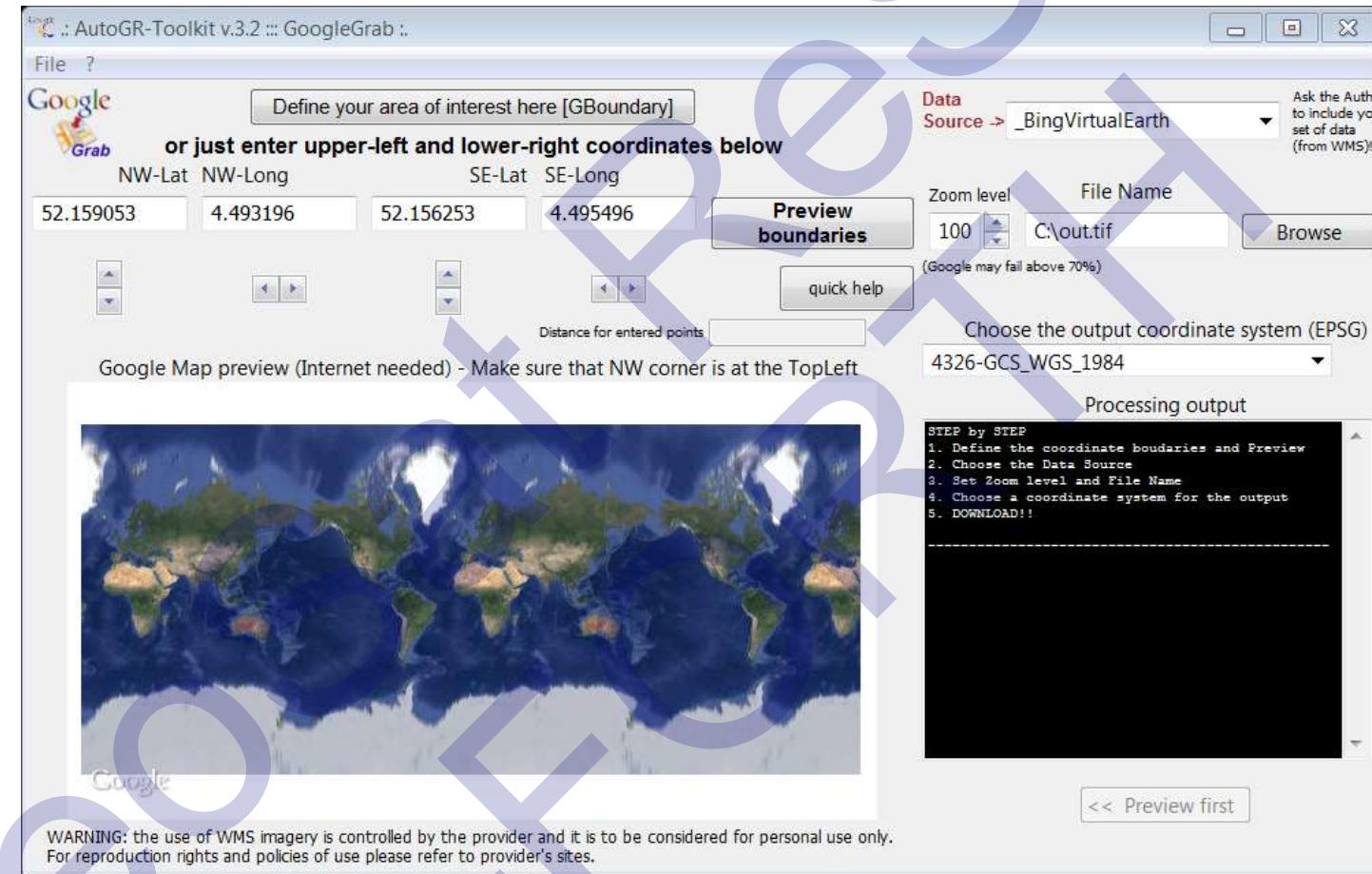
AutoGR-Toolkit 3.2

Geospatial Research Institute
Geospatial Research Institute

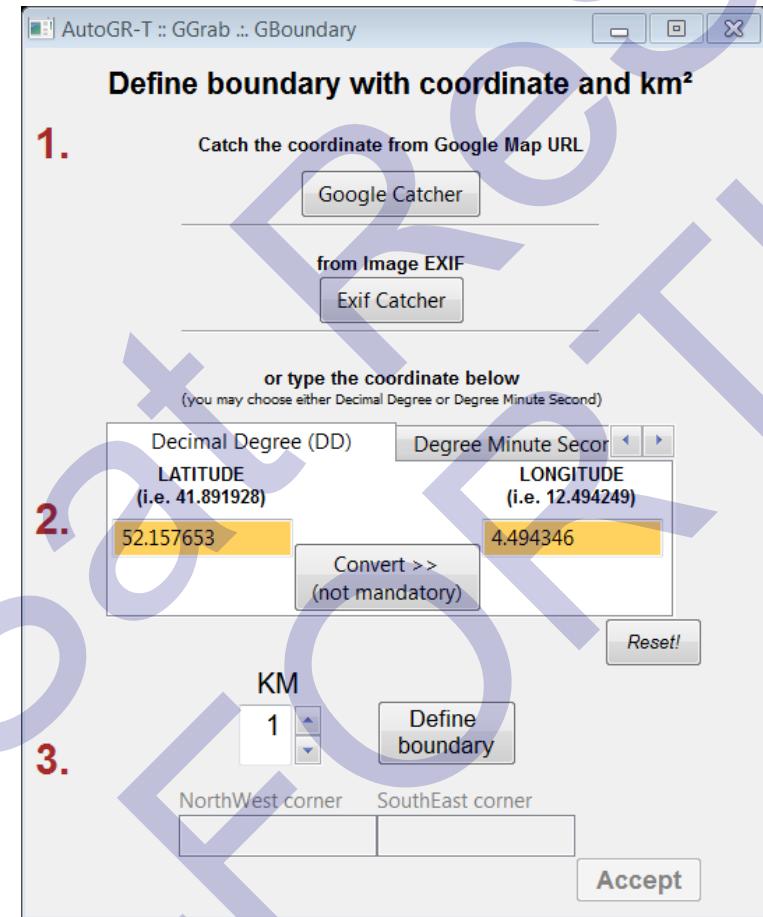
AutoGR-Toolkit 3.2



AutoGR-Toolkit 3.2



AutoGR-Toolkit 3.2



AutoGR-Toolkit 3.2

Catch Coordinates from Google Map

Find your area of interest with Google Map (maps.google.com) and copy/paste the link here below

The URL should look like

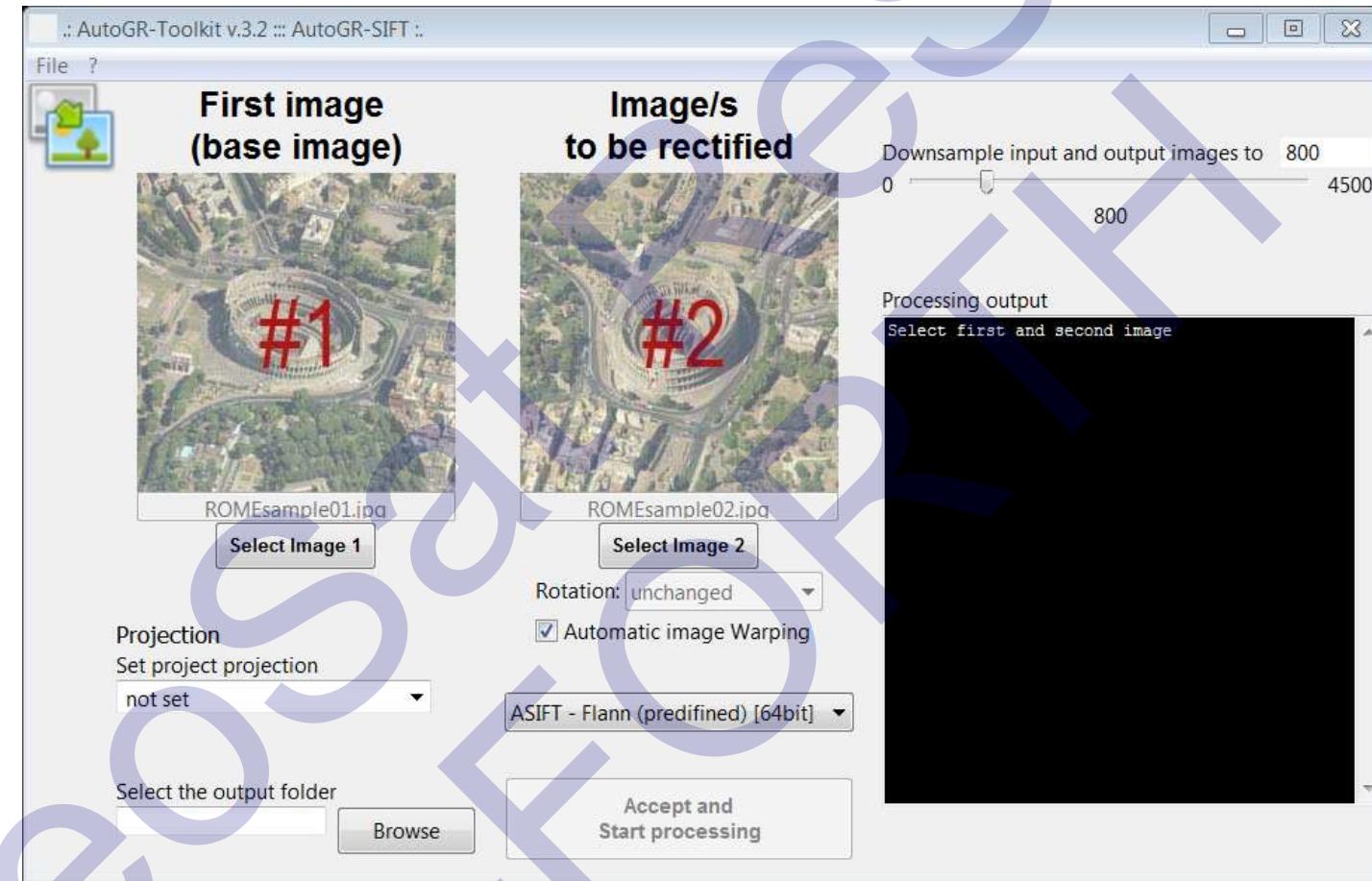
`https://maps.google.com/maps?q=52.159375,4.492679&num=1&t=hz=15`

or

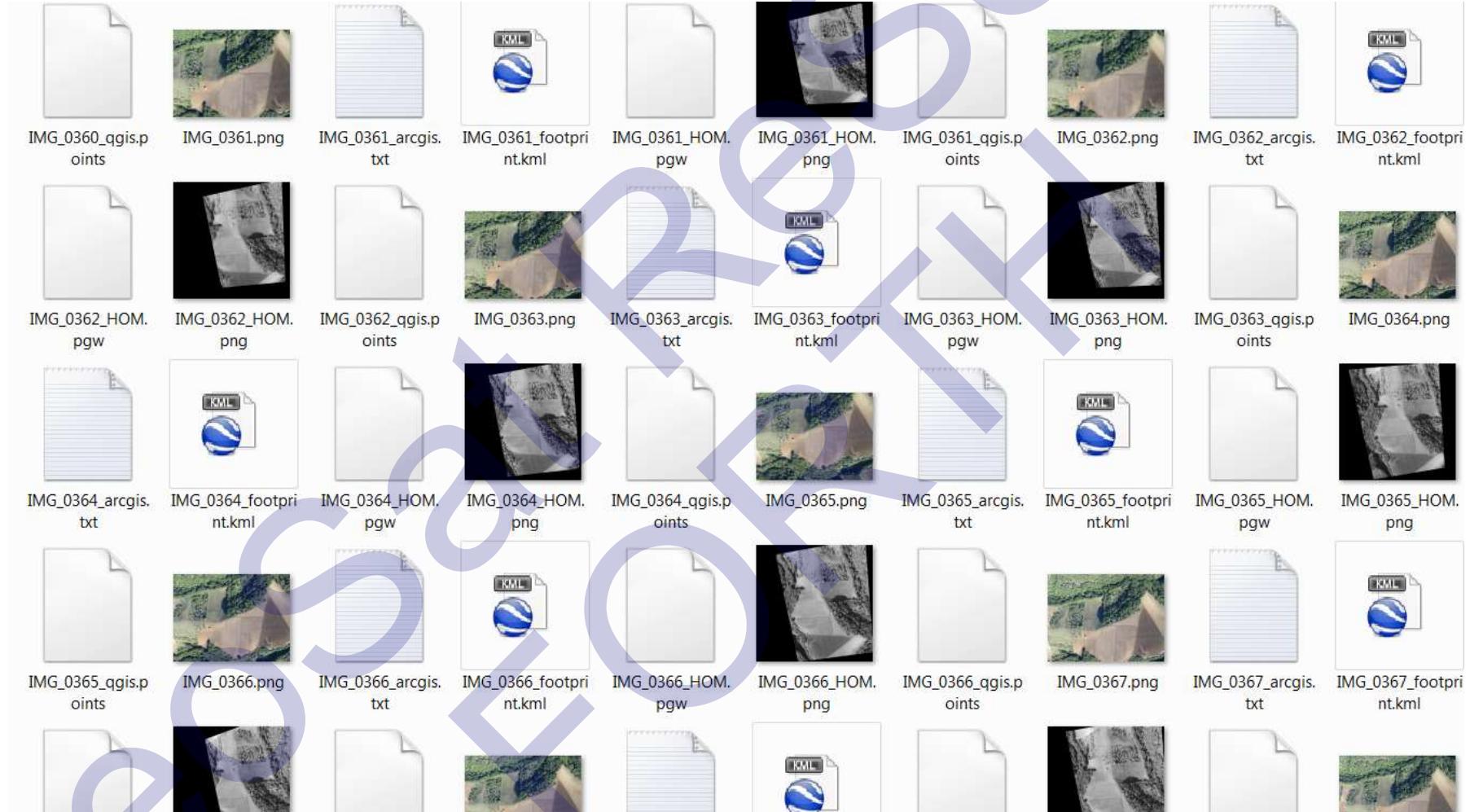
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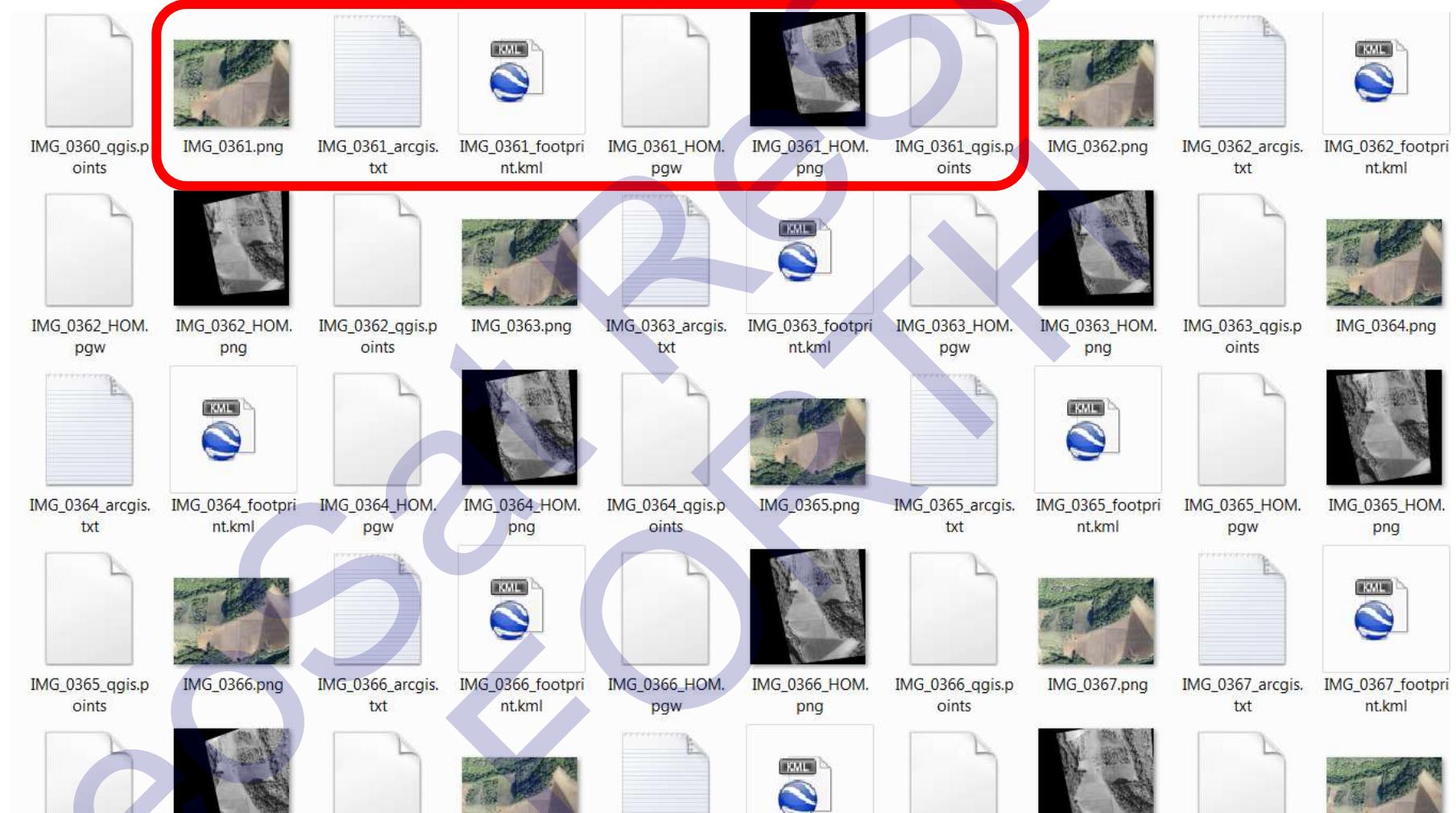
AutoGR-Toolkit 3.2



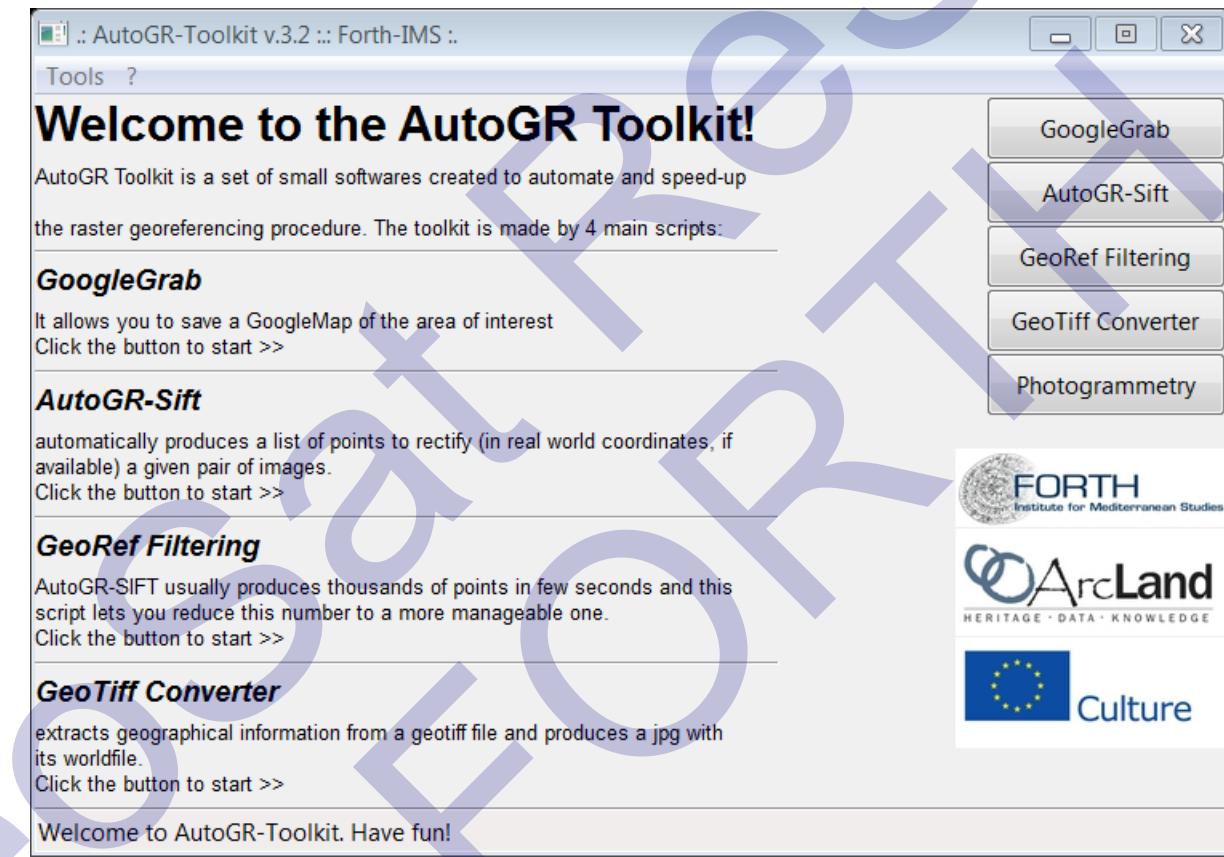
AutoGR-Toolkit 3.2



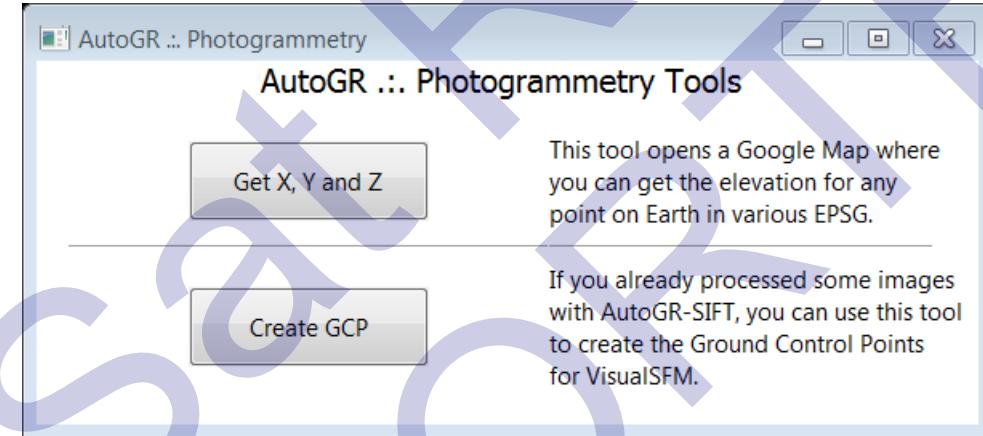
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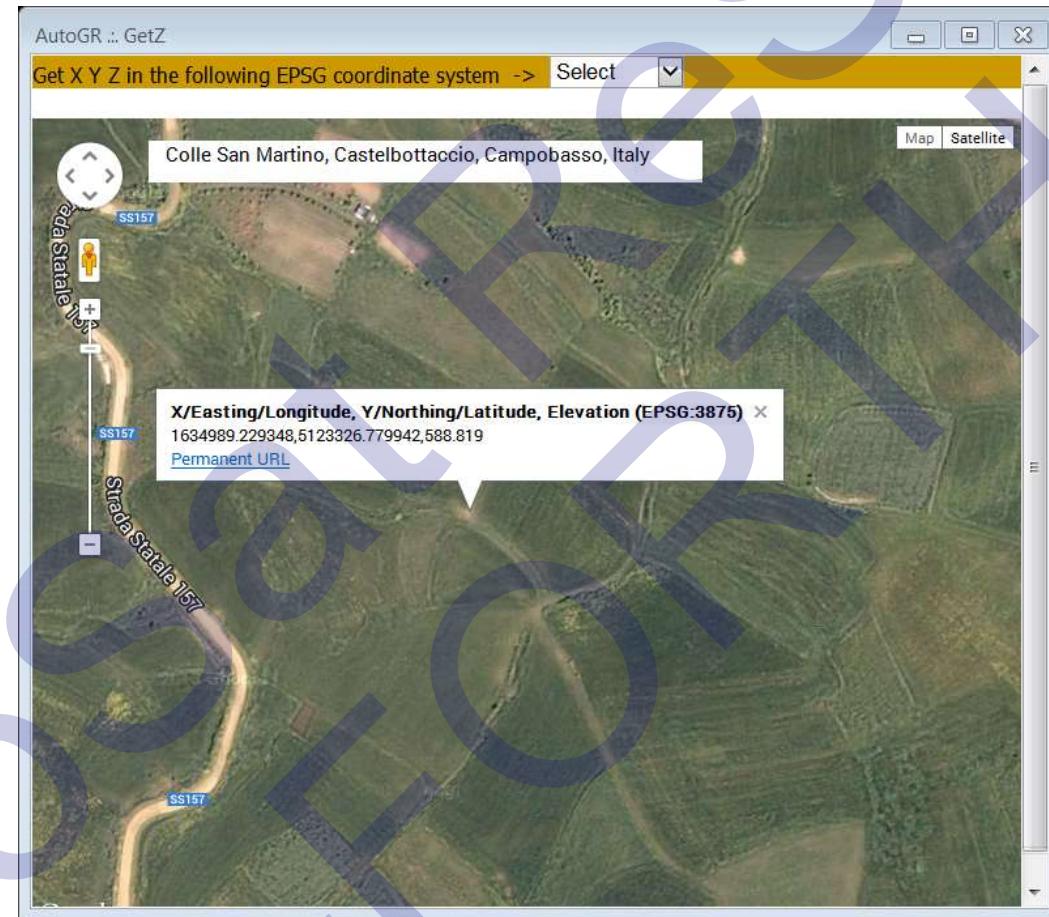
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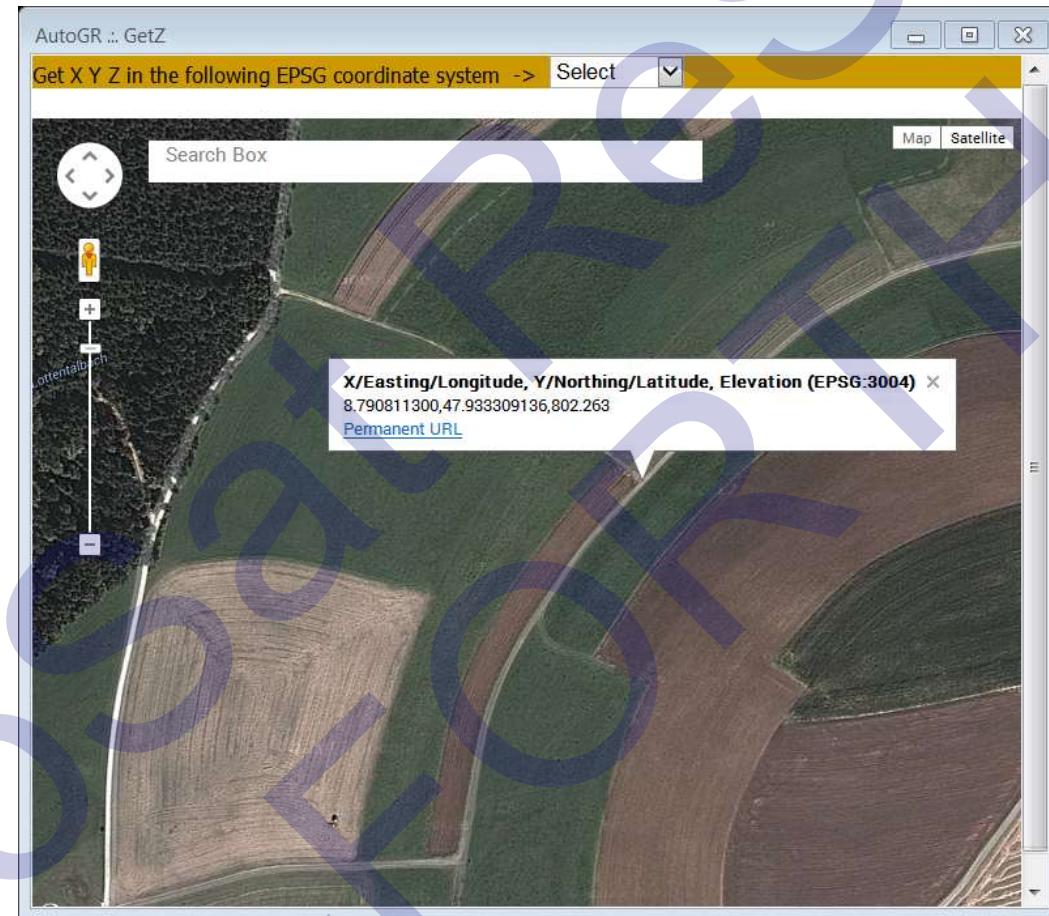
AutoGR-Toolkit 3.2



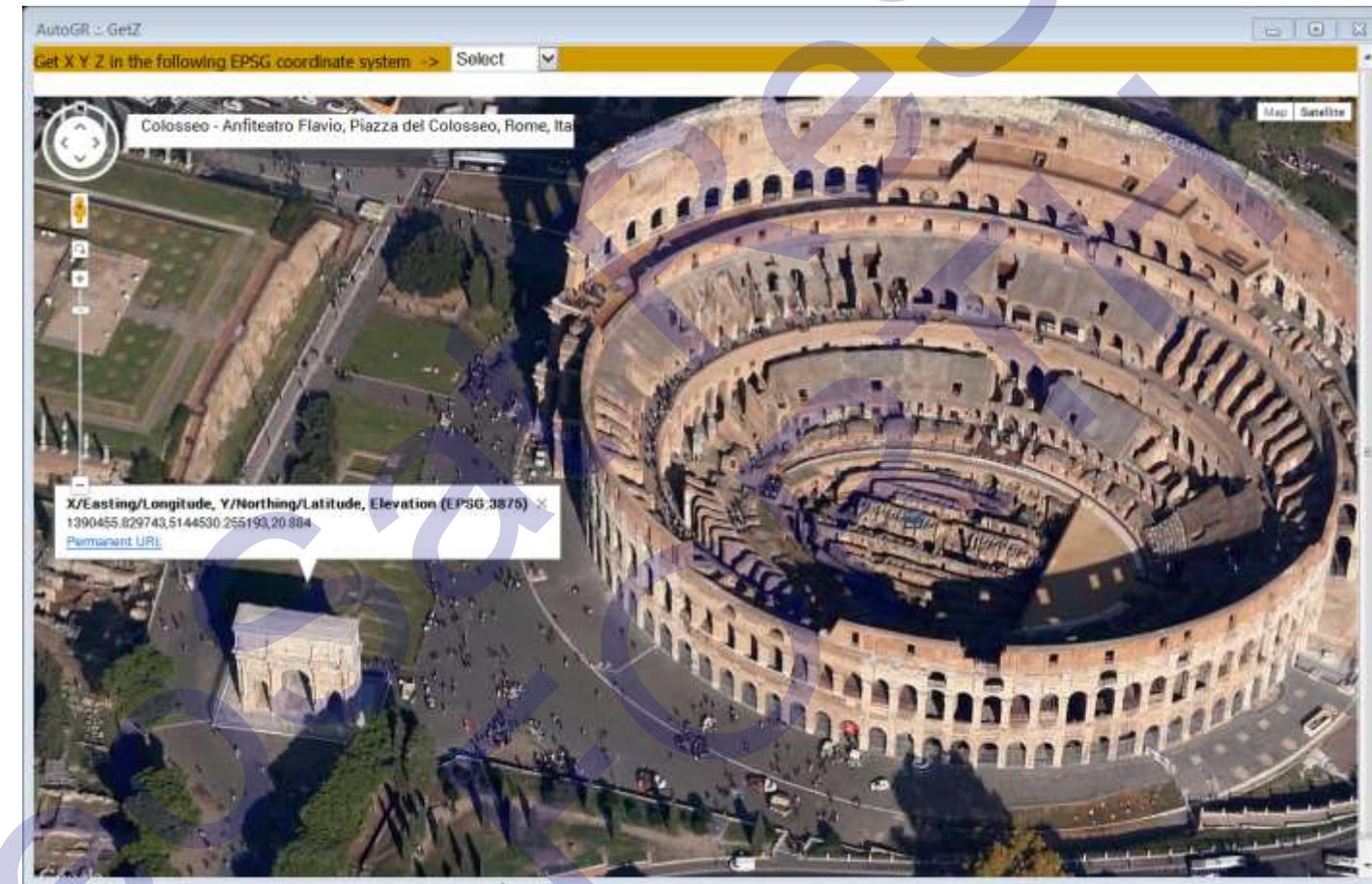
AutoGR-Toolkit 3.2



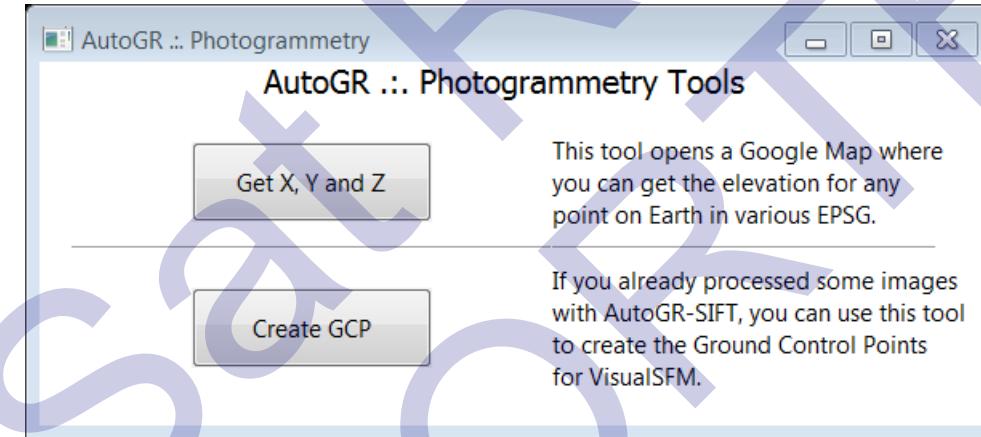
AutoGR-Toolkit 3.2



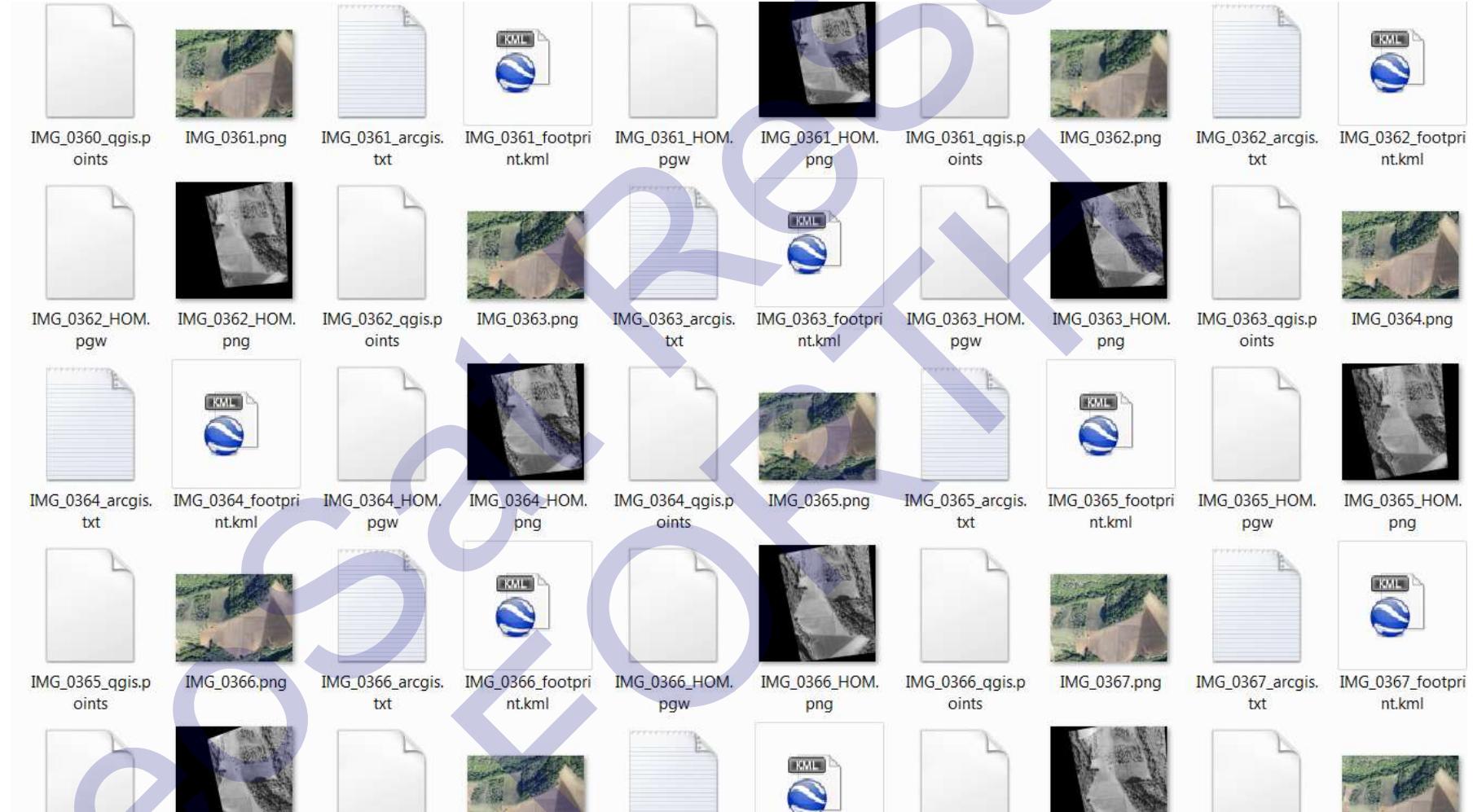
AutoGR-Toolkit 3.2



AutoGR-Toolkit 3.2



AutoGR-Toolkit – 3D matching

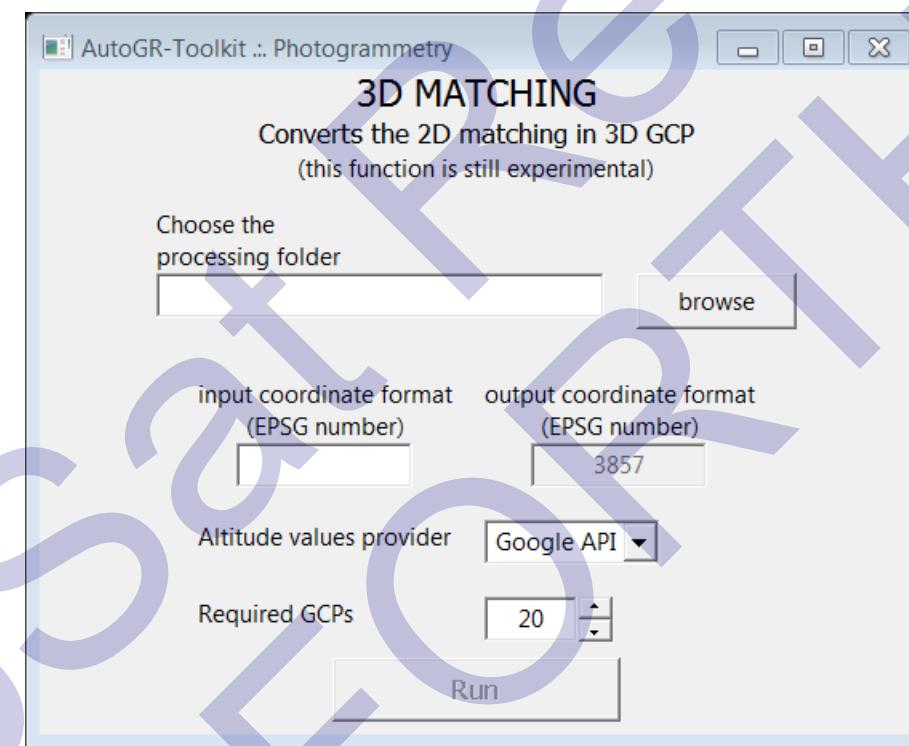


AutoGR-Toolkit – 3D matching

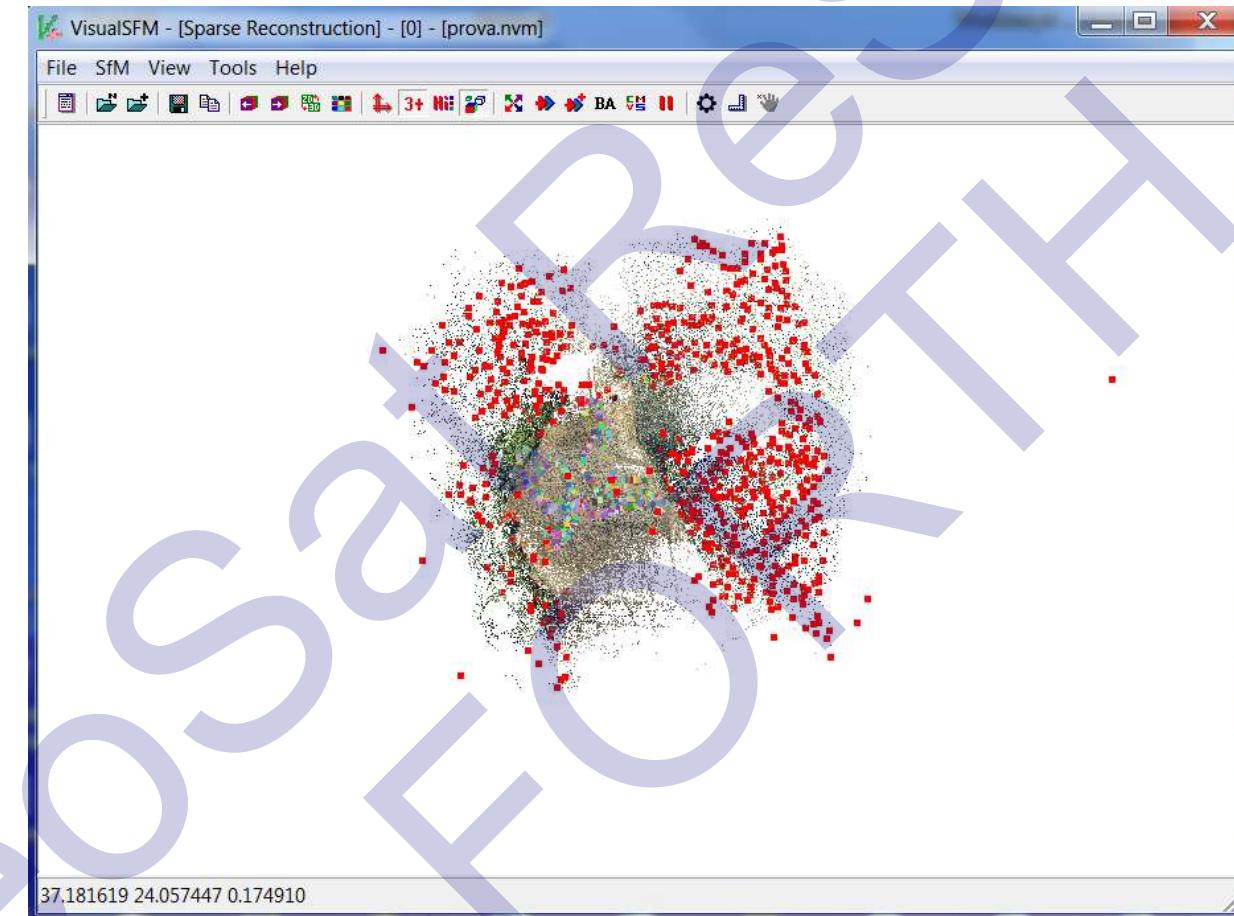


```
1 # Each line of the GCP is as follows:  
2 # FileName image_point_x image_point_y 3d_point_x 3d_point_y 3d_point_z  
3 IMG_0118.jpg 3860.0 230.0 176736.253 4569746.011 363.95  
4 IMG_0118.jpg 2170.0 2910.0 176863.571 4569889.509 365.76  
5 IMG_0121.jpg 1835.0 245.0 177020.899 4569773.389 371.08  
6 IMG_0121.jpg 165.0 290.0 176988.621 4569651.571 376.56  
7 IMG_0121.jpg 2475.0 2885.0 176860.664 4569867.455 367.32  
8 IMG_0121.jpg 2140.0 200.0 177028.988 4569792.953 369.81  
9 IMG_0121.jpg 765.0 250.0 177002.907 4569700.426 374.16  
10 IMG_0121.jpg 160.0 295.0 176988.621 4569651.571 376.56  
11 IMG_0121.jpg 2355.0 235.0 177030.477 4569808.934 369.62  
12 IMG_0121.jpg 2350.0 235.0 177030.477 4569808.934 369.62  
13 IMG_0122.jpg 3460.0 895.0 177021.120 4569899.165 367.34  
14 IMG_0122.jpg 1810.0 460.0 177020.899 4569773.389 371.08  
15 IMG_0122.jpg 1400.0 375.0 177020.067 4569739.644 372.06  
16 IMG_0122.jpg 2810.0 540.0 177029.690 4569849.459 369.58  
17 IMG_0122.jpg 220.0 485.0 176988.621 4569651.571 376.56  
18 IMG_0122.jpg 270.0 380.0 176996.658 4569650.336 376.27  
19 IMG_0122.jpg 1355.0 295.0 177026.595 4569733.318 371.79  
20 IMG_0122.jpg 215.0 490.0 176988.621 4569651.571 376.56  
21 IMG_0122.jpg 3830.0 1465.0 176988.824 4569937.759 368.46  
22 IMG_0122.jpg 1455.0 415.0 177017.375 4569747.317 372.07  
23 IMG_0122.jpg 3715.0 1105.0 177006.971 4569923.599 367.17  
24 IMG_0122.jpg 830.0 455.0 177002.907 4569700.426 374.16  
25 IMG_0122.jpg 360.0 410.0 176999.948 4569657.573 375.89  
26 IMG_0122.jpg 2280.0 455.0 177030.477 4569808.934 369.62  
27 IMG_0123.jpg 2820.0 675.0 177051.493 4569838.608 367.13  
28 IMG_0123.jpg 1220.0 525.0 177036.290 4569703.521 372.40  
29 IMG_0123.jpg 1760.0 580.0 177039.503 4569754.319 370.17  
30 IMG_0123.jpg 1350.0 605.0 177030.998 4569717.883 371.98
```

AutoGR-Toolkit – 3D matching



AutoGR-Toolkit – 3D matching

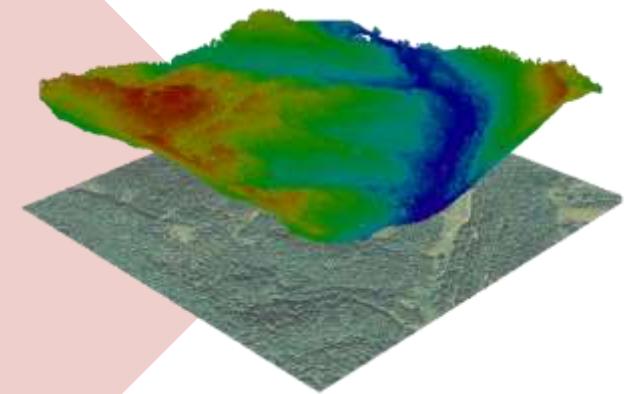


Workflow



4-500m

GeoSat ReSeArch
S-FORTH



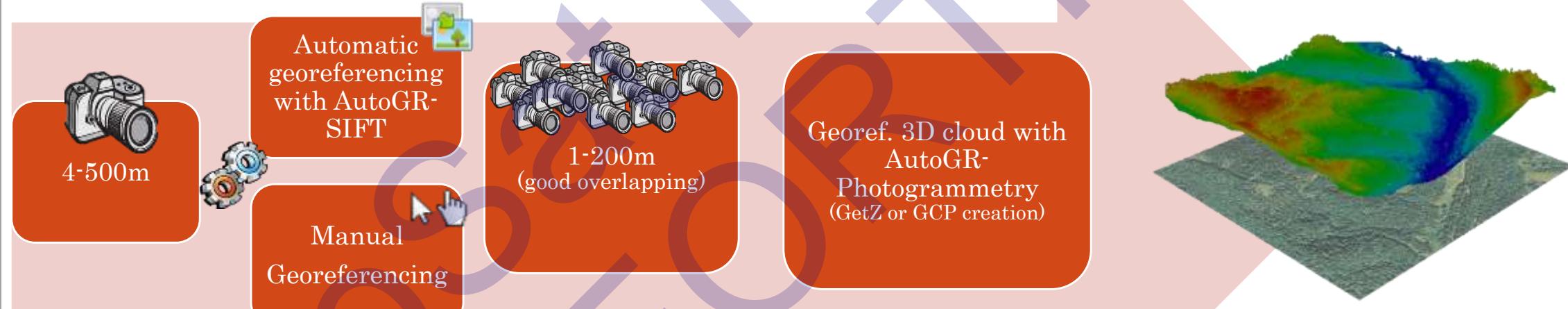
AutoGR-Toolkit – 3D matching



ΕΠΙΧΕΙΡΗΣΤΙΚΟ ΠΡΟΓΡΑΜΜΑ
ΕΠΑΝΑΖΕΥΞΗ ΚΑΙ ΔΙΟΙΚΗ ΝΑΟΙ
Επίτευξης γνώσης & αρχειογράφησης δημόσιων και αρχαίων
κτιρίων, ψηφιακή επένδυση & ανάπτυξη
ΕΠΑΝΑΖΕΥΞΗ ΚΑΙ ΔΙΟΙΚΗ ΝΑΟΙ



Workflow



62

Workflow



63



Thank you!

*From field-work to... "air-work":
photogrammetric applications in Neolithic landscape reconstruction*