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

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
“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. Milojicic
1977-1979: Excavations at Dimini by G. Hourmouziades

1984: Halstead’s catalogue of prehistoric sites in Thessaly, based on a survey made by French

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

“Neolithic Thessaly”

http://neolithicthessaly.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
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 gradiometers 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

CMD Mini explorer - GF Instruments

Depth of investigation

<table>
<thead>
<tr>
<th></th>
<th>GEM2</th>
<th>CMD Mini explorer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical conductivity</td>
<td>HCP 2.5 m</td>
<td>HCP 0.5 m</td>
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<td>1 m</td>
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<td></td>
<td></td>
<td>2 m</td>
</tr>
<tr>
<td>Magnetic susceptibility</td>
<td>HCP 1.7 m</td>
<td>HCP 0.2 m</td>
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GEM2 - Geophex

CMD Mini explorer - GF Instruments

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</table>
Methodologies

GPR

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

Sensors & Software
Noggin Plus System w/ 250MHz antennas
Sampling 50 x 2.5 cm

Penetration Depth ~2.5m
Geoscan Research RM85 resistance meter

Twin Probe array of electrodes with spacing a=1m

Penetration Depth ~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

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)
<table>
<thead>
<tr>
<th>SITE</th>
<th>COVERAGE (in hectares)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Magnetics</td>
</tr>
<tr>
<td>1. Almiriotiki</td>
<td>8.42</td>
</tr>
<tr>
<td>2. Almiros 2</td>
<td>6.60</td>
</tr>
<tr>
<td>3. Bakalis</td>
<td>0.45</td>
</tr>
<tr>
<td>4. Belitsi</td>
<td>1.32</td>
</tr>
<tr>
<td>5. Eleutherochori</td>
<td>-</td>
</tr>
<tr>
<td>6. Kamara</td>
<td>0.88</td>
</tr>
<tr>
<td>7. Karatsangliou</td>
<td>2.96</td>
</tr>
<tr>
<td>8. Karatsantagli</td>
<td>2.71</td>
</tr>
<tr>
<td>9. Kastro Kokkinas</td>
<td>1.08</td>
</tr>
<tr>
<td>10. Nikonanou</td>
<td>2.91</td>
</tr>
<tr>
<td>11. Mati</td>
<td>3.33</td>
</tr>
<tr>
<td>12. Perdika 1</td>
<td>5.19</td>
</tr>
<tr>
<td>13. Perdika 2</td>
<td>3.90</td>
</tr>
<tr>
<td>14. Rizomilos 2</td>
<td>10.48</td>
</tr>
<tr>
<td>15. Visviki</td>
<td>5.12</td>
</tr>
<tr>
<td>16. Zerelia</td>
<td>4.83</td>
</tr>
<tr>
<td>TOTAL (&lt;5 weeks fieldwork)</td>
<td><strong>60.18</strong></td>
</tr>
</tbody>
</table>
### Methodologies

**UAV photography/photogrammetry**

<table>
<thead>
<tr>
<th>Site INDEX</th>
<th>Merged photogrammetric patches (hectare)</th>
<th>Hectare coverage per minute</th>
</tr>
</thead>
<tbody>
<tr>
<td>Almiriotiki</td>
<td>20.7</td>
<td>0.56</td>
</tr>
<tr>
<td>Almiros 2</td>
<td>8.12</td>
<td>0.78</td>
</tr>
<tr>
<td>Belitsi</td>
<td>11.73</td>
<td>0.42</td>
</tr>
<tr>
<td>Karatsagliou</td>
<td>13.07</td>
<td>1.58</td>
</tr>
<tr>
<td>Karatsantagli</td>
<td>12.39</td>
<td>1.04</td>
</tr>
<tr>
<td>Zerelia</td>
<td>32.2</td>
<td>0.90</td>
</tr>
</tbody>
</table>

About 1 hectare/minute
Methodologies
UAV photography/photogrammetry

Magoula Almiriotiki
Early Neolithic – Late Bronze Age
Methodologies
UAV photography/photogrammetry

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Methodologies
UAV photography/photogrammetry
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Methodologies
UAV photography/photogrammetry
Software
Software :: Commercial

- Commercial solutions
  - Pix4D
Software :: Commercial

- Commercial solutions
  - MosaicMill
Software :: Commercial

- Commercial solutions
  - MenciSoftware
Software :: Commercial

- Commercial solutions
- Agisoft Photoscan
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
Welcome to the AutoGR Toolkit!

AutoGR Toolkit is a set of small softwares created to automate and speed-up the raster georeferencing procedure. The toolkit is made by 4 main scripts:

**GoogleGrab**
It allows you to save a GoogleMap of the area of interest. Click the button to start >>

**AutoGR-Sift**
Automatically produces a list of points to rectify (in real world coordinates, if available) a given pair of images. Click the button to start >>

**GeoRef Filtering**
AutoGR-SIFT usually produces thousands of points in few seconds and this script helps you reduce this number to a more manageable one. Click the button to start >>

**GeoTiff Converter**
Extracts geographical information from a geotiff file and produces a jpeg with its worldview. Click the button to start >>

Welcome to AutoGR-Toolkit. Have fun!
AutoGR-Toolkit 3.2
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Welcome to AutoGR-Toolkit. Have fun!
AutoGR-Toolkit 3.2

AutoGR: Photogrammetry Tools

- Get X, Y and Z
- Create GCP

This tool opens a Google Map where you can get the elevation for any point on Earth in various EPSG.

If you already processed some images with AutoGR-SIFT, you can use this tool to create the Ground Control Points for VisualSFM.
AutoGR-Toolkit 3.2
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AutoGR :: Photogrammetry

This tool opens a Google Map where you can get the elevation for any point on Earth in various EPSG.

If you already processed some images with AutoGR-SIFT, you can use this tool to create the Ground Control Points for VisualSFM.

Get X, Y and Z
Create GCP
AutoGR-Toolkit – 3D matching
AutoGR-Toolkit – 3D matching

# Each line of the GCP is as follows:

```
# FileName image_point_x image_point_y 3d_point_x 3d_point_y 3d_point_z
IMG_0118.jpg 3860.0 230.0 176736.253 4569746.011 363.95
IMG_0118.jpg 2170.0 2910.0 176683.571 4569889.509 365.76
IMG_0121.jpg 1835.0 245.0 177020.899 4569773.389 371.08
IMG_0121.jpg 165.0 290.0 176988.621 4569651.571 376.56
IMG_0121.jpg 2475.0 2885.0 176860.664 4569674.455 367.32
IMG_0121.jpg 2140.0 200.0 177028.988 4569792.953 369.81
IMG_0121.jpg 765.0 250.0 177002.907 4569700.426 374.16
IMG_0121.jpg 160.0 295.0 176988.621 4569651.571 376.56
IMG_0121.jpg 2355.0 235.0 177030.477 4569808.934 369.62
IMG_0121.jpg 2350.0 235.0 177030.477 4569808.934 369.62
IMG_0121.jpg 3460.0 895.0 177021.120 4569899.165 367.34
IMG_0122.jpg 1810.0 460.0 177020.899 4569773.389 371.08
IMG_0122.jpg 1400.0 375.0 177020.067 4569795.644 372.06
IMG_0122.jpg 2810.0 540.0 177029.690 4569849.459 369.58
IMG_0122.jpg 220.0 485.0 176988.621 4569651.571 376.56
IMG_0122.jpg 270.0 380.0 176996.658 4569650.336 376.27
IMG_0122.jpg 1355.0 295.0 177026.595 4569733.318 371.79
IMG_0122.jpg 215.0 490.0 176988.621 4569651.571 376.56
IMG_0122.jpg 3330.0 1465.0 177008.824 4569937.759 368.46
IMG_0122.jpg 1455.0 415.0 177017.375 4569747.317 372.07
IMG_0122.jpg 3715.0 1105.0 177006.971 4569923.599 367.17
IMG_0122.jpg 930.0 455.0 177002.907 4569700.426 374.16
IMG_0122.jpg 360.0 410.0 176999.948 4569657.573 375.89
IMG_0122.jpg 2280.0 455.0 177030.477 4569808.934 369.62
IMG_0123.jpg 2820.0 675.0 177051.493 4569838.608 367.13
IMG_0123.jpg 1220.0 525.0 177036.290 4569703.521 372.40
IMG_0123.jpg 1760.0 580.0 177039.503 4569754.319 370.17
IMG_0123.jpg 1350.0 605.0 177030.998 4569717.883 371.98
```
AutoGR-Toolkit – 3D matching

3D MATCHING
Converts the 2D matching in 3D GCP
(this function is still experimental)

Choose the processing folder

Input coordinate format (EPSG number)

Output coordinate format (EPSG number)

Altitude values provider: Google API

Required GCPs: 20

Run
AutoGR-Toolkit – 3D matching
Workflow

4-500m
AutoGR-Toolkit – 3D matching
Workflow

- Automatic georeferencing with AutoGR-SIFT
  - 4-500m

- Manual Georeferencing
  - 1-200m (good overlapping)

- Georef. 3D cloud with AutoGR-Photogrammetry (GetZ or GCP creation)
Workflow
Thank you!

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

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