New Perspectives on Neolithic Agricultural Villages in Eastern Thessaly (Greece) through Remote Sensing Applications


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Archaeological Ephorate of Karditsa & Archaeological Ephorate of Magnesia, Greek Ministry of Culture.
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, French’s survey.

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

Status of knowledge of the Neolithic Landscape in Thessaly

http://neolithicthessaly.ims.forth.gr/

Registration and mapping of Neolithic settlements, VHR/HS Space imagery & GIS spatial analyses for Regional site distribution patterns among ecological and topographic zones of Thessaly.

- GPS/Aerial documentation of 342 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.
IGEAN (Innovative Geophysical Approaches for the Study of Early Agricultural Villages of Neolithic Thessaly)

A multi-year Remote sensing fieldwork campaign to study the physical landscape dynamics of Neolithic settlements within the coastal hinterlands of E. Thessaly (C. Greece).

AIMS:
- explore multiple settlements
- extract new archaeological data on an extensive scale
- analyze the broader habitation configurations of the Neolithic agricultural villages.

Successful documentation of the diachronic development of Neolithic sites
- from core habitation mounds ($\leq 1$ hectare) to large, sprawling communities several hectares in size.
Methodologies – Multi-magnetometer Techniques

Sensorik & Systemtechnologie (SENSYS)
MX Compact system

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

Ideal for large-scale scanning

Bartington single sensor unit also in use in thick vegetation areas
Methodologies – Ground Penetrating Radar (GPR) & EMI Techniques

Penetration Depth ~2.5m

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

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

GEM2 - Geophex

CMD Mini explorer – GF Instruments

GEM2: HCP 2.5 m Conductivity / 1.7 m susceptibility

CMD: HCP 2 m Conductivity / 1 m susceptibility
Methodologies – Magnetic Susceptibility Measurements_ Soilscapes

Coring and soil analysis
Bartington MS2B
Low & High Frequency susceptibility & Phosphate analysis

Methodologies – Aerial Photography
Quadrocopter DroidWorx CX4
🔍 DJI navigation, viewpoint and failsafe
🔍 Average altitude 100-200 m above surface
🔍 Autonomy ~13-15min with camera load
## Selected Results

<table>
<thead>
<tr>
<th>SITE</th>
<th>PERIOD</th>
<th>COVERAGE (in hectares)</th>
<th>Magnetics</th>
<th>UAV</th>
</tr>
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<tbody>
<tr>
<td>1 Agios Demetrios</td>
<td>EN, MN</td>
<td>0.39</td>
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<td>2 Agios Nikolaos</td>
<td>LN</td>
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<td>N/A</td>
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<tr>
<td>3 Almiriotiki</td>
<td>EN-LBA</td>
<td>8.38</td>
<td>20.7</td>
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<td>4 Almiros2</td>
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<td>5 Bakalis</td>
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<tr>
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<td>10 Karatsangliou</td>
<td>LN</td>
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<td>11 Karatsantagli</td>
<td>EN</td>
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<tr>
<td>12 Kastro Kokkinas</td>
<td>LN, FN &amp; historical</td>
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<tr>
<td>13 Nikonanou</td>
<td>MN-EBA &amp; Byzantine</td>
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<td>14 Perdika1</td>
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<td>15 Perdika2</td>
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<td>16 Perivlepto Kastraki2</td>
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<td>17 Rizomilos2</td>
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<td>19 Velestino(3) Mati</td>
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<td>4.87</td>
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</tbody>
</table>

**SUM**  
71.29 182.06
Deposition of colloval deposits

Core habitation zone: 15-20 rectilinear structures with high magnetic values (burnt daub made structures). Enclosed by wall fortifications. A few features outside the core habitation zone.

At least 2 circular ditches & multiple possible entrances
EM Susceptibility (HCP for 0-1.7 m depth)

Magnetic susceptibility indicating different usage areas within the settlement?

EM Conductivity (HCP for 0-2.5 m depth)

High conductivity area to the south \Rightarrow possible evidence of flooding susceptibility ??
Nikonanou (MN – EBA)

Close to Velestino 3 (Mati) and Velestino 4 (Visviki) magoules.

- 2-3 fragmented oval enclosures (<3 m wide) around the magoula.
- The outer enclosure defines the boundary between the high and low conductivity zones, suggested from the EMI (GEM-2 and EM31) conductivity measurements.
- Entrances to the NW and SE.
- Built up area confined within the magoula consisting of (burnt) daub based structures.
- Multiple concentric ditches with various breaks that represent entrances.
- Enclosure walls at the center
- Flooding marks
- Another smaller pre-existing settlement to the east with each having its own system of ditches & enclosure walls.
“Satellite” Settlements and Megaron type Buildings?

The geophysical data support the existence of an early more dispersed occupation followed by a more compact habitation area (see the interrupted sequence of the SE enclosures).

This can be also compatible to the finds of the 1941 excavation trench A: the earlier settlement sequence of 2.8 m thickness dates from the end of the EN to the MN period.

1941 excavations by Hans Reinerth: multi-period long house (LN Arapi- and Otzaki-Dimini phases) consisting of a sequence of rooms (a large hearth surrounded by 4 columns similar to a Mycenaean hearth room → one of the earliest so-called megaron buildings)
Magoula Almiriotiki (EN-MN-LN-LBA) – Magnetics

- Extensive settlement built around a core habitation zone on the highest topographic level. The marsh area.
- Structures on the top have high magnetic values (burnt daub made structures).
Magoula Almiriotiki – GPR (depth 0.7-0.8 m)

Details of Structures

- Low magnetic value probably indicates that the structure(s) has stone foundations

- Rectilinear form 38 m x 10 m.

- In GPR, the large “megaron” type structure appears to be formed from three separate structures built side by side.
Magoula Almiriotiki
Early Neolithic – Late Bronze Age

About 30+ burnt daub structures within the magoula.

Outside the core zone:
- 60+ rectilinear structures
- Structures with low magnetic values (stone built) have 2-3 rooms
- Extensive network of ditches (at times double) surround the settlement – multiphase construction.
Extensive settlement (>200\times100m) that greatly expands beyond a core habitation zone on the highest elevation.
- 13 burnt daub structures within the core zone and “empty” area to the East.

- 50+ rectilinear stone-built structures

- The majority of structures have high magnetic values (burnt daub structures), but others have low magnetic values (stone) with 2-3 rooms (similar to Almyriotiki). 3 phases? Co-existence of habitation at various sections but not in the core of the magoula.

- Ditches and or walls preserved on the northern side of the settlement
**Perdika 2**
- Extensive network of enclosures built on a natural hilltop
- A sequence of openings that gave access into the settlement
- Little evidence for individual structures (some have high magnetic values)

**Magnetics**

**EM Susceptibility (HCP for 0-1.7 m depth)**
- Large rectilinear structures with low magnetic value (stone foundations?) were identified with GPR.
Concluding Remarks

Successful Employment of Geophysical and Satellite remote sensing techniques – Importance of using an arsenal of various approaches (manifold geophysics)
What can we get out of these results?

Karatsantagli

Velestino - Nikonanou

Perdika 1

Perdika 2

Velestino - Mati

Rizomilos

Almyriotiki
Extent & Internal Organization of Settlements

Conceptualize a landscape of variation: Similar and divergent characteristics of settlements in planning and structural materials

- Dimension of settlements and structures
- Internal organization of the settlements, clusters of structures
- burnt and unburnt structures / mudbrick & stone structures
- open/unbuilt spaces, pits, a.o.
Neolithic Ditches

- Existence of enclosures: internal fortifications and external ditches
- Sustaining terracing walls at more abrupt slopes and hilly terrains
- Corridors and entrances
Flooding Simulation and flood vulnerability using ASTER DEM

Rizomilos 2

Karatsangliou

Velestino 4 - Visviki

- Existence of ditches in terms to the surrounding geomorphologic features (e.g. proximity to palaeochannels and to prone flood areas).
- Persistence of habitation even in flood prone areas and the existence of multiple enclosures and ditches around these settlements may suggest counter measures against periodic flooding events.
- Does it suggest flood based cultivation strategies?
A New Perspective in the Neolithic Settlement Organization

Implications regarding the chronological continuation of habitation, the persistency in occupation, the sustainability issues, the social organization and relations of the communities in intra site, local and regional level, etc. ➔ still able to make some reconstruction of Neolithic landscape and organization of the settlements.
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