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Third International Conference on Remote Sensing and Geoinformation of Environment' 16-19 March 2015 - Cyprus Workshop / Special Session on 'Remote Sensing and GIS for Archaeology and Cultural Heritage'

NEOLITHIC DITCHES IN THESALLY

Apostolos Sarris, Nasos Argyriou, Tuna Kalayci, François-Xavier Simon, Jamieson Donati, Carmen Cuenca García, Gianluca Cantoro, Meropi Manataki.

Laboratory of Geophysical – Satellite Remote Sensing and Archaeo-environment Institute for Mediterranean Studies Foundation for Research and Technology, Hellas (I.M.S.-F.O.R.T.H.) Rethymno, Crete, Greece











ΥΠΟΥΡΓΕΙΟ ΠΑΙΔΕΙΑΣ & ΘΡΗΣΚΕΥΜΑΤΩΝ, ΠΟΛΙΤΙΣΜΟΥ & ΑΘΛΗΤΙΣΜΟ ΕΙΔΙΚΗ ΥΠΗΡΕΣΙΑ ΔΙΑΧΕΙΡΙΣΗ:

Με τη συγχρηματοδότηση της Ελλάδας και της Ευρωπαϊκής Ένωσης

Water Resources and Archaeology

- Water resources have played a critical parameter in <u>human occupation and the</u> <u>location of the settlements</u> since the prehistoric times.
- Many settlements, especially in prehistoric periods have been located either along the <u>course of main streams or in a close vicinity to them</u>, exploiting <u>the water</u> resources for their immediate needs and for cultivation purposes.
- At the same time this proximity to water resources has often <u>endangered the</u> <u>habitation quarters and even the whole settlement.</u>
- The <u>floodplains of major rivers are dynamic environments</u> and their past study poses particular difficulties.



Fluvial Activities and Archaeology

□ Fluvial activities influence archaeology in two ways.

First, the <u>choice of locations for settlements was part of a cultural</u> <u>formation process</u> predetermined to some extent by the population's understanding or appreciation of local stream activity.

Second, <u>cultural remains and site preservation and ultimately their</u> <u>discovery and recognition</u> may have been affected with stream flow and flooding.

□ The main aims of the study are to <u>develop new methods of investigation and to</u> <u>reconstruct the environmental and settlement history.</u>





Exploration Techniques and Methodological Approaches

Employment of a variety of methods:

Field walking, geophysical prospection, examination of sections exposed in field ditches, and coring for soil and sediment samples.

These methods are complemented by a range of remote sensing techniques: analyses of satellite and aerial photographs and Digital Elevation Models (DEMs).

Reconstructed (from coring) Digital Elevation Models (DEMs) regarding the period, were considered in this study.



Reconstruction of the Künzing-Unternberg rondel, Museum Quintana, Lower Bavaria

http://en.wikipedia.org/wiki/Neolithic_circular_enclos ures_in_Central_Europe#/media/File:Museum_Quinta na_-_Unternberg_1.jpg

Neolithic habitation in Europe Ground zero





Recorded rate of subsidence of 1.5 m/1000 years for the Larisa basin, is important to study flooding susceptibility.



Case study: Thessaly

Neolithic settlements, so called Magoules, were constructed between the Early Neolithic and Bronze Age (6800-3000 BC). ~350 Thessalian tells (magoulas) have been documented in alluvial plains of Trikala and Larissa.





1.5

Magoules: small hills, within the plain, with a relatively few meters height.

@ Magoula Zerelia



Status of knowledge of the Neolithic Landscape in Thessaly

Registration and mapping of Neolithic settlements in Thessaly & GIS analyses for

the <u>management of the</u> <u>natural landscape</u> &

site <u>distribution patterns</u> among ecological and topographic zones of Thessaly.



Ελασσώνα 2

Δομένικο 1,

Γιατιά Μαυούλα Ζά

Βάδια Δασονωρίου 🕰

έφαλόβρυσο 1

αιο Σπαρτιας (Αατ

δινιώτικη Μαγούλα μυριώτικη μαγούλ

ουργαρό

Γόννοι 1 🗠 Ελάτεια:

Πέρδικα, Νταουτζά Ζε σέλια

Καρατσάνταψή

- 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.

IGEAN (Innovative Geophysical Approaches for the Study of Early Agricultural Villages of Neolithic Thessaly) project, is implemented under the "ARISTEIA" Action of the "Operational Programme Education And Lifelong Learning" and is co-funded by the European Social Fund (ESF) and National Resources (2013-2015).

Application of non-destructive, remote sensing techniques

to <u>explore multiple settlements</u> & to analyze the <u>broader</u> <u>characteristics of Neolithic</u> <u>habitation in Thessaly.</u>



The project has been successful in documenting the <u>diachronic development</u> of Neolithic sites from core habitation mounds (≤ 1 hectare) to large, sprawling communities several hectares in size.

Area of interest



Methodologies – Multi-magnetometer Techniques



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

Ideal for large-scale scanning





Bartington single sensor unit also in use in thick vegetation areas

Methodologies – Ground Penetrating Radar (GPR) & Electromagnetic Techniques Penetration Depth ~2.5m



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



GEM2: HCP 2.5 m Conductivity / 1.7 m susceptibility



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

CMD Mini explorer- GF Instruments





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

ø DJI navigation, viewpoint and failsafe

σ Average altitude 100-200 m above surface

 σ Autonomy ~13-15min with camera lond





Almiros 2

Early Neolithic - Middle Neolithic



Almiros 2 – Magnetics

nT/m

High : 50

Low : -50

Mudbrick fragments

Core habitation zone: 15-20 rectilinear structures with high magnetic values (mudbrick)

2 large circular ditches & multiple possible entrances 20 40 80 m

Almiros 2 – EM Conductivity (HCP for 0-2.5 m depth)





Magoula Rizomilos 2– Magnetics

Multiple concentric ditches with various breaks that represent entrances.

Another smaller satellite or older settlement to the east



Magoula Rizomilos 2- Magnetics



Magoula Almiriotiki

Early Neolithic – Late Bronze Age





Magoula Almiriotiki – Magnetics

-core habitation zone on the highest topographic level
- 60+ rectilinear structures (mudbrick and stone structures)

- Extensive network of ditches





Magoula Nikonanou – Magnetics & EM

Magoula Velestino 4 – Visviki - DEM



A low cost approach to assess flood vulnerability using ASTER DEM.



Geomorphometric information using ASTER DEM

The *Topographic Wetness Index (TWI)*, determines the spatial **distribution of soil moisture** and surface saturation. V-shaped valleys (tectonic active) vs U-shaped valleys (erosional dominated).

- **Region** A: high values of TWI (flat surface with high moisture accumulation and alluvial deposits).
- **Region B:** high values (but lower that region A due to lower stream ordering and water discharge).
- **Region C:** intermediate to low values, revealing steep slopes, major longitudinal ridges and V-shaped valleys.



<u>Slope gradient (Sg)</u>, shows maximum slope steepness ie. the change in elevation between each cell and its neighbors.

- Region A: flat regions
- **Region B:** foot slopes
- **Region C:** undulating terrain & intermittent valley zones; rolling plains
- **Region D:** escarpments & dissected ridges.





Predictive floodplains

Based on <u>selected threshold values</u> in order to isolate the information of the DEM derivatives being relevant to flood impact, the <u>final prone</u> floodplains were determined.

Weighted overlay approach & Analytical Hierarchy Process (AHP) were employed for the definition of the weights.



Flooding zones

- The reconstructed ASTER DEM was used to "flood" the region.
- Flooding zones of 1m & 3m were created and most of the magoules remain flooded.
- Based on the geophysical prospecting, a significant number (if not all) of Magoules characterized by ditches were found within those flooding zones.



Concluding Remarks

- Conceptualize a landscape of variation: Similar and divergent characteristics of settlements in planning and in structural materials
- Internal organization of the structures, clusters of structures
- Corridors and entrances
- Existence of enclosures (ditches/fortifications)
- In areas where frequent or periodic flooding could have been anticipated, it is possible that Neolithic people might <u>have applied variable criteria in choosing</u> sites for temporary or for long-term occupations almost always in close proximity to palaeochannels.
- Manifold geophysical prospection approaches indicate a <u>persistence of habitation</u> <u>even in flood prone areas</u> and the existence of multiple enclosures and <u>ditches</u> <u>around these settlements may suggest counter measures against periodic</u> <u>flooding events.</u>



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