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Integrated GIS, remote sensing and geomorphologic approaches for the reconstruction of the landscape habitation of Thessaly during the neolithic period

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ABSTRACT

The aim of this study is to manifest the contribution of integrated approaches such as GIS, geomorphology, remote sensing and DEM analysis for the detection of neolithic settlements, the modeling of habitation and the reconstruction of neolithic landscape in the area of Thessaly.

Thessaly is a region of low relief in central Greece where hundreds of neolithic settlements called *magoules* were established from Early Neolithic period until Bronze Age. In this study field survey, statistical analysis of coring data, spatial analysis of environmental parameters in GIS and image processing techniques of satellite images and DEMs were carried out to contribute to the detection of the Neolithic settlements and the reconstruction of Neolithic landscape.

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1. Introduction

The three main applications of GIS in archaeology are visualization, spatial analysis and modeling (Church et al., 2000). Additionally, archaeology has become a recent application field for satellite remote sensing and nowadays ancient settlements are able to be detected with high resolution remote sensing techniques (Menze and Sherratt, 2006).

Neolithic Thessaly has been studied for understanding human partitioning and territoriality of the landscape by non-hierarchical human groups. The distinct natural features of the Thessalian landscape are ideal for reconstructing the major habitation patterns of the first Neolithic farming groups of Greece. Thessaly is a region of low relief with great alluvial plain, where hundreds of Neolithic settlements/tells called *magoules* were established from Early Neolithic period since Bronze Age (Alexakis et al., 2008).

In order to proceed with an integrated geo-archaeological research, multiple methodological approaches were employed. Field survey, analysis of stratigraphic coring data, spatial analysis of environmental parameters in GIS environment and satellite image processing were carried out to cover the extensive study area and contributed to the detection of the low relief Neolithic settlements. The fusion of all these data with the digital elevation model (DEM) is capable of providing detailed information for archaeological purposes (Siart et al., 2008). Thus various digital elevation models were reconstructed for each period of the Neolithic, which were ultimately used in the corresponding spatial analysis of the landscape.

At the final stage, predictive models were created to contribute to the detection of unknown settlements. The models that are frequently used to forecast the location of archaeological sites belong to the methodologies of archaeological prospection and are frequently used in archaeological studies (Espa et al., 2006).

2. Study area, data and methodology

Thessaly is an extensive plain region located in Central Greece. It is surrounded by the mountains Antichasia, Ossa, Maurovouni, Pelion, Othris and Pindus. The Neolithic settlement mounds called magoules are low hills of 1–5 m height and mean diameter 300 m. The mounds mainly consist of loam and mud based materials. The vast majority of magoules are laid on Larisa basin and with a smaller number distributed in west Thessaly (Karditsa basin).

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Both of these plains consist of Quaternary alluvial deposits (Alexakis et al. 2009).

Initially the study involved detailed modeling of the Thessalian landscape by incorporating 3 different modules:

- Topographic mapping of the settlements through the use of Global Positioning Systems (GPS). The particular task was carried out to map a large percentage (more than 342 settlements) of the existing archaeological sites (Fig. 1).
- Digitization of 1:50,000 scale topographic and geological maps (Fig. 2) of the Geographic Service of the Hellenic Army and of the Institute of Geological and Mineral Exploration respectively. The original Digital Elevation Model (DEM) of the study area with a cell size of 20 m was based on the digitized 20 m elevation lines of the topographic maps. The geological formations of the geological maps were reclassified to form a unified set of formations and all the further details of the above maps, such as rivers, lakes, faults and modern villages were also superimposed on the particular background layers.
- Construction of a detailed archaeological and environmental database in SQL environment (type of site, chronological phases, type of raw materials present in the sites, height, diameter, geology, vegetation, etc).

3. Landscape reconstruction

Before proceeding to the landscape reconstruction of Thessaly during the various phases of the Neolithic period, the reliability and accuracy of the existing terrain model was evaluated compared to other digital elevation models, such as the 90 m pixel size DEM from the Shuttle Radar Topography Mission (SRTM) and the 30 m pixel size DEMs provided by ASTER images or constructed by the L1-A stereoscopic products (3N and 3B) of ASTER satellite. The equation of Schumann et al. (2008) was used to check the validity of DEMs by comparing a number of reference points (datum points):

$$\mathrm{RMSE}_{\mathrm{DEM}} = \left(\sqrt{\sum E_{\mathrm{R}} - E_{\mathrm{DEM}}}\right)^2 / n$$

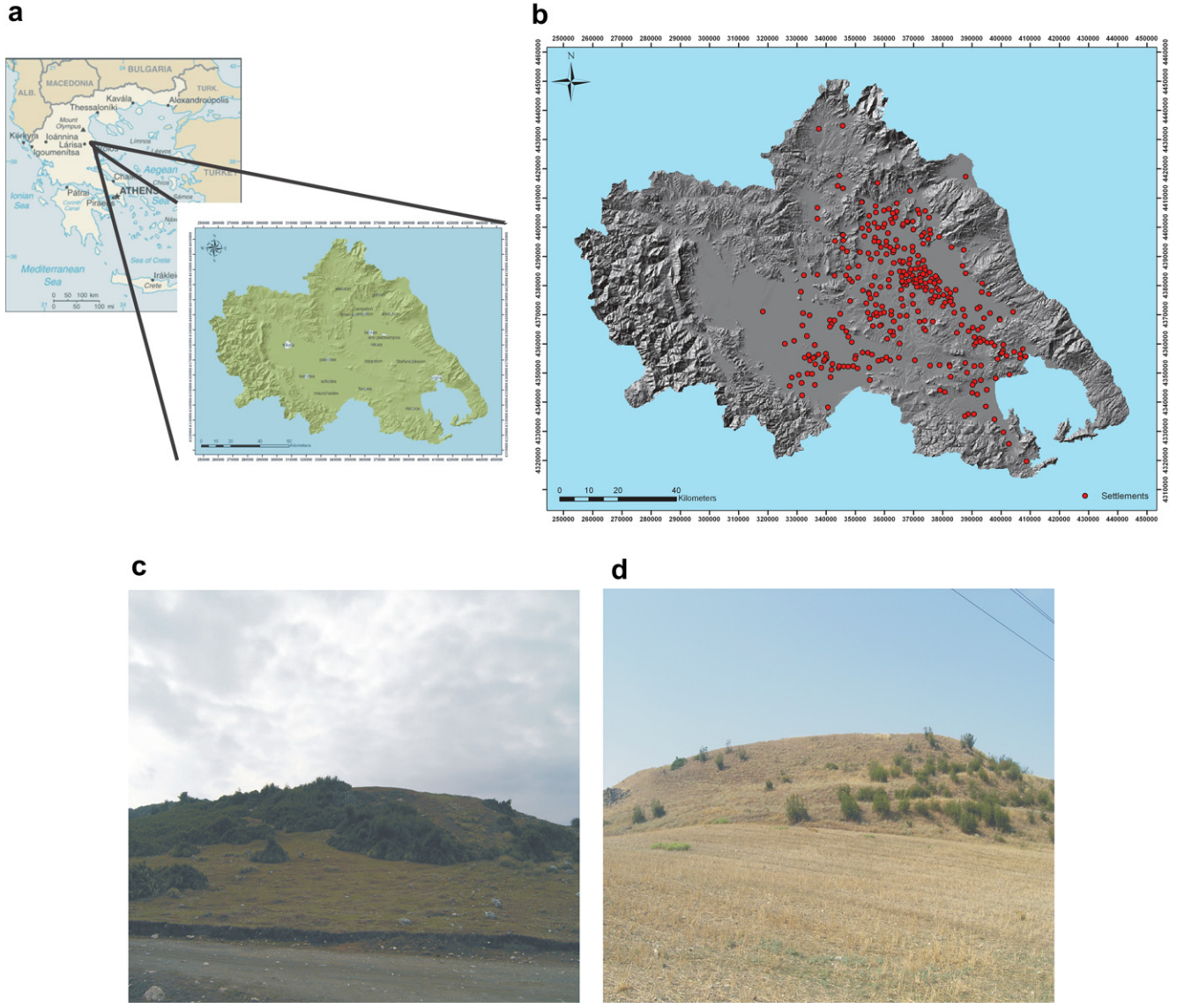

Fig. 1. (a) Thessaly is located in central Greece and constitutes the larger agricultural plains of it. (b) Spatial distribution of magoules in Larisa (east) and Karditsa (west) basins. (c) magoula Rini. (d) magoula Aerino.

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