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SISTEMI CENTURIALI E OPERE DI ASSETTO AGRARIO TRA ETÀ ROMANA E PRIMO MEDIOEVO

ASPETTI METODOLOGICI, RICOSTRUTTIVI E INTERPRETATIVI

THE APPLICATION OF CENTURIAL SYSTEMS AND METHODS OF AGRARIAN ORGANISATION FROM THE ROMAN PERIOD TO THE EARLY MIDDLE AGES

BORGORICCO (PADOVA) - LUGO (RAVENNA)
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I

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SOMMARIO

METHODOLOGICAL INSIGHTS INTO THE STUDY OF CENTURIATED FIELD SYSTEMS: A LANDSCAPE ARCHAEOLOGY PERSPECTIVE

Hèctor Aleix Orengo · Josep Maria Palet Martínez*

The morphological identification of centuriated field systems has been characterised from its beginning by methodological approaches mainly sustained on *actus*-based modular relationships and orientations. Many researchers dedicated to the identification of centuriations have only performed archaeomorphological analyses based on interpretation of aerial photographs and maps without field verification or any other proof of the validity of their hypothesis. Their restitutions consisted of a set of lines over a map or an aerial photograph which often lacked precision and spatial resolution.

This article argues that the study of centuriations should transform its aims, scope and methodologies to be converged with those presented by diachronic trans-disciplinary landscape archaeology. In order to do so a series of integrated methodological approaches are exposed and their applicability discussed.

Introduction

Leaving apart the well preserved examples of Italy and Northern Africa, the archaeological analysis of centuriations has been centred on the identification of the traces present in the modern landscape whose morphological origin can be dated back to Roman times. In this sense, the morphological identification of centuriated field systems has been greeted with scepticism by much of the archaeological community and it has also received criticism from within their own discipline.[1] The lack of a consistent methodological approach which could confidently identify centuriated traces has probably been the main reason.

It is argued in this article that the sole morphological identification of centuriated field systems is an incomplete procedure which can lead to a continued dismissal of the discipline. In this sense, a landscape archaeology perspective becomes very useful in order to study centuriated landscapes from a diachronic approach. The study of landscape dynamics can add a necessary chronological depth which will allow to distinguish Roman traces from those previous or later in time.[2]

Landscape archaeology will also provide the necessary methods and techniques to identify traces with high precision even in the cases where they may not be visible to the naked eye. Lastly, to adopt a landscape archaeology perspective will grant the necessary theoretical background to interpret centuriated field systems not only through materialistic and economical factors but also by ecological and symbolic ones.

During the 1980s, the Besançon Group (University of Franche-Comté, France) developed a series of techniques aimed at identifying centuriated grid systems by their ori-

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[1] Fiches 1996; Favory 1997; Chouquer 2000; Leveau 2000.

[2] Leveau 2006.

entation and by the proportions of *centuriae* with modules based on multiples of the Roman *actus*, a length normally in the range 35.0 m to 35.6 m.[1] These centuriations were identified in the modern landscape by carto- and photo-interpretation. Unfortunately, although this approach, mainly developed among French researchers, helped in identifying several centuriations in France and other Mediterranean regions, in some cases the hypotheses have been proven by archaeological evidence to be false. This failure to identify centuriated systems with certainty has sometimes resulted in the dismissal of photo-interpretation approaches and lack of confidence in the methodological approaches originally developed by the Besançon Group.[2]

This might be the reason why the 1990s were characterised by research that was more conscious of interpretative and chronological problems as well as of methodological approaches. This is reflected in a more careful use of the modular approach and in the development of the archaeology of field systems that analyses the archaeomorphological sequence from a long-term perspective.[3] In addition, the incorporation of archaeological, historical and environmental data has been extremely useful.[4] New techniques were also incorporated in research methods. Geographic Information Systems (GIS) have provided an increase in accuracy and reliability in the location of ancient traces.[5]

From a conceptual point of view, the study of centuriations has also experienced a significant shift. Marxist interpretations with a pronounced economic slant were preponderant throughout French research during the 1980s. Although some groups still support economic and materialistic positions,[6] other specialists have changed their focus towards more social and ideological explanations.[7] Nevertheless, the study of centuriated systems is still grounded on materialistic premises. Economic factors linked to the process of land division draw most researchers' attention.[8]

Methodological approaches to the archaeomorphological identification of centuriated field systems

Archaeomorphological basis

First of all the research should focus on landscape morphological dynamics from a long-term perspective, even if the traces restored do not form part of a centuriation grid.[9] Selected traces are often 'dominant' axes, which carry some 'morphogenetic' character. This means that they have subsisted in the landscape throughout different historical periods, beyond their date of creation, conditioning the orientation of the surrounding field systems.[10] Archaeomorphological restitutions based on this approach usually present continuous lines which vertebrate the landscape, communicating traces which could have been originated in different chronological periods. In this sense, it should not be forgotten that archaeo-morphology studies the modern landscape and therefore only the traces which have kept their use through time have been preserved.

[1] Clavel-Lévêque 1983; Chouquer *et alii* 1987.

[2] Clavel-Lévêque 1993, p. 18; Peterson 1993, p. 55, note 52; Fiches 1996; Chouquer 2000; Ariño *et alii* 2004, p. 61.

[3] Chouquer (ed.) 1996-1997.

[4] Palet 1997.

[5] Romano, Tolba 1996; Romano 1998; Peterson (ed.) 1998a.

[6] Prieto 2002; Arrayás 2005; González Villaescusa 2007; Prieto 2008.

[7] Chouquer 2003a.

[8] Leveau 2000.

[9] Chouquer 1997; Chouquer 2000; Chouquer 2003b.

[10] Favory 1996; Favory 1997.

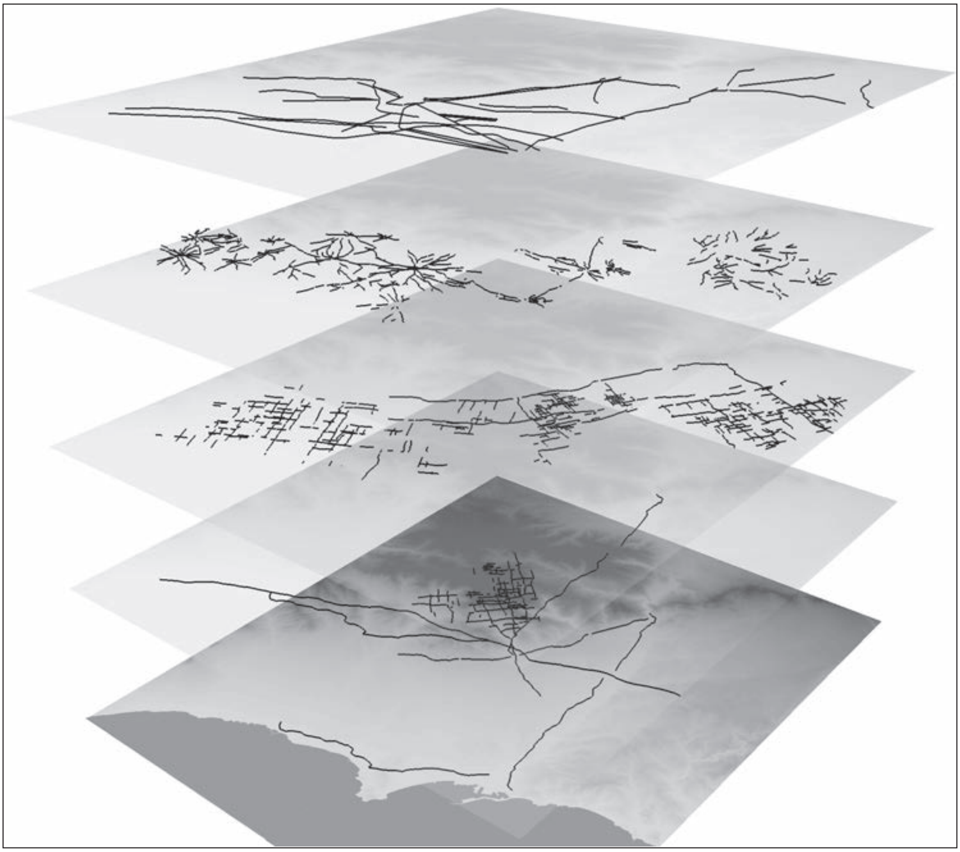

FIG. 1. An example from the *ager Tarraconensis* of diachronic GIS-based archaeomorphological analysis in which several time-ordered road-networks can be appreciated.

On the contrary, restitutions based on more traditional approaches usually present a multitude of short discontinuous lines with no morphological sense.

The importance of identifying not only centuriated, but all road networks and field systems is evidenced by the fact that it becomes possible to establish a relative chronological sequence[1] (FIG. 1). After having selected and progressively dismissed modern morphologies, the more ancient ones become increasingly evident within their coherent setting. This methodology forms the basis of regressive landscape analysis.[2] The chronological sequence that connects different systems can be evidenced through processes such as the 'erasure' of older systems by subsequent ones or the 'seizure' of ancient but still active traces which alter their itinerary to adapt to the new morphological system. These relationships can help to isolate a synchronous morphologic system and date it according to previous and subsequent systems.

[1] VION 1989; ARIÑO *et alii* 2004.

[2] ROBERTS 1987; PALET 1997, pp. 32-33.

Archaeomorphology in a GIS environment

In the last years Geographic Information Systems (GIS) have been widely incorporated in the archaeological study of landscapes. They provide a frame in which all the geographically referenced information necessary to conduct archaeomorphological research can be included and analysed in a multilayered and multiscale environment. They also provide easy and effective management of the data, excellent graphical output and, above all, high spatial accuracy.

The first step to conduct GIS-based archaeomorphological analysis is to develop a custom geo-database. All geographically referred information relevant to the morphology of the study area should be incorporated in the geo-database. It could include orthophotographs, but also different map types, cadastral information, and the location of archaeological sites. Traditionally much archaeomorphological research has been exclusively based on the analysis of aerial photographs, without correlating the results with other geographically referred data. This approach has too often ignored the fact that aerial photographs present deformations caused by the camera lens. These can be considerable at the edges of a photograph. The exclusive use of these photographs to analyse the ancient landscape morphology is an erroneous practice which can lead to faulty results. It becomes evident when this approach is applied to centuriated field systems, a discipline partially based on metrological analysis. The detection of centuriated grids as a result of such procedures should be considered as potentially unreliable.[1]

In order to avoid such deformations it is necessary to orthorectify the aerial photographs and, in doing so, transform them in orthophotographs (FIG. 2). There are several methods and programs that perform different orthorectification procedures. In general, it is necessary to incorporate information relative to the camera (focal length, principal point, resolution, lens distortion, fiducial marks coordinates etc.), many ground control points (GCP) that appear in the photograph and whose exact geographic location is known, and a high definition digital terrain model of the area covered by the photographs. Depending on the scale and quality of the photograph, it is possible to obtain RMSE values under 5 m.

The incorporation of maps also requires certain treatment, depending on the map quality (precision, scale etc.), its projection and geographic parameters: it would only need a reprojection or a geographic transformation and a couple of GCPs to be correctly georeferenced (FIG. 3).

Digital data, mainly provided by public agencies, on the contrary, generally include the necessary geographic parameters for the GIS to automatically include them, thus saving much time and preventing potential mistakes. In this respect, the spread of web map services (WMS) has provided an easy tool for the incorporation of reliable geographic information which can improve the quality of GIS-based archaeomorphological restitutions.

Another element which can be considered of interest is the digital terrain model (DTM). Digital terrain models can be employed in performing GIS-based topographic analysis, such as the modelling of least cost routes, viewshed analyses, flood or erosion modelling etc. These can be useful in studying the genesis, development and taphonomic processes of the study area morphology. There has been some discussion on the

[1] Examples can be found in OLESTI 1995; ARRAYÁS 2005; DECRAMER *et alii* 2006; GONZÁLEZ VILLAESCUSA 2007.

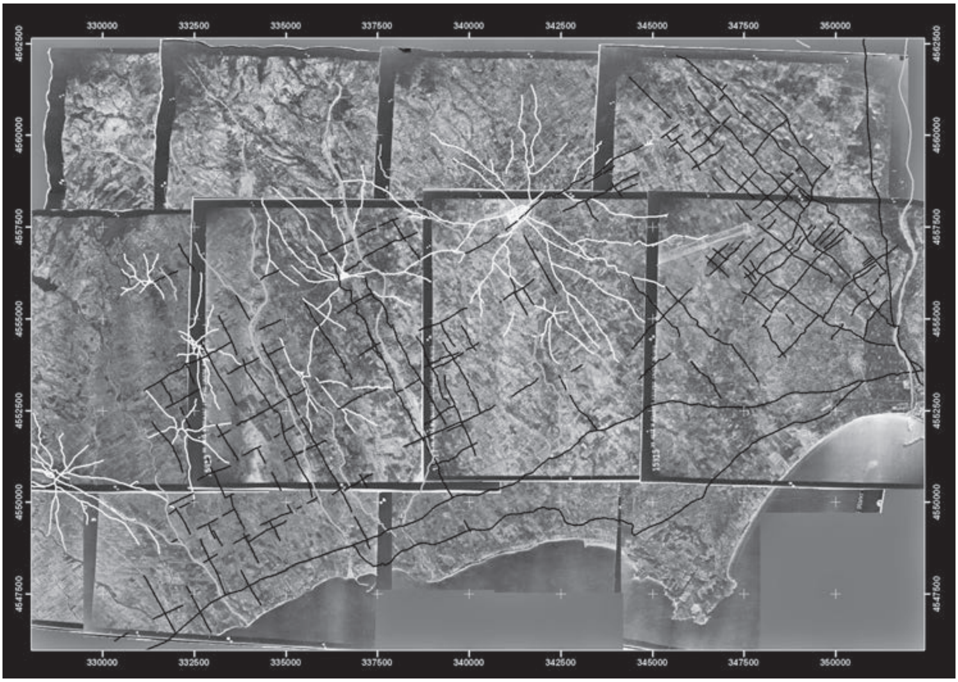

Fig. 2. An example from the *ager Tarraconensis* of archaeomorphological restitution on orthorectified aerial photographs. Note the deformations present at the corners of the photographs.

characteristics a DTM should match in order to be applicable to archaeological analysis. Mainly, it should have enough spatial definition to reflect the smallest type of features which could influence the study area morphology. In the case of Mediterranean alluvial plains it is recommended a definition of 5×5 m/cell which would reflect ravines and other morphogenetic features influencing the study area morphology. Another issue is the appropriateness of employing DTMs developed from modern topographies to analyse archaeological landscapes. The severe landscape change occurred during the XXth century justifies such apprehensions. In order to compensate this change some methods can be employed such as the development of models from old aerial stereopairs[1] (Fig. 4) or digitising ancient detailed topographic maps.[2]

Once the geographic database is developed and all the elements classified by types and dates, GIS-based archaeomorphological analysis can be performed. In order to do so the most straightforward approach is the creation of a polyline vector layer in which the result of the archaeomorphological analysis will be stored. In this respect, GIS vector layers can be linked to a database. This feature is extremely useful in the restitution of traces because it allows the integration of data relative to the source employed in the restitution, such as its reliability or its date. It is also possible to include information about the trace, such as its orientation, depth, associated features, proposed chronology etc.

[1] Orengo, Ejarque, Albiach 2010.

[2] Miró, Orengo 2010.

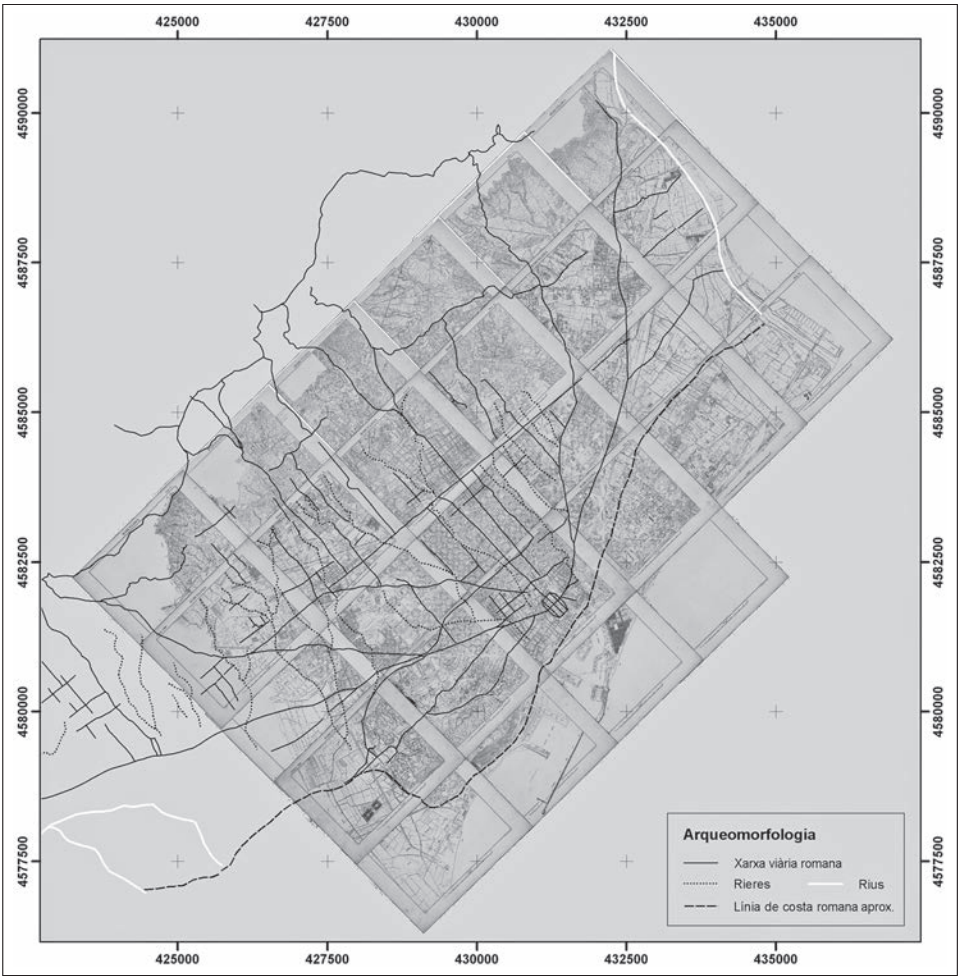

FIG. 3. An example from the *ager Barcinonensis* of archaeomorphological restitution on georeferenced old maps.

Other archaeomorphological analysis

Geophysical survey has been very much applied to locate subsurface structures. Leaving aside the discussion about which technique may be more appropriate in the different environmental settings, its efficiency in this respect has been repeatedly proven. The application of these techniques within archaeology has been mainly directed towards the location of archaeological structures. Taking into account the spatial scale of landscape macrostructures, geophysical survey can provide a much needed tool in the location of buried roads and field boundaries.

During the last years the analysis of multispectral images (from satellite or aerial platforms) has been incorporated in the archaeomorphological research.[1] These images

[1] DONOGHUE *et alii* 2006; ORENGO, EJARQUE, ALBIACH 2010; ORENGO, PALET 2008.

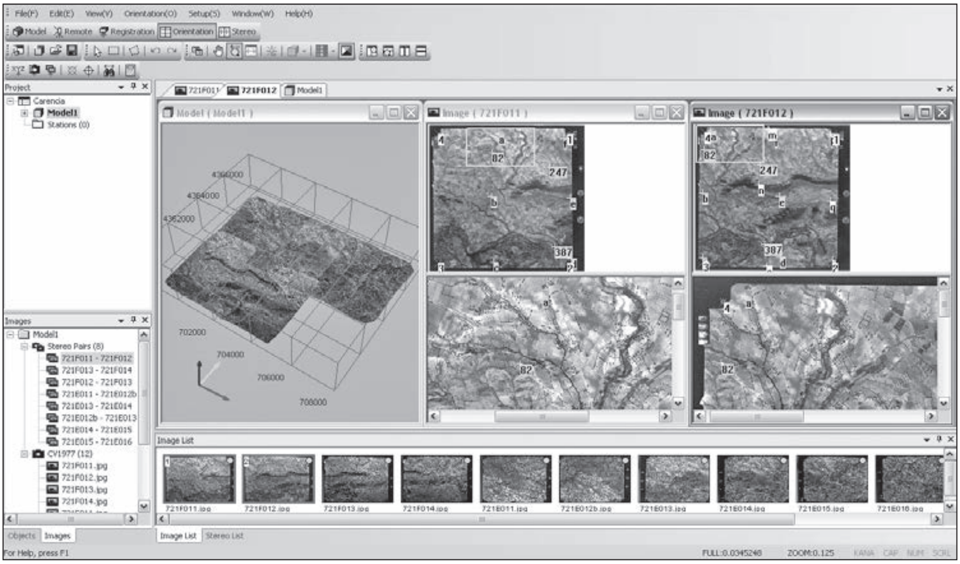

Fig. 4. An example of the creation of a DTM from aerial stereopairs.

Fig. 5. Identification of centuriated lines through the filtering of a Landsat band 5 image. One of those traces can also be appreciated in a short wave infrared aerial photograph.

can locate traces which are otherwise not detectable in the visible range of the electromagnetic spectrum (Fig. 5). Each band can be treated or even filtered to improve its contrast and the visibility of the traces.

Despite their spatial scale has not allowed their direct archaeological use, radar images have a great potential in detecting hidden traces thanks to their ability to penetrate vegetation cover[1] and, under special conditions, soil surface.[2]

Microrelief detection is another technique with great applicability in the detection of archaeomorphological traits. Light Detection and Ranging (LIDAR) allows the creation of such highly defined microrelieves that it is possible to identify ancient field limits, and roads. LIDAR has already proven its utility in mapping the *ager Faliscus* road-system.[3] The use of stereophotogrammetry-based microrelief detection has also proven its utility in the detection of buried roads (Fig. 6). Although much cheaper than LIDAR, these microre-

[1] Parcak 2009, p. 78.

[2] El-Baz, Robinson, Al-Saud 2007.

[3] Cifani, Optiz, Stoddart 2007.

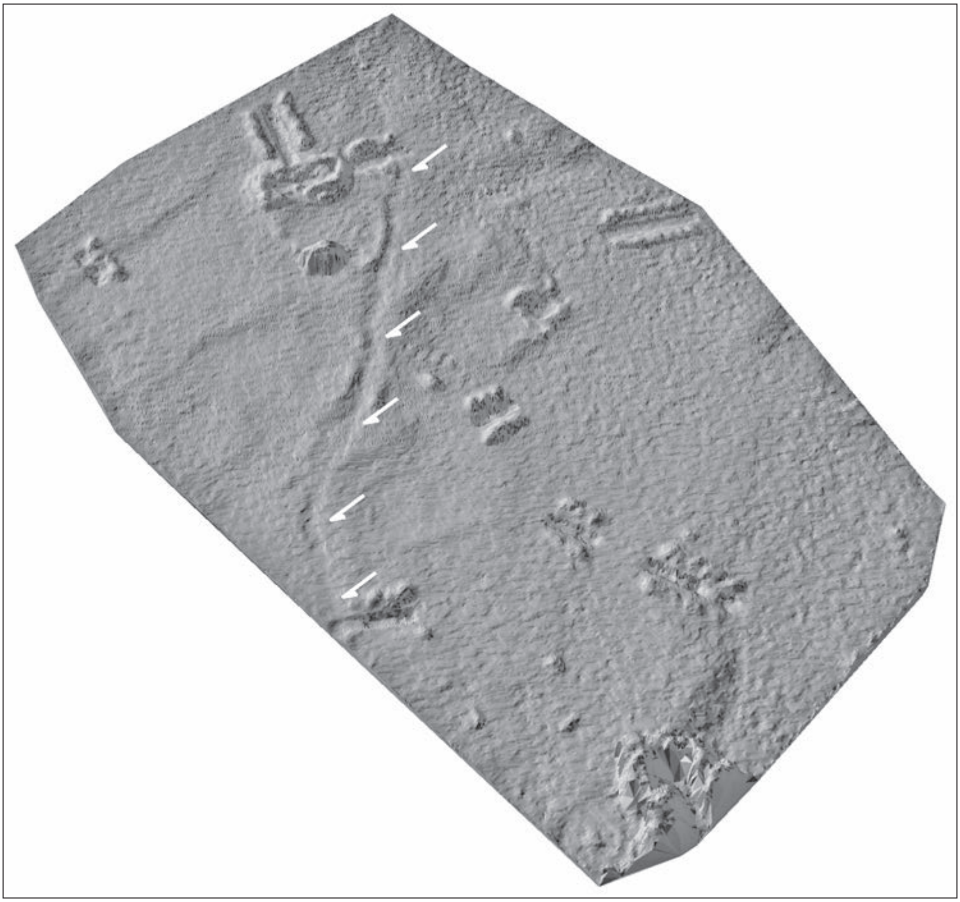

Fig. 6. Microrelief developed from kite aerial photographs in which a buried path can be clearly appreciated. Vilalta site (Targasonne, France), Olivier Passarrius (director, Pôle archéologique - Conseil Général des Pyrénées-Orientales), Carine Calastrenc (photographs, FRAMESPA-CNRS), Hèctor Orengo (photogrammetrical analysis, GIAP-ICAC).

lieves cannot be continuous or systematically applied to centuriated areas since it would imply the treatment of large amounts of data.

Another GIS-specific technique which can be applied to archaeomorphological studies is least cost route analysis (LCR) which suggests the best route given a cost surface that specifies the cost of going through the different areas of the landscape. Slope has traditionally been employed as a major indicator in the generation of cost surfaces but other factors such as rivers, bridges or wetlands can also be added to the model to increase or reduce the cost of passing through certain areas. The great multiplicity of the factors taken into account when planning the setting of a Roman road is reflected in the complexity of the cost models found in relevant archaeological literature.[1]

[1] De Silva, Pizziolo 2001; Van Leusen 2002; Fiz, Orengo 2008.

Another topography-based analysis is viewshed analysis. It shows which parts of the landscape are visible from a specific spot. It has been specifically employed in studying the conceptual basis behind the genesis of centuriated field systems.[1]

Topographic environmental analysis can also provide a good basis for explaining the area morphology and occupation. Some of these can be erosion analysis, somewhat hampered by the inherent difficulties of applying it to model past erosion, or flood analysis with some examples of its archaeological applicability already published.[2]

The archaeomorphological survey

A purposely designed archaeomorphological survey becomes necessary in order to evaluate the different hypotheses drawn by the archaeomorphological analysis. This survey should aim to evaluate the documented traces, their morphology and the stratigraphic relationship among them, but it should also identify all those structures and material dispersions associated to them. Some of these can be topographic markers, boundary markers, milestones, division walls, bridges but also ceramic spots or standing archaeological structures. It allows ascribing chronologies to some traces by associating them to datable structures. It is also useful in rejecting evident modern traces. Finally, it permits the establishment of relative chronological relationships among traces.

Testing the centuriation proposal

There are several ways to test the reliability of a centuriation proposal. This article argues that, to do this, it is not sufficient to measure the distance between the axes and to observe that they are constant and a multiple of the Roman *actus*. Open area archaeological excavation constitutes the most reliable proof of the existence of a centuriation, although there are currently few examples.

The research must also take into account the sedimentary and erosive processes that modify the visibility of the archaeological record. In alluvial plains, the sedimentary covering of ancient roads and field boundaries may allow the archaeological excavation of the traces.[3] Conversely, in other cases, erosion may occur (deep paths, pits etc.), greatly hindering archaeological validation. Such eroded surfaces have been documented in most centuriated landscape of the *ager Tarraconensis*, where Roman soil levels are hard to find.[4]

For this reason, alternative ways of assessing the reliability of the centuriation hypothesis have also been employed. The most common is to superimpose well known archaeological data onto the located traces in order to measure the proximity between them.[5] Among these test data, the main relevant structures are those connected to road networks or agricultural arrangements, which form part of centuriated systems, such as milestones or funerary monuments (both directly related to roads), but also settlement or agriculture-related structures.

In this respect, researches must be cautious when using institutional archaeological site records. Many of the official sources regarding the location of sites contain consid-

[1] Palet, Orengo, Fiz in press; Fiz, Palet, Orengo in press.

[2] Gillings 1998; Fiz, Orengo 2008; Orengo, Ejarque, Albiach 2010.

[3] Berger, Jung 1996; Berger 2003.

[4] Palet 2003.

[5] Peterson 1998b, p. 111.

erable deviations. This is often caused by the use of small scale maps which may lead to inaccurate placements instead of GPS measurements of the site location. It should not be forgotten that the introduction of GPS is a very recent development and site records can be full of outdated registers that were introduced when the most common type of cartographic source was the 1:25.000 and 1:50.000 topographic map series. Therefore, the unquestioned correlation between site locations obtained from institutional records to the archaeomorphological analysis needs to be discouraged since it can lead to faulty results.[1]

Another way to test a centuriation proposal consists in measuring the orientation of the different structures excavated within the centuriated area and comparing them to the orientation of the grid axes, seeking significant coincidences. Elements with clear orientation such as roads, aqueducts, field boundaries or planned settlements can be employed.

Beyond a purely archaeomorphological identification

The incorporation of written sources

Written documents have demonstrated their utility in regressive archaeomorphological analysis.[2] Documents referring to different forms of land management such as donations or sales become especially useful since they take good care of defining the land limits clearly. The limits can consist of landscape features such as roads, aqueducts or other identifiable landmarks. Other types of written sources which provide information are inheritance documents, foundation documents or cadastral documents. Although written sources only provide *post quem* dates, they should be sufficient to obtain a chronological frame where the traces documented in written records and their associated morphology can fit.

The incorporation of environmental sources

Environmental sources are essential in the identification of ancient morphologies, but they can also provide important data related to human-environment relationships. Disciplines such as palinology or sedimentology can offer important insights on the effects a *deductio* had on the landscape.[3] They can also help in reconstructing ancient landscapes and delimiting those areas subjected to human action (Fig. 7). The combination of landscape-oriented disciplines with those analysing human deposits such as carpology or anthracology provides an appropriate frame to develop hypothesis on how humans managed the landscape. They are also a valuable counterpart to the general view on the landscape provided by palinology. An ample knowledge of palaeoenvironmental settings of the study area is basic to carry out satisfactory archaeomorphological analyses.[4] Therefore, ignoring them could lead to erroneous restitutions. Examples of such analysis can be found in González Villaescusa 2006 (fig. 3) with the restitution of traces at the littoral lagoon of La Albufera that used to be much larger in Roman times than it is now. Another example is the proposal of the Roman desiccation of a hy-

[1] An example can be found in Arrayás 2005, pp. 368-386.

[2] Palet 1997.

[3] Palet, Riera 1994; Berger, Jung 1996; De Dapper, Vermeulen 2002; Dall'Aglio, Franceschelli 2007; Franceschelli 2009; Palet, Riera 2009.

[4] Berger, Jung 1996; Franceschelli, Marabini 2007.

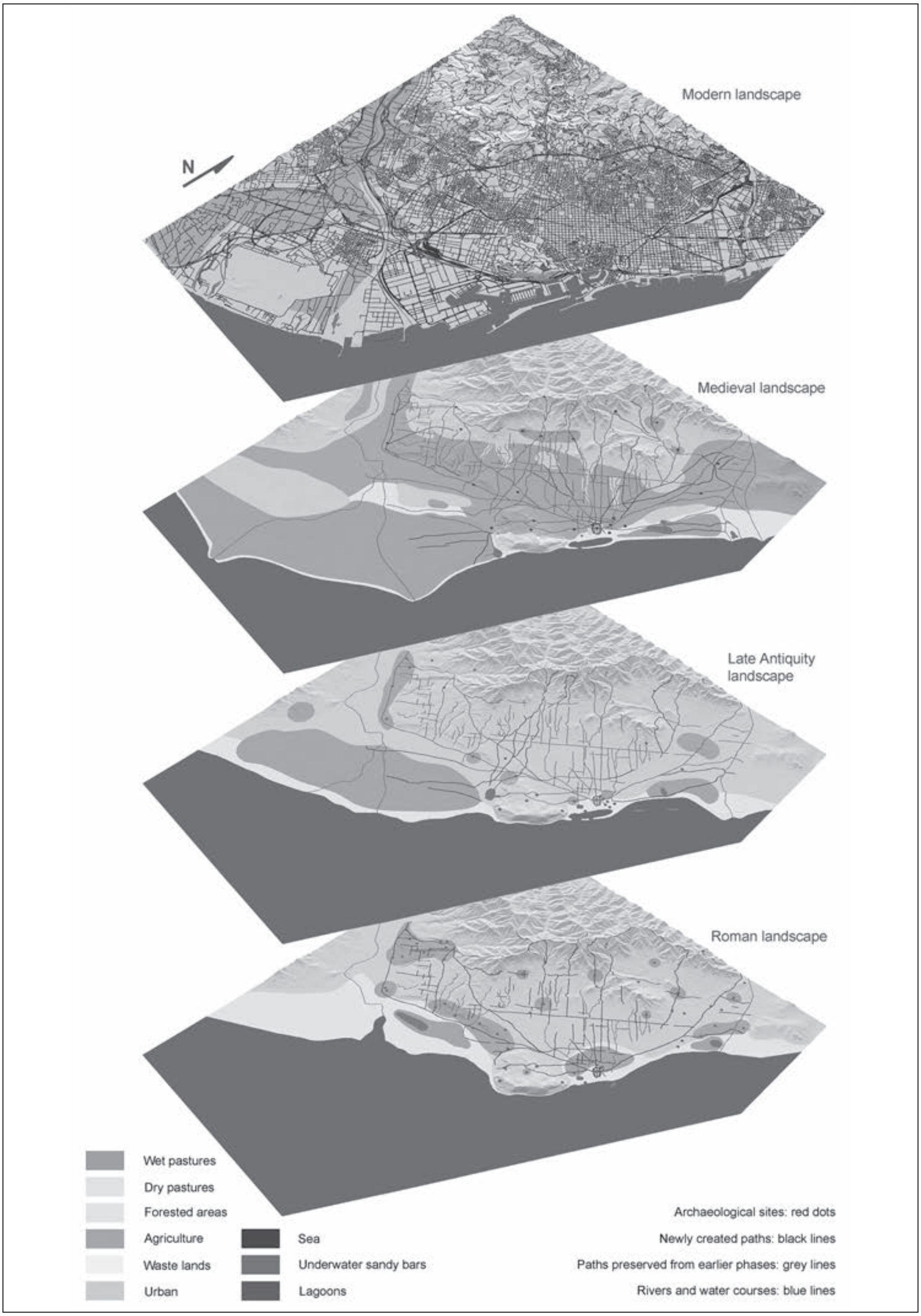

FIG. 7. Example from the *ager Barcinonensis* in which it can be appreciated how the combination of palaeoenvironmental data, archaeological data and archaeomorphological data can offer hypothesis on the diachronical configuration of landscapes.

pothetical wetland in the area occupied by the centuriation of *Ilici*.[1] Both the city and its territory are located on the alluvial fan of the Vinalopó River, a fact that renders impossible the existence of a wetland in the area. These study cases illustrate the difficulty to perform archaeomorphological analysis outside the framework of transdisciplinary landscape archaeology.

Conclusions

Although centuriation was only one form of Roman land division system, its thorough impact on the landscape and visibility in modern land arrangements make it the most commonly recognised expression of Roman landscapes. However, the accurate identification of centuriated field systems is a complex and difficult task which needs the concurrence of many disciplines and techniques in order to offer reliable results. Until recently many researchers have been working in isolation, employing questionable methodologies without offering proof of their hypotheses. During the last years there has been a growing interest in developing new landscape-based methodologies and approaches. Archaeomorphology has been integrated with other techniques, mainly palaeoenvironmental research, increasing the quality and analytical depth of these studies. This will, in turn, result in a renewal of a discipline which has been severely criticised during the last decades.

In this article some integrated methodological approaches have been briefly explored to offer an overview of how adopting a landscape archaeology approach can help in diachronic archaeomorphological analyses.

The study of centuriations needs to move forward by adopting landscape archaeology aims and methodologies. It is thus necessary to integrate transdisciplinary and diachronic approaches in order to produce reliable results and contextualise this research in a meaningful framework.

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[1] Mayer, Olesti 2001; González Villaescusa 2008.

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